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The British Empire Exhibition, 1924.

THERE is to be held, from April to October 1924, in Wembley Park, six miles by road from the Marble Arch, London, on ground occupying about 150 acres, a great exhibition displaying the immense resources, both industrial and productive, of the British Commonwealth, which now extends over one-quarter of the known surface of the globe and has a population exceeding one-quarter of its inhabitants. Its main purpose is to promote the exchange of raw material and manufactured goods within the Empire, an entirely worthy object. As the prospectus says, "We possess every kind of climate, every kind of mineral wealth, every potentiality that is known to the world. We have the best race of men to use and develop them." Under the present seriously disturbed commercial conditions, the value of the general trade of the United Kingdom in 1921 was, of imports, 1,085,500,061*l.*, of which the British Dominions supplied 303,859,326*l.* and foreign nations 781,640,735*l.*, and of exports 810,318,848*l.*, of which the British Dominions took 292,393,701*l.* and foreign nations 517,925,147*l.*

In 1913 we imported from Germany 1,731,000*l.* worth of synthetic dye-stuffs and 146,000*l.* worth from Switzerland, and it is estimated that we bought from British producers about 100,000*l.* in value. Yet the coal-tar colour industry began here both scientifically and commercially from the incidental discovery by Perkin, while engaged in another organic investigation, of a mauve colouring matter derived from coal-tar. It was in 1854, when Perkin was sixteen years of age and a student at the Royal College of Chemistry, Queen Street, London, under A. W. Hofmann, formerly of Bonn University, who was appointed at the instance of Prince Albert (the chief promoter of the Great Exhibition of 1851) director of the Royal College in 1845. From 1856 to 1865 Hofmann was chemist to the Royal Mint. He afterwards went to Berlin as professor of chemistry, where his work covered a wide range of organic chemistry. Perkin's discovery, having regard to our vast supply of raw material, led to the confident anticipation that Great Britain would in future be the dye-producing country of the world. But this was not to be. Its development, mainly because of the lack of facilities here for the supply of adequately trained scientific men, and because of the advanced condition of German scientific education which had been sedulously fostered, took place in Germany, and for the future years our textile and other industries, to the extent of their output of dyed goods (which now exceeds in annual value 200,000,000*l.*), were

dependent for the supply of synthetic dye-stuffs upon Germany and Switzerland.

The importance, however, of a large supply of scientifically trained men, especially in chemistry, and the production of synthetic colouring matters on a large scale, sufficient to entitle it to rank as a chief key industry, have not merely an industrial significance; they have military aspects as well, since the discoveries and the applications of science may be used for evil purposes as well as for good, as the history of all wars shows. During the great war the Germans resorted to the use of poison gas, and thus started a course of "chemical warfare." The production of poison gas in its many forms was made possible because Germany had a fully developed dye-stuff industry, not merely in its personnel, but also in the perfection and extent of its plant, and the organic substances which were used and the methods employed were closely related to those required in the manufacture of synthetic colours. The Allies entered upon similar methods of attack, but in order to provide the means, except in the case of one large manufacturing firm producing dye-stuffs in Manchester, they had to erect special factories for the purpose.

If, however, we succeed in establishing coal-tar dye industries on a scale sufficient to meet the demands of our manufacturers, alike in quality, quantity, and price to those of our foreign competitors, we shall no longer have any cause for fear either in respect of our industries or in the event of war. But in order to achieve this and other desirable aims, we have to emulate the spirit and adopt the means and methods of the most progressive nations for the encouragement of scientific research and its application, together with the opportunity of advanced education for all who are worthy to receive it. The experience to be gained from previous exhibitions on a similar scale held at home and abroad, and the results accruing therefrom, should not be overlooked. The British Empire Exhibition to be held at Wembley, if it is not to miss a serious and fundamental purpose, must awaken a spirit of emulation for a wider extension of the means of knowledge and better conditions whereby its fruits can be achieved.

The Great Exhibition of the Industries of All Nations, of 1851, was remarkable from the fact that the building covering twenty acres of ground was erected of glass and iron after the designs of Joseph Paxton—a fine example in itself of the genius of the English engineer and a triumph of his technical skill. The exhibits were arranged under four heads: 1. Natural productions; 2. Machinery; 3. Manufactures; 4. Works of Art. It was attended by upwards of six million people of all nations. It was a financial success, the profits of which were invested in land at South Kensington on which numerous institutions for the advancement of science and art have been placed. "There began with it," says J. Scott Russell in his book on "Systematic Technical Education," "a series of competitive trials of intelligence and skill between the citizens of the different civilised nations of the world." We were supreme in the sphere of modern manufacturing machinery, but in respect of matters of taste and artistic design and skill we were far behind the French. The direct fruit of it all was, so far as this country was concerned, to be found in the organisation of the Science and Art Department (1853), whereby was brought within the reach of the workman, whether engaged in a mechanical or artistic handicraft, the means of study and experiment in the principles of his occupation. It reacted similarly on the educational policy of foreign nations, especially in France and Germany. They established schools of applied science according to the special needs of the town or industrial centre, the results of which were seen in the exhibition held at Paris in 1855, and especially in the International Exhibition held at South Kensington in 1862. There was abundant evidence that while we had progressed greatly in artistic taste and skill in design and workmanship, other nations had advanced in the industrial applications of science. There was Prussia with her ingots of Krupp steel, Switzerland with her fine display of Schönbein aniline colours, America with her automatic machines, Italy with her manufactures of classic earthenware, France with her fine steam-engines for her marine service.

"It was [however] the exhibition of 1867 in Paris," says J. Scott Russell (he was one of the English jurors), "which gave the nations, and especially England, a final lesson. By that exhibition we were rudely awakened and thoroughly alarmed. We then learnt, not that we were equalled, but that we were beaten—not on some points, but by some nation or other on nearly all those points on which we had prided ourselves."

There was shown the engineering products of a great establishment at Creusot in Eastern France concerned with mining, smelting, locomotive building, and other branches of commercial machinery in serious competition both in quality and price with like products from England. In addition to abundant raw material on the spot, coal and iron ore, the workers had the advantage of a systematic o ganisation of technical schools, which contributed very largely to the satisfactory results produced.

The Centennial Exhibition, held in Paris in 1900, furnishes another example of the value of these inter-

national exhibitions to the progress of industrial science. It was a marvellous display of executive skill and arrangement, and is well worthy of the closest study. Whether regarded from a constructive and engineering point of view, or from that of form and colour, the various features of the exhibition were endless in their variety and offered the most suggestive examples to the engineer, the designer, and the artist. A striking feature of the exhibition was the extent of space given to the display of facilities of education in France from the primary schools to the most advanced means of scientific and technical training. This was not confined solely to France, but other countries joined in it, notably the United States of America, which made a fine display. The exhibit arranged by South Kensington of gold-medal and other premiated works in the annual National Art Competitions challenged the admiration of foreign critics and caused the French authorities to say that they wondered, since such excellent designs could be produced, how it was that English manufacturers came so largely to France for designs. Another notable feature of the exhibition was the joint display of German scientific instruments. The exhibit was arranged collectively by ninety-eight German firms of instrument-makers, and was placed in charge of a scientific expert with qualified assistants, who undertook to explain and demonstrate to inquirers the purpose and merit of the various exhibits. Such an example of co-operation may be commended to the notice of the executive committee of the British Empire Exhibition.

The desirability of a special display of the educational activities of the various dominions of the Empire may also be suggested, such, for example, as was arranged with marked success for the United Kingdom at the Franco-British Exhibition held in London in 1910 in a specially adapted building, which included a lecture hall.

Having regard to the numerous research boards and committees for the investigation of scientific industrial problems under the auspices of the Department of Scientific and Industrial Research, the seventh annual report of which has lately been issued, and also to the existence of many separate societies for a like purpose, it seems appropriate that a special building or Hall of Science should be provided, in which lectures, experiments, and demonstrations illustrating many aspects of scientific work and discovery should be constantly arranged, as was done at the successful Scientific Novelties Exhibition just concluded at King's College, London. Such provision would give a living interest to the exhibits and serve to stress the the importance of purely scientific research in the development of industry.

Area of Distribution as a Measure of Evolutionary Age.

Age and Area: A Study in Geographical Distribution and Origin of Species. By Dr. J. C. Willis. With chapters by Hugo de Vries, H. B. Guppy, Mrs. E. M. Reid, and Dr. James Small. Pp. x+259. (Cambridge University Press, 1922.) 14*s.* net.

TO determine the value of Dr. Willis's book is not easy. The author delivers his message with enthusiasm and emphasis. "Age and Area," he reiterates, provides a penetrating and wholly new light on evolution. His supporters, four of whom contribute chapters to the book, endorse this opinion and tell us it is all right. Table after table exhibits special phenomena on which Dr. Willis relies. These tabulations seem to have been scrupulously made, and they certainly demonstrate some remarkable and novel results. The book is written with perfect sincerity and a conviction almost naive. Whatever its worth may prove to be, it is an honest attempt. So imposing an array must produce an effect in the mind even of the critical. But there are disquieting features. Repetition of the bald assurance that Age and Area is the true faith should be unnecessary. A judicious advocate would leave that conclusion to flow more quietly from the evidence. When, for example, we read, "As one of our leading ecologists says in a letter to me, and underlines, 'this will be strongly in favour of your Age and Area hypothesis,'" we remember seeing testimonials like that elsewhere and in more mundane application. But though the reader's scepticism is thus instantly aroused, the matter is worth careful attention, for to have hit on a new method of investigating even a part of the theory of evolution is no common achievement, and that the author has done this cannot in fairness be denied.

The main idea is not difficult to grasp. It is simply that, subject to various provisos, the area which a species "occupies" upon the earth is a measure of its antiquity in evolution. "Occupy" is scarcely a fortunate word in so formal a definition. The area "occupied" by a species has immediately to be explained as meaning the area over which the species *extends*, or has extended as shown by the fossils. Lingula lives now in the Chesapeake and in Philippine waters, but to speak of it as "occupying" the whole world would be confusing, even though it is found fossil in many countries.

A species once evolved is conceived as spreading in an ever-widening circle, much as a culture may do, inoculated upon a gelatine plate. If the medium be homogeneous and growth be undisturbed, the size of

the circle will be a function of the age of the culture until the medium is covered. The species or genera in the course of their dispersal are held to throw off new species and new genera, each of which again spreads concentrically from the focus of its inception. The throwing off of these new forms of life is regarded by Dr. Willis as a "casual" process, and regarding it some very definite inferences are drawn, of which we will speak later.

Now every evolutionist agrees that, *apart from disturbing elements*, area is a measure of age. If the matter rested there nothing would be in dispute, but nothing fresh would have been contributed to the discussion. We are, however, asked to believe that in practice this mode of estimating the age of a species is, on the whole, trustworthy: that endemic species and rarities in general can and must be for the most part accepted as new starters in evolution, and not as survivors. That is, of course, a paradox, but it constitutes the main thesis of the work. Dr. Willis takes the floras of Ceylon and New Zealand into special consideration, besides those of other isolated places, mountain tops and remote islands, and in brave defiance of all that science has hitherto taught us regarding the peculiar plants and animals limited to such localities, he tells us that, on the whole, the reason why those creatures occupy such small areas is that they have not yet existed long enough to have spread far. If any one objects that in application to the special cases which immediately suggest themselves, Sphenodon, the dodo, Leucodendron, etc., such a contention is preposterous, Dr. Willis would reply that he knew as much already, and that he is concerned not with special cases, but with averages and general propositions. He is within his right. The second proviso is that comparative estimates of age are only to be based on area when forms within the same "circle of affinity" are compared.

Everything then turns on the computation of these averages and on the criteria by which "circles of affinity" are to be recognised. Unfortunately no means are suggested by which we are to tell whether a species or genus is a novelty or a relic, and obviously none can be forthcoming. We may make shrewd surmises, but if things like that could be declared with certainty the study of evolution would be on the way to becoming an exact science. Meanwhile estimates of age based on area "occupied" must be exceedingly hazy. Giant tortoises live in the Mascarenes and in the Galapagos, and therefore must be reckoned ancient, as they doubtless are. When they become extinct, say in the Mascarenes, which they presumably will, they would start again as novelties at the bottom of the list, but for the accident that the remains of such creatures form conspicuous fossils. Of the New Zealand shrubby Veronicas one, *V. elliptica*, occurs also in Fuegia; having the widest recorded range it must be deemed by far the oldest of these species. Once extinct in either locality, whether Fuegia or New Zealand, it would be ranked with the rest of the New Zealand species as new mutations.

Then again the surface of the terrestrial globe is, as we all know, a medium of complex heterogeneity. By no provisos, safeguarding clauses, or anticipatory exclusion can considerable areas be defined in which dispersal may be observed which has not been promoted or limited, diverted or arrested, by countless interferences. Very rarely, if ever, do we find that reasonable uniformity and constancy of conditions, even in space, let alone time, without which we are warned the theory must not be applied. In areas which may be judged most uniform at a given point of time, the operation of sharply limiting causes is manifest. If, as in prairies and steppes, for hundreds of miles the conditions appear geologically and meteorologically uniform, the mere presence of living things introduces heterogeneity. Dr. Willis is well aware of this. In one of his best chapters he discusses "barriers" in the widest sense, and he makes us realise how difficult it must be for a new-comer species to get a footing or to spread among plant-associations already established. On the Central Asian steppes, for example, one can distinguish on the remote horizon by their colour the spots where encampments have stood. These patches are mainly characterised by the presence of nettles, which grow in such places. Nettles, as Dr. Willis remarks, are very easily dispersed by wind, yet nowhere else do they establish themselves in the Artemisia steppes—only in places which man and his animals have made fit for their growth. European weeds abound in the Eastern States where the soil has been cultivated, but few invade patches of unbroken territory. Quantitative estimates of the allowances to be made for heterogeneities and barriers in general cannot be attempted. Therefore in the hope that the heterogeneities will be so many and so various as to cancel, a reservation is introduced to the effect that the groups of species to be compared should each be not less than ten in number. But the difficulty is a real one, and in dealing with any troublesome or unconformable phenomena these considerations provide endless loopholes for escape.

A still more formidable difficulty is encountered in the endeavour to declare which classes of forms may be compared legitimately with the object of determining their relative ages from the areas they occupy, and which are not comparable. To have some con-

sistent criterion by which comparables may be recognised is absolutely essential to the application of the method. Nevertheless no information offered reduces the difficulty materially. We are told that only forms in the same "circle of affinity" are to be taken—a definition which is plainly left vague deliberately. How this is to be construed we are never precisely told. The species to be compared must be more or less alike in their modes or at least in their facilities of dispersal—a property we have commonly no means of estimating in any trustworthy or quantitative way. Unless I have misunderstood the chain of reasoning, its validity is severely strained at this point.

The author is shy of special illustrative examples and they need not be essential to an argument dealing solely with general propositions, but in a chapter contributed by Prof. Small we are provided with an illustration on the largest scale. There we are given to understand that the natural order Compositæ is a "circle of affinity" to which the method of Age and Area can be properly applied. If a group so polymorphic and heterogeneous as the Compositæ constitute a "circle of affinity," the members of which can be compared for these purposes, where are we to stop? The tribes of Compositæ are arranged in a genealogical tree upon which the presumed point of origin of each is marked, and we are told that the order of evolution as given on the tree, which has been constructed from anatomical data, agrees substantially with the numerical estimate of the areas occupied by each tribe. Needless to say, numerous eminent botanists have arranged the tribes in almost as many other ways, probably with equal propriety. These speculative genealogical trees, once fashionable, are, I had supposed, discredited. All that they can attempt is the display of a logical order of interrelationship based on the modifications of the special set of organs selected as a criterion; for the Compositæ this order will differ with each set of organs chosen. In support of Prof. Small's arrangement he gives an imposing tabulation of the geological levels in which each tribe is believed to have arisen. Not until the text of Prof. Small's previous papers is consulted does a reader discover that this tabulation is almost wholly conjectural. In a well-written and judicious chapter by Mrs. Reid, who discusses what palæobotany can produce in support of Age and Area, we find no such confident pronouncements. The inclusion of the chapter on the Composites reflects more credit on Dr. Willis's candour than on his scientific judgment. The propositions made in the name of the theory there stand forth with a neglect of caution which Dr. Willis himself seldom exhibits.

For the reasons given, the theory of Age and Area, except in so far as it is truistical, is as yet of doubtful value, and unless amended to meet the difficulties specified it cannot be applied with any confidence. I suspect that certain predictions respecting the flora of the islands near New Zealand, which, though made in advance, as we are frequently reminded, were fulfilled, did not involve any feat of which common sense would have been incapable.

Dr. Willis is a great advocate of the theory of mutation in its crudest form. The speculation now presented to us as Age and Area is a development of an idea which came to him when he reflected on the fact that in Ceylon several endemic species are limited to small areas, though sometimes associated with related species of wider distribution. The theory of mutation of de Vries appeared at about the same time, and Dr. Willis asked himself whether the wonderful "mutations" which had been reported in Œnothera might not exemplify the process by which the Ceylonese endemics had been begotten by the "wides," as he calls them. Endemics had previously been held to be largely relics. In the new light they become "in the vast majority" novelties, about to spread with the lapse of time in widening circles. On any theory of evolution endemics must be in part novelties and in part relics; but why, apart from the theory of Age and Area, we should believe that endemics are in such great majority novelties I do not clearly understand, for though we know little of origins we are certain that myriads of species have become extinct. It is surely contrary to all expectation that the process of extinction should be in general so rapid, and the final endemic phase so short that the number of species in that final stage of existence should be insignificant.

The supposition implies the optimistic but embarrassing corollary that a species, once established, is in no great danger of extermination unless some catastrophic or lethal change occur in the conditions of life. *Cupressus macrocarpa* is admitted to be in danger because, as we are told, the Monterey peninsula is drying up. This is used as the stock illustration of the mode in which authentic extinction should occur. As it serves three times in this capacity, bearing perhaps an undue burden in the argument, we may infer that examples of extinction through predicable secular change are not plentiful. Unless, indeed, the change can be traced directly or indirectly to human action, the cause whether of gain or loss of territory is apt to be a mere matter of surmise, for though losses are so familiar we must not forget that there are also mysterious gains—even in our own area. Who shall say what gave *Capros aper* its chance? A doubtful British species in the time of Couch, it

became a nuisance in the trawl, some time at least in the eighteen-eighties. How did the showy *Plusia moneta* become a common British moth? No one recorded it here before 1890. Extinction must ensue from countless causes. If compelled to specify one class of cause as operating rather than another, we should regard the appearance of a new and antagonistic organism as by far the most formidable and effective agency of extinction; but we have only to glance at anthropological data to observe that no rule obtains as to the length of time which the process of extermination will take. Whatever doubts be entertained as to the significance of adaptation in delimiting *specific characters*, there can be none that survival is determined by selection according to the balance of the profit-and-loss account on the workings of the machine.

Wondering at the Ceylonese endemics, Dr. Willis asks rhetorically, "Had one arrived in Ceylon just in time to see the disappearance of a considerable flora?" We may reply, What more likely? Is the alternative interpretation, that he had come in time to attend the birth of a new flora, more acceptable? About half the endemics of Ceylon, he tells us, occur on the tops of single mountains or small groups of mountains. Does he really suppose that future ages will witness the spread of such species downwards from the mountain tops?

In reading the chapter on the origin of species and the many passages in which references to mutation are made, I see signs that Dr. Willis, though making large assumptions in the name of genetical experiment, is not sufficiently conversant with the present state of genetical science. Both from observation and from experiment, the certainty that variation is largely discontinuous has been established. If for the moment we abrogate the consideration of interspecific sterility we might declare that forms mistakably like new species do actually arise suddenly. But this is scarcely mutation as contemplated by the theory of Age and Area. If we were told categorically which "wide" species is regarded as the putative parent of which endemic, we should be in a position to consider how far this interpretation is consistent with what we know of variation. From anything so precise Dr. Willis shrinks. Here and there we get a glimpse of what he would like us to infer. The endemic *Coleus elongatus*, for example, he is inclined to claim as the immediate product of *C. barbatus*, from which it differs in some ten respects. The shrubby Veronicas are characteristic of New Zealand; if pressed Dr. Willis would point to the "wide" *V. elliptica* (mentioned above) as their putative parent. Similarly the Chilian *Ranunculus acautis*, or alternatively *R. crassipes* (found in Kerguelen), which both occur in New Zealand, might be adduced as the parent of the endemic Ranunculi of those islands. Though undeniable as possibilities, we have to consider what warrant for such guesses can be drawn from the observed facts of variation. The answer is quite clear that up to the present scarcely anything comparable has been observed. The "rogue"-peas, the "fatuoid" mutations of oats (Nilsson-Ehle and later Marquand), with perhaps a very few more, are all that can be quoted as precedents, none certainly in point. No one familiar with genetical work would be disinclined to entertain the supposition that such groups of endemics as the New Zealand Veronicas may not improbably be co-derivatives from one or more crosses; so also may the hosts of "species" of Cratægus which Prof. Sargent has described largely as endemics on derelict farms of the Eastern States. But to establish these propositions, genetical and doubtless cytological work on a vast scale is required, and far too little has been yet done to justify the bold assumptions lightly made in the doctrine of Age and Area.

The evidence adduced by de Vries from Œnothera which led him to propound the theory of Mutation is clearly enough the precedent which Dr. Willis has at the back of his mind. From the first the meaning of the Œnothera work was ambiguous. The researches of Renner and of Heribert-Nilsson have now shown that those early suspicions were justified, and that the "mutations" of Œnothera are not genuine illustrations of the origin of species by variation in descent from a pure form. Had de Vries grasped the implications of Mendelian analysis, he could never have so interpreted them with any confidence. The few words in which he conveys his benediction on this new venture should be read with caution and reserve by persons unfamiliar with the history they purport to relate.

Unconvincing as the main argument of "Age and Area" appears, the reader will find in it some curious and interesting discoveries. Of these the most remarkable is the uniformity of the statistical distribution of species among the genera of various and most dissimilar forms of life, both plants and animals. The monotypic genera, with one species each, are always the most numerous, commonly forming about a third of the whole group, the ditypics, with two species each, are the next in frequency, genera with higher numbers of species becoming successively fewer. Set out graphically, according to the number of species they contain, the genera exhibit what is here called a "hollow curve" of frequency, and there is no gainsaying the fact that these curves, though collected from such miscellaneous sources, have a remarkable similarity. Another curious feature exhibited by this

marshalling of the genera according to the number of their species is not merely that the percentage of monotypes is largest on islands (as might be expected), but that it is exceptionally high in S. America and in Africa. The corresponding curves from several other regions are altogether different. I do not wholly follow the argument by which these features of regularity are interpreted as giving strong support for the theory of Age and Area. Whatever be the meaning of the regularity of the curve of frequency of species distributed according to genera, the occurrence of order in this unexpected place does not readily accord with the Darwinian view that specific diversity is primarily or closely dependent on fitness. That deduction, which looked so attractive in the superficial survey which was all that could be undertaken in Darwin's time, became practically untenable so soon as the phenomena of variation were accurately explored, and it is not surprising that close investigation of another part of the species-problem has revealed a similar weakness.

On the other hand, though the point is a minor one, the considerations collected under the title "Size and Space," though adduced as fatal to the theory of Natural Selection seem to have little cogency. On the average, genera with more species are shown to extend over greater space, and hence the area occupied by a genus corresponds roughly with the number of species it contains. What else could we expect? A large college, with a larger and more varied supply of competitors, commonly shows more successes (and indeed more failures) in more varied departments of activity than will be achieved by a smaller establishment.

One excellent purpose Dr. Willis's book will certainly serve. It will renew the debate on the mode of evolution, which for many reasons has of late years languished. Whatever doubts arise regarding the new deductions, Dr. Willis once more makes geographical distribution a live study, showing quite unexpected lines along which it may be pursued. The delimitation of floral areas—or, for that matter, zoological areas too—was, as he says, a dull and almost futile exercise of scholasticism. The introduction of statistical methods, here altogether appropriate, offers great possibilities.

In stronger hands a still greater effect might have been produced. The style of presentation scarcely attains the level required of such works by an age not over-exacting in that respect. Finish is no longer demanded of scientific authors, and we have come to suppose that loose writing is compatible with clear thinking. None the less it makes very difficult reading. Those who are not alienated by such blemishes will find the book interesting as a challenge. How far the new ideas are of value and how many of them are fallacious we shall scarcely know till they have been tried in practice over wide fields of experience, and examined in perspective from many aspects.

W. BATESON.

The Internal Combustion Engine.

The Internal-Combustion Engine. By Harry R. Ricardo. Vol. 1: *Slow-speed Engines.* Pp. vii+488. (London and Glasgow: Blackie and Son, Ltd., 1922.) 30*s.* net.

MR. RICARDO has completed the first volume of his promised book on the internal combustion engine, and according to the preface "hopes shortly to be able to complete the second." Seeing that the present volume deals entirely with the slow-speed engine, and was for the most part written many years ago, it is to the volume to come, dealing with the modern high-speed engine and embodying the results of recent researches, that the readers of NATURE will turn with greater interest. Mr. Ricardo is giving us two books rather than two volumes of one book, and it is a pity therefore that the volume now completed is not provided with an index.

The development of the internal combustion engine coming so much later than the steam engine, it was natural that during infancy its progenitors should be more disposed to seek the aid of physics and chemistry as god-parents than had been those of its rival, the steam engine, which received this baptism only in riper years. It is refreshing to a student of science to see how—and in Mr. Ricardo's contributions in particular—the limits of internal combustion engine design are studied in the light of modern knowledge of the detonation of compressed gases, flame temperature and flame velocity, the effect of change of specific heat, the effect of mass on dissociation. The results are very striking. The investigator of a new problem, instead of groping for a solution in the dense thicket of possibilities, is able, by using the laws of physics and chemistry as guides, to mark off the possible from the impossible, and so to reduce the area to be cleared to very much smaller dimensions. One catches the process at work in the volume before us, but for the culmination of its productiveness one has to wait for the stimulus of the war period with its impetuous demand for new engines for more and more effective flight. The impetuosity of this demand is illustrated by M. Rateau's recent paper at the Institution of Mechanical Engineers: two long-unsolved problems of the internal combustion engine are the compounded engine and the gas turbine: the needs of aviation are shown by M. Rateau insistently to demand some sort of solution of both these problems

at once, to enable flight at really high altitudes to be possible.

In the present volume Mr. Ricardo covers a wide field: all important types of slow-speed engine are described. Some of the work is thus rather that of editor than author, but opportunity for the exercise, at its best, of the latter rôle is seen particularly in the sections relating to engine balancing and piston friction, where the subject is dealt with in masterly fashion and cleared of the unnecessary complication so often found in other books on this subject. Some writers have photographic vision, Mr. Ricardo's is selective and acute. We receive this volume of his book with interest, and look for the second with pleasure. H. E. W.

Lord Moulton.

The Life of Lord Moulton. By H. Fletcher Moulton. Pp. 287+8 plates. (London: Nisbet and Co., Ltd., 1922.) 15*s.* net.

MR. FLETCHER MOULTON'S life of his father is an attractive volume which gives a vivid picture of the career of a man of remarkable ability. Beginning with very scanty financial resources, Lord Moulton spent some three and a half years as an assistant master after leaving school before he entered for a scholarship at Cambridge. During this time, however, he carried off three successive scholarships at the University of London, and so established a record of success which remained unbroken during his time at Cambridge.

Two consecutive chapters describe Lord Moulton's work at the Bar and on the Bench, first of the Court of Appeal and then as a Lord of Appeal and a member of the Judicial Committee of the Privy Council. The latter part of the book is given up to a description of his work during the war, and to those successful efforts which made it possible to assert that in this country, at any rate, empty shells were never kept waiting for supplies of explosives with which to fill them. For a solution of this most difficult problem of supply Lord Moulton relied mainly on the production and utilisation of a very large output of ammonium nitrate, and the principal chapter devoted to this period of Lord Moulton's life bears the appropriate title of "The Fight for Amatol." In this fight he was handicapped, not only by the inertness of this explosive, which in the early days created a well-deserved prejudice against it, but also by the difficulty of turning down inferior and sometimes fraudulent substitutes when these were advocated with the aid of influential supporters.

The most notable of these substitutes was "Halakite," a new and wonderful explosive, alleged to be capable of acting both as a propellant and as a high explosive, with the additional advantage of containing no nitroglycerine. The first samples supplied by the inventor were found, however, to contain 20 per cent. of nitroglycerine, and samples supplied to the French Government consisted of British Mark I cordite coloured yellow with lead chromate. The twenty pages devoted to this case are probably a fair measure of the amount of time that was absolutely wasted by Lord Moulton's department when the inventor had found an editor sufficiently influential to work up a scandal but also sufficiently ignorant to be taken in by his claims. Lord Moulton himself had, however, a remarkable ability for detecting real promise in the propositions put before him, and in nearly every case where a difference of opinion arose, subsequent experience showed that Lord Moulton was right and his critics were wrong. This was notably the case in reference to amatol, which remained not merely in service throughout the war, but is generally recognised as providing one of the best fillings now available for H.E. shells for land service.

A chapter is devoted to Lord Moulton's scientific work; but although a summary is given of his experiments with Spottiswoode, the usual references by which a scientific reader would trace this work are not given. An examination of the Royal Society's Catalogue of Scientific Literature shows that these experiments are described in two papers bearing the titles "On the Sensitive State of Electrical Discharges through Rarefied Gases," Part I. (Phil. Trans., 1880, 170, 165-229), and "On the Sensitive State of Vacuum Discharges," Part II. (Phil. Trans., 1881, 171, 561-652). In the spacious days of forty years ago it was possible for a man of pre-eminent ability to secure election as a fellow of the Royal Society on what might now be regarded as a mere sample of the scientific work of which he was capable. Under these conditions Lord Moulton's election in 1880 was a natural sequel to his partnership with Spottiswoode, following upon his earlier record as Senior Wrangler and Smith's prizeman. His greatest service to science was, however, undoubtedly the whole-hearted co-ordination of chemical enterprise which he brought about during the war, and then strove to perpetuate in time of peace.

Lord Moulton was educated at Kingswood School, and maintained his interest in the school to the end. During the first year after the Armistice he took part as an old boy in the annual dinner, which had been allowed to lapse during the war, and also distributed the prizes at the school where his first academic success had been won. A Moulton scholarship founded by his son will perpetuate his association with the school, and a scheme is already in progress for supplementing this by a stained-glass window in the chapel recently erected as a war memorial.

Our Bookshelf.

Effects of Winds and of Barometric Pressures on the Great Lakes. By John F. Hayford. (Publication 317). Pp. v+133+16 plates. (Washington: Carnegie Institution, 1922.) 2.75 dollars.

THIS book records what is probably the most complete investigation yet made of the effect of winds and atmospheric pressure on the slope of the surface of great sheets of water. It deals with Lakes Erie and Michigan, which are large and of fairly irregular outline and bed-contour, and are situated in a region where the meteorological conditions are well observed. Continuous records of water-level are afforded by several gauges on each lake, designed to smooth out the local wave-fluctuations. Mr. Hayford has constructed an elaborate theory connecting the daily change of level of the water surface, as revealed by each of these gauges, with the north and west components of barometric gradient on the current and preceding days; proportionality factors, varying with the station, are derived by the method of least squares from large numbers of observations. The winds, being more rapidly variable than the barometric gradient, are considered from hour to hour; the hourly change of level at any gauge station is related to the hourly changes in the values of a certain function of the wind-velocity during the hour in question and the following hour; the said function is derived partly by theoretical reasoning. The numerical constants of the theory have been worked out in great detail, in order that the real changes of content of the lakes may be derived from the gauge-readings with sufficient accuracy to enable the evaporation from the surface to be estimated in varying circumstances.

British Meteorological and Magnetic Year Book, 1920. Part III. Section 2. *Geophysical Journal*, 1920. (Air Ministry: Meteorological Office.) 1*l.* 5*s.*

THIS publication comprises the daily values of the meteorological and geophysical elements at three observatories of the Meteorological Office, namely, Kew Observatory, Richmond; Valencia Observatory in Ireland; and Eskdalemuir Observatory, Dumfriesshire; and at the St. Louis Observatory in Jersey: daily values of solar radiation at South Kensington; wind components at fixed hours at four anemograph stations; tabulations of occasional soundings of the upper air; and results of observations of cloud and aurora. The annual supplement contains upper air temperatures by means of soundings with registering balloons and aeroplane ascents, giving monthly and annual averages with averages for the period 1917–1920; notes on seismological work at Eskdalemuir Observatory; the water-level recorder at Kew Observatory; and tables of monthly means of magnetic and electrical data for Eskdalemuir and Richmond respectively.

The introduction to the volume gives all details and necessary references to the actual data here brought together, following, in most cases, the arrangement of former years. It is to be noted that the soundings with pilot balloons and temperature determinations by means of aeroplanes will be discontinued, as these data now appear in the Daily Weather report.

The volume, like its predecessors, forms a valuable contribution to the study of the meteorological and geophysical elements, and the homogeneous nature of the data will be thoroughly appreciated by those who utilise the information.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1923. Edited by George E. Brown. Sixty-second issue. Pp. 808. (London: H. Greenwood and Co., Ltd., 1922.) Paper, 2*s.* net; Cloth, 3*s.* net.

IT is a matter for congratulation that the abatement in the cost of printing papers has allowed of the use of paper of a quality superior to that which had to be employed for some of the preceding volumes of the Almanac. The arrangement of the matter is the same as heretofore. The Editor takes for the subject of his special article "What Camera and Lens to have," and hopes that those who are asked for advice on the subject will refer their questioners to it, and so provide a full answer and save their own time. Besides the calendar, which gives the public holidays in more than thirty different countries, there is a directory of Photographic Societies and other bodies, giving much information concerning each. The Epitome of Progress is the largest section, and the items are well classified and indexed. The usual statistical matter, photographic formulæ, and tables of all sorts, complete a most useful, practical and up-to-date reference book.

Proceedings of the Aristotelian Society. New Series, Vol. 22: Containing the Papers read before the Society during the Forty-third Session, 1921–1922. Pp. ii+242. (London: Williams and Norgate, 1922.) 25*s.* net.

THE volume contains the papers of the Session 1921–1922, abstracts of which have appeared from time to time in our Society notices. It reflects the great interest aroused by the discussion of relativity problems. Einstein's theory is the subject of a symposium to which Prof. Wildon Carr, Prof. T. P. Nunn, Prof. A. N. Whitehead, and Dr. Wrinch contribute. We may also direct attention to two papers, one by Prof. Johnstone on "The Limitations of a Knowledge of Nature," and one by Mr. Tavani on "Physical Space and Hyperspaces," both of which are of special scientific interest.

The Supremacy of Spirit. By C. A. Richardson. Pp. viii+159. (London: Kegan Paul and Co., Ltd., 1922.) 5*s.* net.

MR. RICHARDSON in this short volume sets forth, in clear and concise terms, the philosophical theory which he expounded in his "Spiritual Pluralism" in order to show its relation to the new psychology and its bearing on the somewhat dubious methods and even more elusive facts of psychical research. He states the case for psychical research, in its claim to be a purely scientific investigation, as well as it can be stated, but the argument is too brief to deal at all adequately with the scientific objections, those which are completely free from prejudice.

Letters to the Editor.

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

The Spectrum of Neutral Helium.

IN a letter to NATURE of November 25, p. 700, concerning my first communication (NATURE, August 19) on this subject, Prof. Raman expresses the opinion that the representation of helium lines derived from my assumption of the mutual apathy of the two interatomic electrons has a purely arithmetical character and would thus be deprived of any "real physical basis."

Disregarding a number of remarks reducible to the laceration of the empirically established series, a regrettable feature pointed out by myself (*Astrophys. Journ.*, September 1922), it will be enough to reply here to Prof. Raman's chief and apparently strongest objections. These are two: first, that the numerous coincidences yielded by my formula are simply explicable as so many "fortuitous arithmetical coincidences," and, second, that the particular value (109723) of the Rydberg constant N used in that formula is, in general, inadmissible, this value belonging legitimately to He^+, with a single electron, but not to the neutral atom with its two electrons.

Now it so happens that precisely these two points have steadily occupied my attention since the formula was first published, and I am therefore able to reply to both of them without delay. The corresponding details of reasoning and numerical data being all given in a paper just communicated to the American Physical Society (for its Boston meeting, December 27-29), to which readers may be referred, it will suffice to describe here the bare results.

1. Consider only those lines for which the final quantum numbers lie between 3 and 8, and the initial ones between 4 and 20, which fall within the interval $\nu = 17{,}000$ to 37,850. The total number of such distinct lines is $n = 680$. Among these there are $k = 45$ lines covering observed helium lines, with a mean deviation $|\delta\nu| = 2{\cdot}57$. In the considered ν-interval there are in all 97 observed lines. Whence, the mean (geometric) probability of hitting an observed line in a single trial by mere chance, $p = 0{\cdot}0182$, and the probability P of hitting k or more such lines in n (680) trials, by Bernoulli's theorem, $P = 1 - \Theta(x)$, where $\Theta(x)$ is the error-function and

$$x = \frac{\Delta}{\sqrt{2p(1-p)n}}, \quad \Delta = |k - pn|.$$

In our case $pn = 12{\cdot}40$, $\Delta = 32{\cdot}60$, and therefore the probability that our set of 45 coincidences should be "fortuitous" is

$$P = 1 - \Theta(6{\cdot}61),$$

which is a little less than $1{\cdot}7 \cdot 10^{-13}$—small enough to discard every suggestion of the play of blind chance. This conclusion is considerably strengthened when other groups of coincidences tabulated in the *Astrophys. Journal* are similarly treated.

Of particular interest, in this and other respects, are the 18 lines of the type $\left(\frac{m_1 \cdot m_2}{4 \cdot 8}\right)$, and another group of three lines, each of the type $\left(\frac{5 \cdot m}{4 \cdot 4}\right)$ and each covering an empirical "combination" line of the "doublet system."

2. Let m be the mass of each of the two electrons, M that of the nucleus, and $\epsilon = m/M$. Taking account of the wobbling of the nucleus, through which the otherwise indifferent electrons perturb each other indirectly, and rejecting terms in ϵ^2, etc., the energy of the system in any stationary state, say $n_1 = \iota$, $n_2 = \kappa$, is found with comparative ease. This divided by ch gives the corresponding "term," say $T_{\iota\kappa}$, our ν being the difference of two such terms. If this be written

$$T_{\iota\kappa} = 4N_{\iota\kappa}\left(\frac{1}{\iota^2} + \frac{1}{\kappa^2}\right),$$

then $N_{\iota\kappa}$, the "Rydberg constant" belonging to the particular pair $(\iota\kappa)$ of electronic orbits, is a certain symmetrical function of the integers ι, κ, and of the mutual orientation of the two orbits. For the case of quasi-circular orbits (*i.e.* such as would become circular for $\epsilon = 0$ or no wobbling) the investigation given in the Boston paper leads to the interesting result

$$N_{\iota\kappa} = N_\infty\left[1 - \epsilon - \epsilon\gamma\frac{\iota^6 + \kappa^6}{(\iota^2 + \kappa^2)\iota^2\kappa^2}\right], \quad . \quad . \quad (1)$$

where N_∞ (about 109737) is the constant for $M/m = \infty$, and γ the time-average of the cosine of the angle between the radii vectores of the two trabants. This formula holds for any inclination (i) of the two orbits and for any phase difference (α) of the two electrons describing them.

Now, a purely kinematical reasoning gives for $\iota \neq \kappa$ the value $\gamma = 0$, and for $\iota = \kappa$,

$$\gamma = \gamma_{\kappa\kappa} = \tfrac{1}{2}\cos\alpha(1 + \cos i), \quad . \quad . \quad . \quad (2)$$

where α is the angular distance of one electron from the ascending node when the other electron just passes through it.

Since for $\iota = \kappa$ the arithmetical expression in (1) becomes equal to unity, we have

$$N_{\kappa\kappa} = N_\infty[1 - \epsilon - \epsilon\gamma_{\kappa\kappa}], \quad . \quad . \quad . \quad (1a)$$

which, by (2), can assume any value from N_∞ down to $N_\infty(1 - 2\epsilon)$, with $N_\infty(1 - \epsilon)$, the desirable He^+ value, just in the middle of the interval. If, *e.g.*, the orbits are coplanar and $\alpha = 180°$, we have $N_{\kappa\kappa} = N_\infty$, for then there is no wobbling; if $\alpha = 0$, $N_{\kappa\kappa}$ would reach the other extreme value, about 109709, and for $\alpha = 90°$ we should have the mean value (109723), which might even be made the only value if the lines of the type $\iota = \kappa$ are not to be very broad. There is thus no essential difficulty. Moreover, very few among my tabulated lines have $\iota = \kappa$.

For the overwhelming majority of those lines we have $\iota \neq \kappa$, when γ vanishes, and (1) becomes, no matter what the inclination of the orbits and the phase difference of the electrons,

$$N_{\iota\kappa} = N_\infty(1 - \epsilon), \quad . \quad . \quad . \quad . \quad (1b)$$

which is precisely the value (109722 to 23) used in my formula. This in itself seems to be a strong support for that formula.

LUDWIK SILBERSTEIN.

December 6.

Returning to my letter of December 6, I beg to supplement the same by a result of my last week's work, which seems to give the proposed theory a much stronger support than all probability estimates, for it represents *in toto* and orderly some empirical series of helium. In fact, guided by a few coherent items of my original table, I find that the whole *diffuse series of singlets*, denoted by $1P - m$D, is represented by

$$\nu = 4N\left(\frac{18 \cdot 2n}{20 \cdot 4}\right) \equiv N\left(\frac{9 \cdot n}{10 \cdot 2}\right),$$

two final and one initial quantum numbers being

fixed. The other initial number $2n$ being given the successive values 6, 8, etc., or

$$n = 3, 4, \ldots 14,$$

the formula gives, with N = 109721·6, all the twelve observed members of the series from $m = 2$ to $m = 13$, respectively, the first with a deviation of 5, the second within 0·7, and the remaining ten members within a fraction, ranging from 0·1 to 0·35 Å.U.

The possibility of reducing 4N to N, based on the fact that all numbers are even, is interesting, especially as it forces itself on us also in the case of the fundamental and the principal series of singlets, which, though less precisely but again orderly and without gaps, are represented by

$$\nu = 4\mathrm{N}\left(\frac{2n}{6}\right) \equiv \mathrm{N}\left(\frac{n}{3}\right), \quad n = 4, 5,$$

and

$$\nu = 4\mathrm{N}\left(\frac{14 \cdot 2n}{8 \cdot 4}\right) \equiv \mathrm{N}\left(\frac{7 \cdot n}{4 \cdot 2}\right), \quad n = 3, 4, 5, \ldots 14.$$

This reducibility (to *one* N), if interpreted physically, would mean that the helium nucleus attracts each of its electrons with only one-half of its total charge, as if its lines of force formed two bundles, each entirely engaged with one of the two trabants. Details concerning these three series and the last-mentioned possibility will be given at the coming Boston meeting of the American Association.

LUDWIK SILBERSTEIN.

129 Seneca Parkway, Rochester, N.Y.,
December 13.

Echinoderm Larvæ and their Bearing on Classification.

MAY I ask your permission for a short space in which to reply to Dr. Mortensen's letter published in NATURE of December 16, p. 806, under the title "Echinoderm Larvæ and their bearing on Classification." The points which Dr. Mortensen raises are two —namely (*a*) whether the Echinoderm metamorphosis is a metagenesis, *i.e.* an alternation of generations, or not, and (*b*) whether the fixed stage in the life-history of Asteroidea is a reminiscence of an ancestral condition or a secondary modification of development. I shall deal with the second point first. Dr. Mortensen states:

(1) That the group Spinulosa among Asteroidea are not primitive but modified forms and that the Paxillosa are the more primitive group, and that in this view certain modern systematists whom he quotes agree with him.

(2) That since the Astropectinidæ (Paxillosa) do not have a Brachiolaria stage in their ontogeny, this stage is not primitive and ancestral but secondarily intercalated where it occurs in the development of Spinulosa and Forcipulata.

I must confess that I am unconvinced by Dr. Mortensen's arguments. In his original work, reviewed by Dr. Bather, he forgot that the Brachiolaria larva was found in Spinulosa but referred it to Forcipulata only.

The systematists whom he quotes are neither palæontologists nor physiologists but—for the most part—students of the external features of preserved specimens only. Koehler (one of them) regards Hudsonaster, one of the oldest Asteroids known, as "voisine des Astropectinides," and W. K. Fisher also states that "typical Phanerozonia such as the Astropectinidæ are more primitive than the Spinulosa."

Now what these specialists are impressed by is the "phanerozonate" character of the Astropectinidæ, that is, the edging of the arms with a series of broad plates termed the "marginals." I have always protested against regarding this feature as a primitive character and in this protest I have the support of the best British authority on fossil starfish, W. K. Spencer. The fact is, the apparent marginals of these ancient starfish are not homologous with the marginals of the modern Paxillosa at all but are the adambulacrals. Reasoning from imperfectly described fossils and superficially described modern forms has completely misled the older systematists.

Ludwig, whom Dr. Mortensen quotes, was a worthy pioneer in the knowledge of Echinoderms, but he belongs in all his thoughts and views to another epoch. His classification, for example, of the Holothuroidea into Actinopoda and Paractinopoda has been completely disposed of by modern embryological research. In my letter of a year ago, I gave physiological and anatomical reasons for regarding the Astropectinidæ as Asteroids secondarily modified for a life on sand. I can only express the doubt whether Dr. Mortensen could have regarded the Astropectinids as primitive if he had ever thoroughly dissected one.

With regard to the homology of the stalks of the Bracholaria larva of the Asteroid and the Pentacrinoid larva of Antedon, I should like to reiterate the following facts:

(1) The larvæ are, broadly speaking, comparable; in both there is a long præoral lobe, a ventral stomodæum, right and left posterior cœlomic sacs.

(2) In both forms there is a fixing ("sucking") disc formed at *precisely the same spot*, and in both the præoral lobe is converted into a stalk.

Is it not infinitely more probable that the precisely similar stage of fixation is an original and ancestral feature in both ontogenies, and not as Mortensen supposes, ancestral in the Crinoid and secondarily intercalated in the Asteroid ontogeny?

Of course, the subsequent metamorphosis is very different in the two cases—but this difference I have correlated with the adoption of different feeding habits by two sections of the primordial Echinoderm stem. I have the support of Mr. Tate Regan, based on his study of a widely different group, that what he calls "habitudinal differences" are the basis of all differential evolution.

With regard to the "metagenesis" of Echinoderm larvæ, Dr. Mortensen states that in one species of Ophiuroid the whole larval body is reproduced by the remnant of the ciliated apparatus cast off at metamorphosis. This case is certainly unique among Echinoderm larvæ and I cannot accept it until Dr. Mortensen brings forward better evidence. In any case, it will not, even if true, alter our views as to the significance of the larva. May I remind Dr. Mortensen that Antedon among Crinoids and Amphiura among Ophiuroids can both eject their entire alimentary viscera and reduce themselves to a framework of arms with a nervous centre and yet regenerate all that is lost? Finally, in Dr. Mortensen's appeal to Dr. Bather, he forgets that what Dr. Bather objected to was my fathering of Dr. Mortensen's views on him. My friend Dr. Bather and I are in substantial agreement in our views on Echinoderms.

E. W. MACBRIDE.

Royal College of Science, South Kensington,
London, S.W.7, December 18.

DR. MORTENSEN (NATURE, December 16, p. 806) says that ". . . since the larvæ of the more primitive Asteroids (the Phanerozonia) are devoid of a Brachiolaria stage, the sucking disc . . . must be a later specialised structure. . . ." Surely the statement is an error, and (even if it were true) the conclusion unjustified. The Phanerozonia of Sladen

includes eight families. One of these families, the Asteropectinidæ, contains species with non-attaching larvæ. Two other families (the Asterinidæ and the Gymnasteriidæ) have species with attaching larvæ (Asterina, *Q.J.M.S.*, 1896, and Porania, *Q.J.M.S.*, 1915). It is true that the Asterinidæ approach the Cryptozonia in some respects, but taken by itself this fact might rather lead us to look on the Asterinidæ as "primitive"—an annectant family between the two great orders of starfish. The Gymnasteriidæ are frankly Phanerozonate.

While Asteroid classification is admittedly perplexing, we are on fairly safe ground when dealing with the recognised families. At present it is known that members of five different starfish families (Gymnasteriidæ, Asterinidæ, Echinasteridæ, Solasteridæ, Asteriidæ) have attaching larvæ, while members of only one family (Asteropectinidæ) have larvæ without a sucker.

Dr. Mortensen's virtual narrowing down of Phanerozonia to Asteropectinidæ renders valueless his citations of Sladen, Ludwig, Hamann, and Gregory in support of the arguments in his letter. I yield to no one in appreciation of Dr. Mortensen's work, but even if the adult Asteropectinidæ were in some respects a primitive family (I believe the opposite), still to draw the conclusion which he says "inevitably" follows from this premise, in defiance of the direct data of comparative Asteroid ontogeny, not to speak of other considerations, would surely be one of those strangely naive misuses of the Recapitulation theory which have done much to obscure its essential truth.

JAMES F. GEMMILL.

University College, Dundee,
December 22.

Age and Area in Biology.

IN his recent book, "Age and Area," Dr. Willis gives (p. 114) the following: "Table showing in the horizontal lines the average number of vice-counties in Britain reached by the most widely distributed species in each genus of different sizes, and by the second, third, fourth, and fifth most widely distributed species."

	Average No. of vice-counties reached by the				
	1st sp.	2nd sp.	3rd sp.	4th sp.	5th sp.
Genus of over 10 sp. .	108	104	96	86	79
6·10 sp. .	103	84	64	49	33
5 sp. .	98	76	39	22	16
4 sp. .	89	61	35	13	..
3 sp. .	89	48	27	..	..
2 sp. .	73	33	..	..	..
1 sp. .	50	..	..	..	..

Dr. Willis is convinced that the only explanation of the gradual diminution in average distribution from top to bottom of the table is that the average age of the species in the upper rows is greater and that they owe their wider distribution to their age. The gradation can, however, be explained without the help of either the principle of "Age and Area" or that of "Size and Space," as will become obvious if the method of constructing the table be considered. The average distribution of all the species in each of Dr. Willis's classes, in part obtained from the table above and in part from the London Catalogue, tenth edition, proves to be as follows:

No. of spp. in Genus	over 10	10-6	5	4	3	2	1
Average No. of vice-counties reached	40	48	50·25	49·5	54·6	53	50

The averages thus vary somewhat irregularly. In taking the average of the most widely distributed species in the first class, more than 90 per cent. of the lower numbers are rejected, in the second more than 84 per cent. are rejected, in the third class 80 per cent., in the fourth 75 per cent., in the fifth 66 per cent., in the sixth 50 per cent., and in the seventh none at all. Naturally this changes an approximately equal set of numbers into a falling series.

It is now possible to deduce the converse of Dr. Willis's theorem; for by reversing his process and rejecting the higher numbers it can be shown that the age of the "youngest" species decreases with the size of the genus.

The average distribution in vice-counties of the *least* widely distributed species in each genus according to size of genus, in part from Dr. Willis's table and in part from the London Catalogue, is as follows:

No. of spp. in Genus	over 10	10-6	5	4	3	2	1
Average No. of vice-counties reached	3	5·4	16	13	27	33	50

The regularity continues for the next "youngest" species, as can be seen from the original table. In neither case would the regularity suffer if the vice-comital numbers were redistributed to the species by any random method, for the chance of a genus receiving both a very high and a very low number would increase proportionately with its size.

W. C. F. NEWTON.

The John Innes Horticultural Institution,
Merton, October 31.

Soaring Flight and the "Olfactory" Organs of Birds.

THE note on page 784 of NATURE, December 9, misses the point of the theory I wish to be tested. The theory is that the well-developed "olfactory" nerves and apparatus of those birds which are capable of soaring flight has the function, not of smell, but of a delicate tactile sense whereby the bird is able to detect and take instant advantage of those upward air currents which recent experiments with gliding machines have shown to be so important in soaring flight.

It has been shown by Darwin and others that vultures do not smell with their well-developed olfactory apparatus. The experiments referred to in NATURE of December 9 show that this nervous apparatus is not necessary to give the bird its homeward direction or to enable it to indulge in flapping flight. So well-developed an apparatus is almost sure to have some function. It is obvious that soaring birds are in constant need of a means to detect the direction and strength of wind currents, especially those in an upward direction, and to adjust their balance and their wings accordingly. When soaring, the eyes and bill of the bird are directed downwards and the mucosa of the nostrils is exposed to any upward currents of air. I think it very likely, therefore, that the well-developed "olfactory" apparatus of these birds is a mechanism for detecting the direction and quality of air currents, and that the central "olfactory" ganglia enable the requisite adjustments of balance and direction of wing and tail planes to be made. The fact that birds whose nostrils have been plugged have been able to fly home by flapping in no way contradicts this theory.

To test it, I suggest in the first place that the

sensibility of the olfactory mucosa should be abolished by painting with a 20 per cent. cocaine solution; and then see if a bird such as a gull can balance and soar as well after painting as before. Plugging of the nostrils, or section of the nerves, can also be tried. The effect to look for is on the capacity for soaring and gliding flight, not of flapping flight.

W. E. M'KECHNIE.

17 Chepstow Place, London, W.2,
December 15.

Nature Study and Phenology.

PHENOLOGY is the name given to that branch of meteorological science which has as its object the studied effect of weather conditions upon the seasonal development of animal and plant life.

From the late seventies of last century, and since 1891 on a uniform systematic plan, the Royal Meteorological Society has issued an annual report on phenology. This report, by collating and co-ordinating the work of a number of observers—mostly amateurs—in the British Isles, is able to present in summary form, supplemented by tables and maps, information of a most valuable botanical, ornithological, and agricultural nature.

Nevertheless, to accomplish such results, all that its observers are required to do is to note carefully the first appearance of certain birds and insects, twelve in number, and the first blooming of fourteen common plants. Other migrants and notes are asked for, but these are of secondary importance.

Here is a work which should surely appeal to the Nature-lover. By simply recording a few observations on a prescribed form, and forwarding the same promptly about November 15 (the close of the phenological year) to the Royal Meteorological Society, 49 Cromwell Road, S.W.7, the work of the amateur is lifted from a purely local value to become a real link in the progress of scientific research.

Stations are still urgently needed in many parts of our islands, and a copy of our observing form will be forwarded upon application to the office of the Society, or to one of us.

J. E. CLARK,
41 Downscourt Road, Purley, Surrey.
I. D. MARGARY,
Chartham Park, East Grinstead, Sussex.

Water Snails and Liver Flukes.

IN connexion with the letter on the above subject in NATURE of November 25, p. 701, I should like to ask Dr. Monica Taylor if she has actual proof of sheep coming into contact with *Limnæa peregra*? The habitat of this species is so much more "watery" than that normally chosen by *L. truncatula* that it seems very doubtful if sheep could eat it with their food. Again, *L. truncatula* is such a widely distributed species that it seems difficult to believe that it is either rare in or absent from any district in which damp sedgy pastures are to be met with.

Planks left undisturbed for a few weeks, or cut rushes shaken over a newspaper after having lain on the ground for a time, might reveal the presence of *L. truncatula* in many places from which it was apparently absent. And what of *L. palustris*, the habits of which are often nearer to those of *L. truncatula* than *L. peregra*?

A. W. STELFOX.

National Museum, Dublin,
December 12.

REFERENCE to "The Life-History of the Liver Fluke," by A. P. Thomas (Q.J.M.S., 23, 1883), or indeed to almost any text-book in zoology, will show Mr. Stelfox that in order to become infected it is not necessary for sheep to eat the intermediate snail host of *Fasciola hepatica*. It suffices that the encysted cercariæ be swallowed. The latter may be found at considerable distances from their snail host, for the tailed cercariæ which give rise to the encysted forms exist as such for about a week after they have escaped from the host and are extremely active. On account of their microscopic character (they are just visible to the naked eye as snowy specks) the merest trace of water suffices for their needs. The more "watery" habitat of *L. peregra*, which is extremely common in all sorts of ditches, puddles, and streams, constitutes no impediment, therefore, to this snail acting as a disseminator of the liver-rot parasite granted that it can become properly infected. That it is capable of being infected and of setting free perfectly developed cercariæ I have abundant evidence.

In answer to my request for literature references to any host other than *L. truncatula* of the liver-rot parasite, Dr. Paul Pelseneer has kindly given me several, one of which (Lutz, *Centralbl. f. Bakteriol. und Parasitenk.*, xi. pp. 781-796, 1892), since it refers to *L. peregra* as an intermediate host of *Fasciola hepatica*, may be of use to Mr. Stelfox. With regard to the first of the methods of discovering *L. truncatula* suggested by Mr. Stelfox, I have had negative results in some districts although the sheep in these same districts are infected.

MONICA TAYLOR.

Notre Dame, Dowanhill, Glasgow,
December 16.

Effect of Moonlight on the Germination of Seeds.

DURING the summer of 1921 I investigated the effect of moonlight on the germination of seeds, and the results seemed to indicate a greatly increased velocity of germination. In order to determine whether this might be due to the effect of the moonlight on the diastase, a small quantity of mustard seed was crushed, and weighed quantities, after mixing with known amounts of water, were exposed to moonlight in Petrie dishes, controls set alongside being covered. Estimation with Fehling's solution of the sugar produced showed that there was an increased yield of about 15 per cent. caused by the moonlight.

A possible explanation of these results is to be found in the fact that at certain periods moonlight is plane-polarised, and in order to test this suggestion the experiments with crushed mustard seed were repeated with daylight after polarisation, either by reflection or by a Nicol prism. Control experiments were also carried out both in darkness and in ordinary daylight. The temperature was the same for all three experiments in each case and lay between 10° and 18°. A remarkable increase in the amount of hydrolysis was always noted when polarised light was used. Similar results were obtained with fresh oats, wheat, and cornflour, to which diastase had been added.

The investigation of this phenomenon is now being continued at Liverpool in conjunction with Prof. E. C. C. Baly and Prof. J. McLean Thompson, and the results already obtained are worthy of record since they give strong support. Diastase is added to a suspension of freshly prepared starch and the mixture well shaken. A drop of the mixture is placed on three slides under microscopes, one

being exposed to polarised light, one to ordinary light, the third being kept in darkness. After thirty to sixty minutes, depending on the strength of the diastase, rapid hydrolysis can be seen to take place on the slides exposed to polarised light, while in the two controls the starch granules remain almost intact for some hours. By the use of a delicate thermocouple, the temperature was proved to be the same in all three cases. When the light is intense, the starch granules in the case of the polarised light break down entirely to little masses of dextrin and crystals of sugar which give deposits of cuprous oxide on warming with Fehling's solution. These results have been obtained with potato starch and the endosperm of maize and of wheat, the latter without the addition of diastase if freshly prepared.

In view of the suggestiveness of these observations the investigation is now being extended in various directions, and I hope to communicate the results in due course. ELIZABETH SIDNEY SEMMENS.

Chemical Laboratories,
University of Liverpool,
December 16.

Medical Education.

REFERRING to my letter (NATURE, December 9, p. 769), Prof. Dakin writes (NATURE, December 23, p. 845): "I am not quite clear whether this question has been propounded to invite answers, or to introduce another of Sir Archdall Reid's favourite discussions on mutations and fluctuations, etc." Prof. Dakin may rest assured that I do not invite a discussion about mutations and fluctuations. To be frank, I do not think such a discussion, conducted on purely scholastic lines, out of touch with reality, would be profitable. My object was simply to protest against the waste of time to which, as I supposed and still suppose, unhappy medical students are compelled. Here are some truths, none of which, I think, Prof. Dakin will deny categorically, but all of which, in practice if not in theory, are repudiated by many teachers of biology.

(1) Every relevant and verifiable fact, no matter how observed, is equal before science. Experiment is only one way—a very good way when need arises—of observing. The vast majority of authentic facts about living beings is derived from direct observation. People who limit their data to facts derived from experiment, or any other mode of observing, are, like those who insist on purely Christian, Mahomedan, or Hindoo testimony, merely sectarian. Dwelling in an islet of evidence they ignore the continent of truth which lies at hand.

(2) Our powers of observing are proportionate to our familiarity with the objects of study. Thus we can scarcely differentiate between peas in a pod or sheep in a flock; to an Englishman newly arrived in China all the natives seem much alike; but among our own kind, whom we study from birth to death, especially among our intimates, we see differences of every shade (*i.e.* fluctuations) between vital and enormous extremes—as, for example, in powers of resisting disease. Obviously, the experimenter who works among plants and lower animals knows nothing about fluctuations, and less than he ought to know about mutations. Lacking the necessary powers of observation, he merely guesses. That he guesses wrongly was abundantly demonstrated by my letter.

Can Prof. Dakin deny (*a*) that men, the only living beings minutely observable, are subject to stringent natural selection, (*b*) that this selection occurs amid fluctuations, (*c*) that evolution, proportionate to the length and severity of the selection, has resulted, (*d*) that human races never differentiate while there is interbreeding, but differentiate rapidly and invariably when separated by time and space, (*e*) that human races blend perfectly when crossed except in traits linked with sex, (*f*) that in spite of multitudinous human racial differentiations, there has never yet been recorded a useful human mutation, or one that changed the type of a race, (*g*) that human mutations (*e.g.* club-feet, idiocy, albinism) are not *inherited* independently, but are only *reproduced* independently, and (*h*) that lost ancestral traits never appear among natural varieties, but frequently among artificial varieties, even when purely bred.

Unless a biologist is able (1) to accept the foregoing propositions, or (2) to disprove them, or (3) to demonstrate that man is outside the scheme of Nature, he is not competent to teach biology to medical students; for, after these students leave him, they will observe for themselves, and be taught by men who have observed, with a minuteness and accuracy impossible to workers among plants and lower animals, and the things they then learn will be directly contrary to the teachings of the biologist.

I have before me the synopsis of instruction in biology of the Royal Colleges of Physicians and Surgeons. I must admit that it is a vast improvement, chiefly by way of elimination, of the rubbish (for a medical man) that I was taught as a student and which I supposed was still taught. The syllabus for 1923 will be even shorter and better. Biology, which should make doctors, in their vast numbers, the most potent scientific influence in the community, is disappearing from the curriculum. But I observe that the student must still learn the general structure of the Hydra and Lumbricus, the general structure and elementary physiology of Scyllium and Rana, and the elementary facts of evolution, heredity, and variation. But of what use, as taught by biologists, can these subjects be to the medical student? What, for example, will he learn about evolution, heredity, and variation? Will he learn that some characters are "innate," and the rest "acquired"? Recently I spent eighteen months trying to find out what biologists meant by these words and none could tell. Will he learn from a Lamarckian teacher that acquired characters are inherited, or from a neo-Darwinian that they are not? I spent a like period in trying to find out what was meant by "inherited," and failed again. Will he learn from a Darwinian that fluctuations furnish the materials for evolution? Or from a Mutationist that only mutations do so? Or will he be presented with such statements as the following: "The standard deviation of a coefficient of correlation computed from data derived from classes, members of which are mutually correlated, with special reference to the case of fraternal and parental correlations calculated from entries of siblings"? Will any biologist tell him that every character is a product of the combined action of nature and nurture (that is, is equally innate and acquired), that the human being is of such a nature that he is especially responsive to the nurture of use, and that this peculiarity bestows on man his position in the scale of life and has made him the educable and therefore, according to the teaching he receives, the rational animal—able to learn, for example, sense or nonsense concerning biology.

G. ARCHDALL REID.

9 Victoria Rd. South,
Southsea, Hants.
December 26.

Breeding Places and Migrations of the Eel.

By Dr. JOHS. SCHMIDT, Copenhagen.

IN an article in NATURE ten years ago (August 22, 1912, p. 633) I gave a review of the position at that time of the question of the breeding grounds of the freshwater eel (*Anguilla vulgaris*). We had then been working for seven or eight years upon the question, and it was our intention to pursue the work further by means of investigations extending across the Atlantic.

In the ten years then following falls the period of the Great War. This rendered work at sea impossible. We managed, however, partly before and partly after the war, to carry out an investigation covering the greater part of the northern temperate waters of the Atlantic, and the question, Where does the eel breed? can now, in the main, be considered solved. At the same time, we have ascertained the duration and extent of the migrations of the eel-fry.

The previous investigations had been undertaken with the well-equipped research vessel *Thor*, but its radius of action would not suffice for transatlantic cruises. From 1913 until 1921, when the Danish Government acquired the mine-sweeper *Dana* to replace the *Thor*, we were obliged to make our investigations from ships without any special equipment for marine research, partly from various trading ships plying on transatlantic routes, and partly from two schooners kindly placed at our disposal by the owners (1913–1914, the *Margrethe*, 90 tons; 1920–21, the *Dana*, 550 tons).

I shall in the following give a brief survey of the discoveries made regarding the breeding places of the eel since my article in NATURE in 1912, adding also some remarks on the immigration of the eel-fry to Europe. For further details I must refer any readers interested to my recently published paper in the Philosophical Transactions.[1]

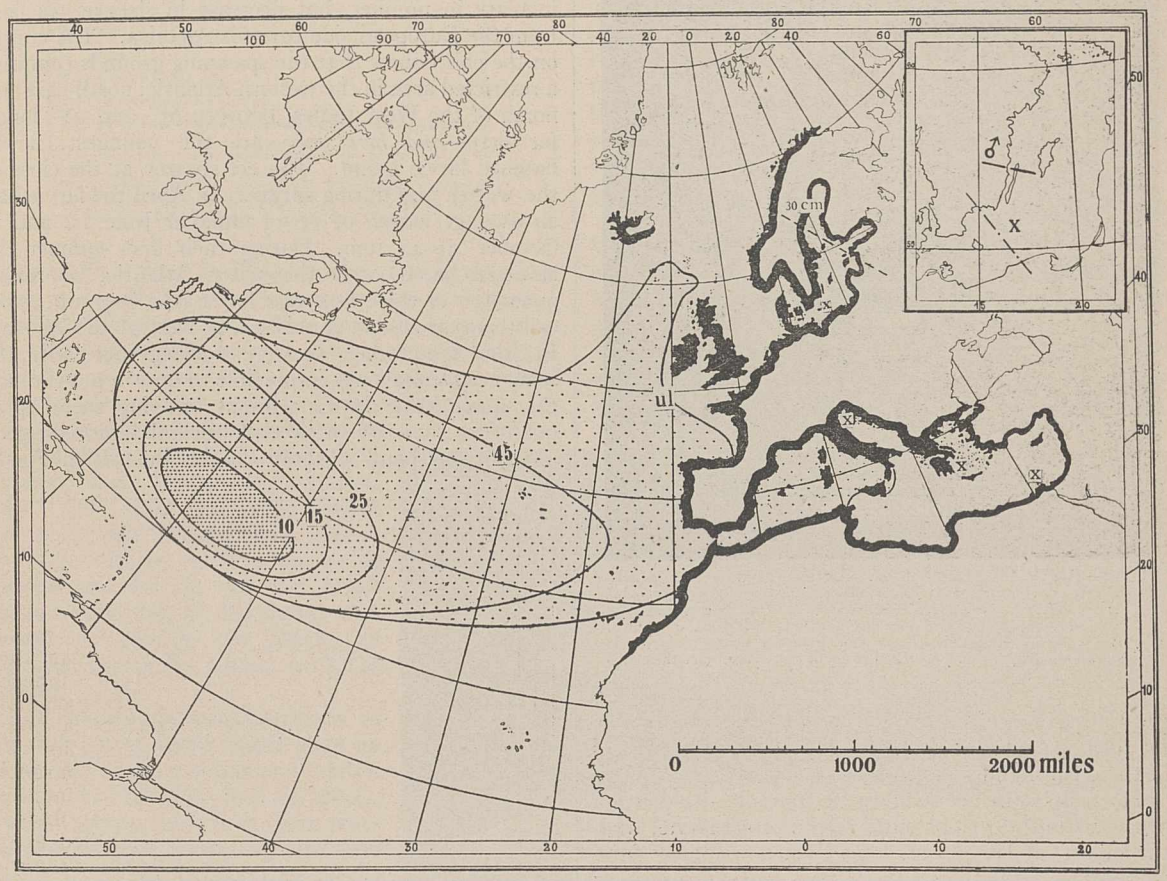

FIG. 1.—European eel (*Anguilla vulgaris*). *Spawning places* (bounded by innermost—10 mm.—curve); *distribution* of *larvæ* (dotted area) and of *adults* (black strip along the coasts where the eel occurs).

The curves show limits of occurrence; *i.e.* larvæ less than 25 mm. have only been found inside the 25 mm. curve, etc. The outermost curve denotes the limit of occurrence of unmetamorphosed larvæ (*ul*), ♂ and 30 cm. (in the Baltic) of male eels and of eels less than 30 cm. in length. X: eastern-most records of unpigmented elvers (Baltic and Mediterranean).

In my article in NATURE (August 22, 1912, p. 633) I summed up the position as follows: "We cannot say as yet where exactly the spawning takes place, and but little more than that the spawning places must lie in the Atlantic beyond the Continental Slope, and that they must be in the Northern Atlantic."

The smallest (youngest) developmental stage of the eel then known to us was a larva of 34 mm. length. In order to say anything definite as to where in the

[1] Philosophical Transactions of the Royal Society of London, Series B. No. 385, vol. 211, pp. 179-208, 1922.

Atlantic our eels did breed, we had to find far younger stages, for a larva so large as 34 mm. might well be imagined to have moved a great distance from the spot where it came into the world. Nor was it enough to find a few isolated specimens of the youngest stages; a spot which could be declared to be the site where the great hosts of eels from the European continent assemble for their spawning must necessarily yield earliest stages of the offspring in great numbers.

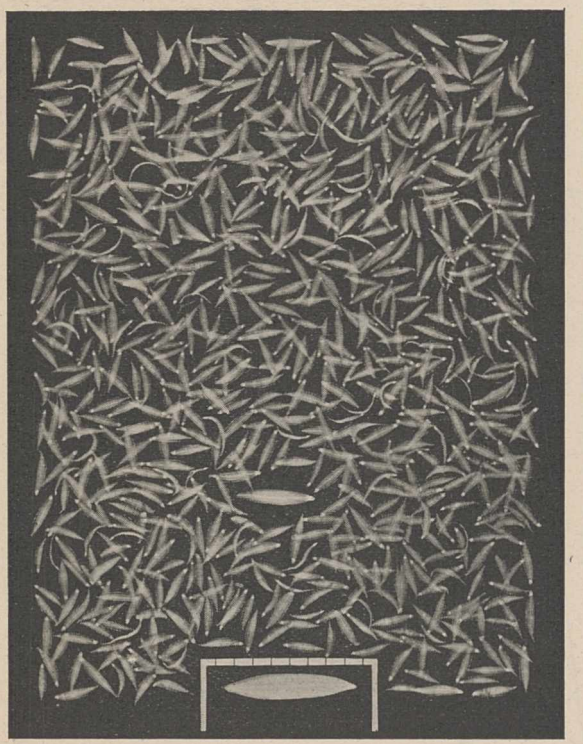

FIG. 2.—Sizes of eel larvæ (*Anguilla vulgaris*) caught in a single haul of two hours' duration at *Dana* Station 871 (lat. 27° 15′ N., long. 61° 35′ W.) in the western Atlantic, June 27, 1920, depth about 50 metres. About 800 specimens of O-group and 1 of I-group are shown. A II-group specimen, length 74 mm., from the eastern Atlantic, is shown for comparison. Reduced to about one-quarter (see the centimetre-scale).

The task before us, then, was to chart the distribution of the various developmental stages of eel-larvæ, from the oldest, about 7½ cm. long—which we knew from previous investigations were to be found off the coasts of Western Europe and in the Mediterranean—to the earliest tiny stages which no one as yet had ever seen. If we could ascertain where, and at what seasons, these tiny larvæ were found, then we should at the same time have discovered *where* and *when* the eels spawn. Once it was known where the various sizes (age-groups) of growing larvæ occurred, it would be possible to form an idea as to the extent and duration of the migrations of the eel-fry from the breeding grounds to the fresh waters of Europe.

These years of research have been rich in excitement and suspense; disappointment alternating with encouraging discoveries, and periods of rapid progress with others during which the solution of the problem seemed wrapped in deeper darkness than ever. One is tempted to describe the investigations in their chronological sequence, from first to last, in order to show how by slow degrees, advancing step by step, we came to see great parts of the life-history of the eel emerge from the darkness that surrounded it. The question of space, however, precludes this. We must content ourselves with setting forth the facts as they now appear, after eighteen years of work, and seeing what conclusions may be drawn from them.

. . . . . .

The chart Fig. 1 gives us the main sum of these many years' investigations into the distribution of the eel larvæ. This may be briefly stated as follows: The larvæ of our European eel (*Anguilla vulgaris*) are found distributed across the whole of the Atlantic Ocean from off the coasts of Europe to those of the United States. They increase in number, but decrease in size, as we pass from the European side towards America. The curves on the chart show that the spawning grounds comprise a restricted area in the western Atlantic, north-east and north of the West Indies, between 65° and 48° long., for here—*and here only*—are the youngest, newly hatched larvæ found. The eel spawns at the close of the winter and during spring. In April the larvæ had an average length of 12–13 mm., in June 25, and in October 35–40 mm. During their first summer the larvæ are found only in the western Atlantic. Enormous quantities of these first-year larvæ (the O-group, as we call them) are found at this season west of 50° W. long. In June 1920, when we were working there with the schooner *Dana*, it was impossible to draw a net through the upper water layers without bringing them up in quantities, and we often took several hundred specimens at one haul, as shown in the illustration Fig. 2.

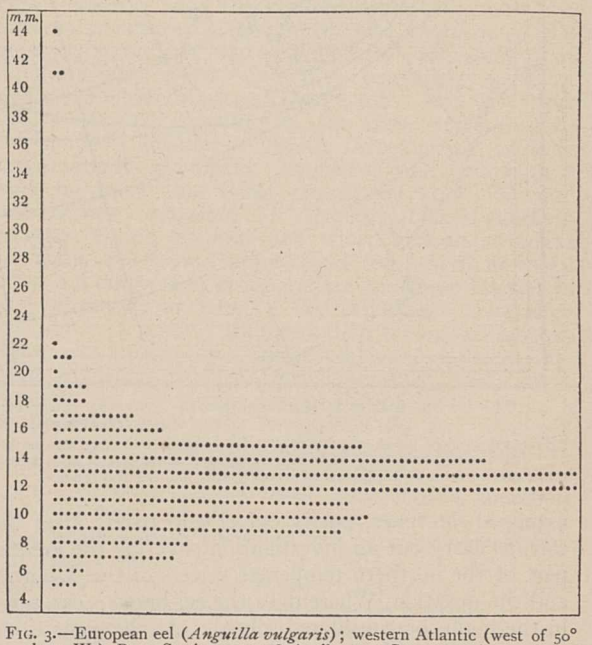

FIG. 3.—European eel (*Anguilla vulgaris*); western Atlantic (west of 50° long. W.), *Dana* Stations 935-948, April 1921; C-group and 3 specimens of I-group.

We are therefore excellently acquainted with the sizes and growth of the O-group larvæ. In June 1920 the four or five thousand specimens taken varied from 7 to 37 mm. in length, with an average of 25 mm.

In the course of the autumn and winter, the great bulk of the first-year larvæ (the O-group) disappears from the spawning grounds in the western Atlantic, but

a number of stragglers remain there throughout the winter, appearing in the following spring as a I-group, sharply distinguished in point of size from the young fry of the O-group which have come into being mean-

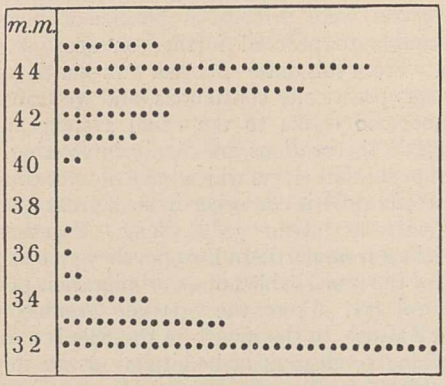

FIG. 4.—European eel (*Anguilla vulgaris*); western Atlantic (west of 50° long. W.), *Dana*, June 1920. Showing limit between O-group and I-group.

time (see Figs. 3 and 4). These specimens of the I-group, however, found in early summer west of 50° W. long., are comparatively few. The great majority, now measuring 50-60 mm., have, in the course of the winter, moved north-east and east, and are now in the central Atlantic, about as far as the longitude of the Azores, or even some distance farther east. In the following year again, by early summer, these larvæ have attained their full size, averaging about 75 mm., and appear now, as a II-group, off the western shores of Europe and far up in the Mediterranean, having, in the latter case, passed in through the Straits of Gibraltar during the winter, or in the autumn.

The retrograde metamorphosis of the full-grown larvæ takes place in the course of the autumn and winter. In the process, they become elvers, and in spring, being then three years old (the III-group) move up into fresh water, when the temperature of the latter permits. At this stage of development they resemble miniature eels (Fig. 5). The average length is about 65 mm., but they have lost greatly in dimensions and weight during metamorphosis, running no fewer than 1500 specimens to the pound. In England, it is more especially on the west coast, in the Bristol Channel, that the elvers ascend in very great quantities during the spring, the phenomenon being generally known among the inhabitants, who catch them for human consumption, or even for feeding pigs. The name "elver," too, comes from this part of the country. There are interesting accounts from Gloucester telling how, in March and April, fishermen stand in hundreds along the river banks, each with a hand net, fishing for elvers, and often making astonishingly large catches—a hundredweight of fish per man in one night. Bearing in mind the fact that 1500 elvers go to the pound weight, it will be realised that enormous quantities of eel fry must come in every year to the coasts of Europe from the Atlantic, numbers answering well to the great masses of tiny larvæ we found with the *Dana* on the breeding grounds of the eel in the western Atlantic. In 1920, 1921 and 1922, we found first-year larvæ (O-group) of the respective years on those grounds, but at this present time of writing (October 1922), none of these will yet have reached their destination, the fresh waters of Europe. Not until next spring (1923) will the fishermen of the Bristol Channel be able to catch elvers of the 1920 stock, which appeared in our nets in the western Atlantic in June 1920, and are shown in Fig. 2. And not until $2\frac{1}{2}$ years from now—that is to say, in the spring of 1925—will the 1922-year class, specimens of which were taken by the *Dana* expedition about six months ago (April and May 1922) near Bermuda, make their entry into the Severn.

Moving eastward, then, across the Atlantic, the eel fry come to the shores of Europe, and it is natural that here they should be found in greatest numbers. It is here also, that the capture of them has developed into an actual industry, as for example, apart from the Bristol Channel, also at several places in the south-west of Ireland, but especially on the west coast of France and the northern shores of Spain.[2] They are taken here in tons, and the inhabitants have special names for them (*civelles* or *pibales* in France, and *angúlas* in Spain).

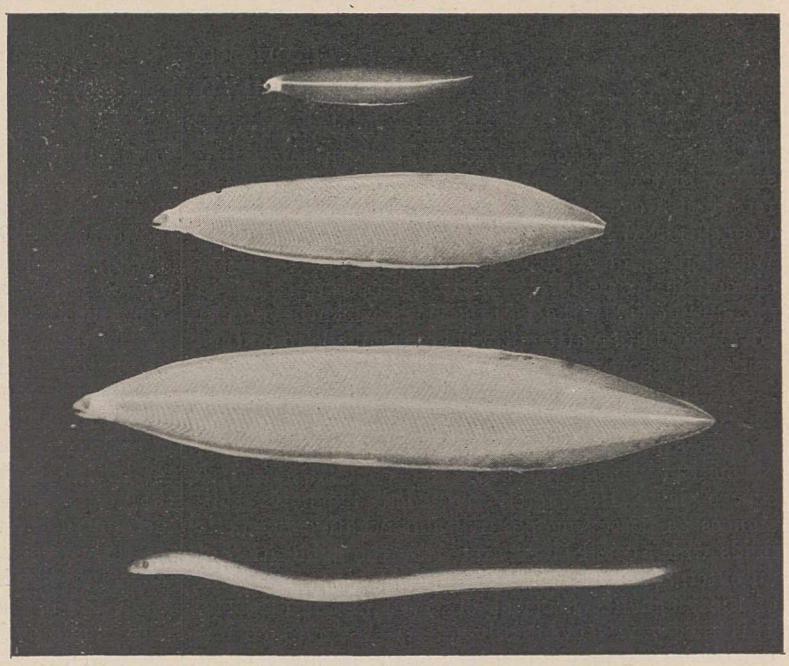

FIG. 5.—European eel (*Anguilla vulgaris*); showing the size of the four youngest year-classes (O-, I-, II-, and III-groups) in June; slightly enlarged: the top specimen measures 25 mm. in length.

It must not be imagined, however, that all the eel fry coming from the Atlantic will be stopped by the west coasts of Europe. Great numbers of them continue

[2] Also at some places in the western Mediterranean on the west coast of Italy, the elver fishery reaches the status of an industry in itself.

on their way—living semi-pelagically—to the eastward, until the metamorphosis is completed, and the small eel young have acquired a dark covering of pigment. In Northern Europe they move—by way of the Channel and round the north of Scotland—through into the North Sea and farther, *via* the Danish waters, to the western parts of the Baltic, where they have been found so far east as E. of Bornholm, at stages where the metamorphosis was not yet quite completed (Dr. A. C. Johansen, with the *Thor*), Fig. 1. In the northern parts of the Baltic, elvers are not known, or indeed any eels less than 20-30 cm., though the eel occurs right in to the innermost waters of that sea. The eels found in Finland are large females, and on the east coast of Sweden no males have been found north of lat. 57° 08′ (off Öland); see Fig. 1. This peculiar fact evidently answers to what we know from the great rivers, where the female eels generally move farther up into the higher reaches than the males.

The eel fry enter the Mediterranean at an early stage, as unmetamorphosed larvæ, most often not even having attained their full larval size, between one and a half and two years old. As unmetamorphosed larvæ they are found throughout the western basin, west of Italy, and at times, perhaps, still farther to the eastward. Even in the most easterly parts of the Mediterranean, an ascent of elvers takes place, these being transparent, and thus not having fully completed their metamorphosis. I have in this connexion received some information, with samples, from Mr. Geoffrey W. Paget, Director of Fisheries Investigations in Cairo. At a pumping station near Alexandria, where fresh water is pumped in large quantities into a channel leading direct to the sea, Mr. Paget found, on February 24, 1920, "that elvers were present in prodigious quantities, being unable to proceed further on account of the station. From this date—February 24—until April 15, fishing was practically continuous, and we transported over 5,000,000 elvers to the canal systems inland." Mr. Paget's observations are highly interesting, showing as they do that elvers which have not yet completed their metamorphosis can occur in such great quantities so far east as about 30° E. long. Together with observations from northern Europe, they give us a clear picture of the remarkable power of migration possessed by the eel fry. From the breeding grounds in the western Atlantic to the mouth of the Nile is a distance approaching 90 degrees of longitude, or one-fourth of the earth's circumference, and this distance is covered by the eel fry in the space of about three years. They may reach the Nile and the western Baltic before their metamorphosis is yet complete, and the greater part of the journey is made while they are still in the leaf-shaped larval stage. No other instance is known among fishes of a species requiring a quarter of the circumference of the globe to complete its life history, and larval migrations of such extent and duration as those of the eel are altogether unique in the animal kingdom.

Theories of Magnetism.

By Dr. A. E. OXLEY.

MUCH attention has been devoted in recent years to theories of magnetism, and an interesting survey of the position of the subject is given in the report of a committee of the U.S. National Research Council issued by the National Academy of Sciences, Washington, in August last (vol. 3, part 3). It is difficult in a descriptive article of moderate length to present judicially the various views which have been advanced, but an attempt will here be made to do this, using the report referred to as a basis, and supplementing it with accounts of one or two advances not recorded therein.

Poisson in 1820 published a mathematical theory of magnetism which was based on Coulomb's inverse square law. He merely regarded magnetic substances as possessing positive and negative magnetic fluids which could be separated by the application of an external magnetic field resulting in the production of the magnetic effects as observed in bar magnets. This theory was eventually (1831) shown to be untenable by Faraday's discovery of the phenomenon of diamagnetism.

Ampère's theory (1825), based on Oersted's discovery (1820) of the magnetic effects of an electric current, may be regarded as the foundation of modern magnetic theories, though at that time the laws of electromagnetic induction were unknown. This theory led Weber (1854) to develop a theory which aimed at an explanation of the magnetic effects of bar magnets on the assumption that the molecules were *always* equivalent to miniature magnets, whether the substance were magnetised or not, the action of the external field being merely to align the miniature magnets along the direction of the applied field. No explanation of the phenomenon of hysteresis was given, however, until Maxwell ("Electricity and Magnetism," § 444) extended Weber's views and interpreted the more complicated hysteresis effects in terms of certain quasi-elastic forces.

The theory of Ewing (1890) enabled us to visualise the nature of these hypothetical controlling forces by attributing the sluggishness of the response to an applied field as due to the interaction between special groups of molecules. This gave a rough explanation of hysteresis effects in terms of the mutual actions between complex groups of molecular magnets, and accounted for the shape of the hysteresis loops, the coercive force and the retentivity of a ferro-magnetic substance like iron.

At the beginning of the present century, attempts were made by Voigt and J. J. Thomson to outline an electron theory of magnetism based on the magnetic effects of a moving electron, but it was not until the theory of paramagnetism and diamagnetism of Langevin appeared (1905) that a satisfactory interpretation of these phenomena was presented.

The classical researches of Curie (1895) had shown that substances could be divided into three groups as regards their magnetic properties under an external field. These are, (1) diamagnetic substances, which show a minute negative induced moment, practically independent of temperature; (2) paramagnetic sub-

stances, which show generally a larger and positive induced moment, varying inversely as the absolute temperature, and (3) ferro-magnetic substances, which show still larger positive magnetic moments, which vary with the temperature and external field in a complex way. In each case the total induced moment per gram of the substance, divided by the applied field, is called the specific susceptibility. On Langevin's theory, a molecule consists of a congeries of revolving positive and negative charges; if the total initial magnetic moment of these is zero, the substance is diamagnetic, if it is not zero, the substance is either paramagnetic or ferro-magnetic. The diamagnetic effect must exist in all matter, but is masked by the larger para- or ferro-magnetic effects in the latter case. Langevin's theory indicated that when there is no interaction between the molecules, the diamagnetic effect is independent of temperature, while the paramagnetic effect varies inversely as the absolute temperature in accordance with the Curie rules mentioned above. Langevin did not consider ferro-magnetism; this was done by Weiss.

These remarks hold only in so far as there is no appreciable mutual action between the molecules. In ferro-magnetic substances, such action is pronounced, and Weiss (1907) extended Langevin's theory by introducing an intrinsic molecular field to represent this mutual molecular interference. According to Weiss the molecular field has not necessarily a magnetic origin; it corresponds to the forces determining crystallisation, but for magnetic purposes it may be regarded as a magnetic field proportional to the intensity of magnetisation, and its value is then of the order 10^7 gauss. Weiss further showed that the energy of this field is a measure of the thermal change when, at the critical temperature, the substance passes from the ferro-magnetic to the paramagnetic state. The results obtained with magnetite above the critical temperature showed that Curie's rule of paramagnetism held but that the constant of proportionality had a series of different values over certain temperature ranges. These values were interpreted by Weiss as due to sudden changes of the molecular magnetic moment by a unit, the value of which was found to be $16{\cdot}4\times10^{-22}$ c.g.s.e.m.u. This is the Weiss magneton; its value has later been corrected to $18{\cdot}54\times10^{-22}$. Weiss and others claim that this unit exists in many ferro-magnetic substances and in paramagnetic salts, though in the latter substances the evidence is not quite so conclusive. Further practical and theoretical extensions of the work have been made by Weiss, Kunz, Honda, and Frivold, but lack of space prevents an extended account of these here.

Honda (1910) made an extensive examination of the variation of susceptibility of many elements with temperature, and concluded that, in general, the Curie rules did not hold. In 1914 he submitted that the magnetic moments of molecules were not constant but depended on the temperature, and that they exert forces on one another which hinder their lining up parallel to the field. In solids which are paramagnetic, the magnetic unit is a spherical group of molecules. This sphere becomes elongated in the ferro-magnetic state. A second theory due to Honda (1914) advocates a gyroscopic motion of the molecule to account for diamagnetism and paramagnetism. This is very similar to the theories of Gans (1910–1916). There appears to be no doubt that certain gyroscopic motions are involved, but more recent evidence (see below) indicates that these do not arise from *molecular* rotations but from a gyroscopic property of the *electron* itself, i.e., *the electron is a magneton*.

Certain departures from the Curie rules for paramagnetic crystals at low temperatures have been examined by Onnes, Oosterhuis, and others, and interpreted in terms of a molecular field in a manner similar to that of Weiss.

The variation of diamagnetism accompanying the transition from the liquid to the crystalline state has been investigated by the writer (1911–22), who found that organic compounds changed their specific susceptibility by a few per cent. The theoretical explanation of the results was obtained by including in the Langevin theory of diamagnetism a term depending on the *local* polarisation which determines a *local* molecular field. Weiss regarded his molecular field as uniform, but in the present case it must be of an alternating character as we pass from molecule to molecule of the crystal. It exists whether the substance is subjected to an external field or not, and distorts the electron orbits, producing a few per cent. change of specific susceptibility on crystallisation. It can be shown that (1) these local fields are of the same order of intensity as Weiss's field, namely, 10^7 gauss, (2) the energy of this field is a measure of the latent heat of fusion, (3) the existence of such a field would induce a magnetic double refraction which is comparable with the natural double refraction of crystals, (4) the change of volume on crystallisation is the magneto-striction effect of this molecular field, and (5) the energy of the local molecular field per unit volume represents the tensile strength of the crystal.

Thus it appears that in all crystalline media there are intense local fields, the linking up of which from molecule to molecule determines the rigidity of the crystal. We are not certain what is the true nature of the field; it is probably partly electrostatic and partly magnetic. That the magnetic forces are important in determining the distribution of the planes of cleavage in crystals has been emphasised by the writer (1920), a *uniform* magnetic field being capable of isolating the cleavages, *i.e.*, of distinguishing between an open or close packing of the molecules in certain directions.

The present position of magnetic theories is fascinating. There appears to be evidence that the ultimate magnetic particle is neither the molecule nor the atom but the electron itself; in other words, the electron is not merely an electrostatic charge but also a magnetic doublet or magneton. Such a structure no doubt accounts for the spiral tracks of the β-particles as observed by C. T. R. Wilson. The problem of the interaction between such doublets in crystalline media is far from being solved. It appears that a useful picture of the mechanism is obtained on the Lewis-Langmuir theory (elaborated by Langmuir in 1919) of the cubical atom. In non-ionised media the coupling force between atoms is formed by units, each consisting of a pair of electrons, and each pair corresponds to a single valency bond of chemistry. The influence of

magnetic forces in determining crystalline structure, magne-crystallic action, and chemical combination in non-ionised media is apparent. It is interesting to note that Pascal (1910) showed that in organic compounds, all of which are diamagnetic, the molecular susceptibility is (apart from certain peculiarities of structure common to certain types of compounds) equal to the sum of the atomic susceptibilities of the component atoms. This is not true of ionised compounds, such as metallic salts, where the coupling between the atoms is probably of an electrostatic nature.

Further developments of the magneton theory were made by Parson (1915), who identified the electromagnetic coupling between pairs of magnetic doublets with the force of chemical combination. The magneton, or anchor ring electron, has been applied by Allen (1920) to interpret the phenomena of optical activity and optical isomerism. In connexion with the magnitude of the local magnetic field, namely, 10^7 gauss, it is interesting to note that Allen's calculations give a value 10^8 gauss at a distance from the anchor ring equal to its radius.

A number of attempts to obtain a quantum theory of magnetism have been made in recent years by Oosterhuis, Keesom, Gans, Reiche, and others. These are based on the assumption that the molecules are endowed with quantised molecular rotations, but the theory of Gans is the only one to take account of molecular interactions.

In connexion with these views the theory of Bohr and Sommerfeld must be considered. Though this has proved so successful in the interpretation of the fine structure of spectral lines, it does not appear at all obvious how the open elliptical orbits of this theory can give the uniquely balanced systems required to explain diamagnetism, nor does it give a picture of the directed forces which are responsible for crystal lattices. These considerations suggest that the atom must have a static structure. Perhaps the electron itself is quantised, the motion of its parts being highly localised compared with atomic dimensions. The electrons in an atom may be distributed on spherical or ellipsoidal surfaces, and the passage from one surface to another determine the emission of a definite amount of radiation of a certain frequency.

Quite recently Whittaker (1922) has published a new quantum mechanism of the atom based upon the existence of a number of atomic magnetic doublets. If an electron collides with this system the collision is perfectly elastic if the velocity of the electron is less than a certain amount. If the velocity exceeds this amount the electron passes through the magnetic system and hands over to the latter a definite quantum of energy which is identified as Planck's quantum. The derivation of the Balmer series can be obtained from this conception; it may later be found equally effective in interpreting the fine structure of spectral lines. Allen has replaced the particular magnetic structure postulated by Whittaker by a pair of ring electrons, thus identifying Whittaker's model more closely with Langmuir's cubical atom. The atomic structure is dynamical locally but is essentially static at ranges comparable with molecular dimensions. The static structure is required to account for crystalline and magnetic properties of matter in the non-radiating state. Recent experiments by the writer (1922) indicate that the occlusion of hydrogen by palladium produces a system the electronic configuration of which is similar to that of silver, and the fall in paramagnetism of the palladium is consistent with this view, silver being diamagnetic. Manganese which has been fused in an atmosphere of hydrogen is ferro-magnetic, although pure manganese is paramagnetic. Iron which has been fused in hydrogen has a higher coercive force than ordinary iron (like cobalt). These experiments indicate that when hydrogen is occluded in one of these elements an electronic system is produced corresponding to an element the atomic number of which is one higher than that of the element occluding the hydrogen. The suggestion is that the hydrogen electron, in such systems, enters into the outer shell of electrons of the metallic atom.

A static model, consistent of course with a highly localised dynamical model, such as the one advocated above, seems to be the only satisfactory interpretation of these results.

Obituary.

PROF. OSCAR HERTWIG.

THE death of Oscar Hertwig, formerly professor of anatomy in the University of Berlin and director of its Anatomical-Biological Institute, removes from the scene one of the chief leaders in morphological science. He formed a link in that chain of illustrious men including Johannes Müller, Gegenbaur, Fürbringer, and Gaupp, which has demonstrated how fully Germany has realised the importance of entrusting its great chairs of anatomy to men who are anatomists in the broadest sense of the word, leaders in vertebrate morphology and not merely experts in the details of anthropotomy.

Hertwig was most widely known through his series of admirable text-books. His "Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbeltiere" made its appearance in 1886 and has passed through numerous editions, both in its extended and in its condensed form ("Elemente," 3rd Edition, 1920). "Die Zelle und die Gewebe," first published in 1893, and known in its later editions as the "Allgemeine Biologie," is still widely used as a most admirable text-book of general biology on a cytological basis. During the years 1901–6 Hertwig brought out the various instalments of that wonderful encyclopædia which bears the characteristically German title "Handbuch der Entwicklungslehre der Wirbeltiere," edited and in parts written by himself. While it is, perhaps, permissible to hope that the appearance of this colossal work marks the approaching end of what may be called the encyclopædic age of biology, in which real progress has become more and more impeded and slowed down by the accumulation of minute details, there can be no question regard-

ing the value and utility of Hertwig's great "handbook."

Hertwig, a laboratory worker rather than a field naturalist, had no belief in "das schon morsch gewordene Lehrgebäude des Darwinismus," and to this fact we owe the last of his larger text-books—the useful and interesting, if not wholly convincing, "Das Werden der Organismen," first published in 1916 and now in its third edition.

Oscar Hertwig's really great, indeed epoch-making, contributions to the development of biological science are to be found, however, not in his text-books, but in a comparatively small group of original investigations, some of them carried out in co-operation with his brother Richard, which are of the most fundamental importance. It was in 1875 that Hertwig, forestalling van Beneden by a few months, showed for the first time, by his studies upon sea-urchin eggs, what was the real nature of the fertilisation of the animal egg—that the process consisted essentially of the fusion between the nucleus of the egg and the nucleus of one single spermatozoon. In 1878 there appeared the monograph by the brothers Hertwig upon the sense organs and nervous system of the medusæ—a work published before its time and perhaps destined to fill its rôle more completely in the future with a fuller recognition of the fact that the most fundamental function of the nervous system is to preserve intact the organic continuity in the animal body throughout its evolutionary increase in bulk.

In the early eighties of last century, Oscar and Richard Hertwig, stimulated by the work of English morphologists — Huxley, Lankester, and Balfour — turned themselves to the investigation of the foundations of the germ-layer theory, clearing up the muddle which had resulted from the non-recognition of what we now know by Hertwig's name, mesenchyme, and corroborating and amplifying Lankester's conception of the enterocœlic nature of the cœlom.

In 1890 Oscar Hertwig published his comparison of "Egg- and Sperm-formation in Ascaris," in which he worked out in minute detail the parallelism in gametogenesis in the two sexes, and cleared up the mystery of the "polar bodies," long known as characteristic of the unfertilised animal egg. Hertwig showed that male and female gametes are alike formed in sets of four, but that in the female sex three of each four degenerate, the three degenerate eggs being the polar bodies.

The last of Hertwig's works that demands mention is his study of those extraordinary malformations of vertebrate embryos to which he applied the name "spina bifida." In these the body of the embryo is divided into two halves by a longitudinal cleft traversing the notochord and the greater part of the central nervous system, and yet this seemingly irreparable injury proves no insuperable barrier to continued development. In many cases the cleft closes, the two halves unite and a perfectly normal individual results. Hertwig correlated these monstrosities with a hypothetical evolutionary stage in which the neural surface of the ancestral vertebrate was traversed by a slit-like primitive mouth, and to-day this is still the only working hypothesis at our disposal to explain a very extraordinary phenomenon.

It must not be imagined that Hertwig's activities were limited to such fields as are indicated by the various works to which allusion has been made. He interested himself in the social questions of the day, and the very last of his publications that has come into the writer's hands is "Der Staat als Organismus" (1922), with a trenchant criticism of some of those forms of extremism that are so rife at the present time.

Mr. A. Trevor-Battye.

Mr. A. Trevor-Battye, who died at Las Palmas on December 20, was an accomplished naturalist and Arctic traveller. The second son of the Rev. W. Wilberforce Battye, he was born in 1855 and adopted in 1890 the additional surname of Trevor on succeeding to certain estates that had fallen to his father. After leaving Oxford, Mr. Trevor-Battye indulged his taste for natural history in extensive travels in North America, Africa, the Himalayas, and Arctic Europe. In 1894, in the yacht *Saxon*, he visited the little known island of Kolguev, in the Barents Sea, with the object of devoting the summer to the study of its bird life. The *Saxon*, on returning from a cruise to Novaya Zemlya, missed Mr. Trevor-Battye through inability to reach the east coast, and returned to England without him or his companion, Mr. Hyland. The two Englishmen joined a party of wandering Samoyedes and made good their retreat to the mainland by sledge and boat. This was a fruitful expedition and completed the exploration of Kolguev.

In 1896 Mr. Trevor-Battye returned to the Arctic regions, accompanying Sir Martin Conway as naturalist on his expedition to Spitsbergen. Mr. Trevor-Battye made explorations around Dickson Bay and, with Prof. Garwood, climbed Hornsunds Tind. A few years later he visited Crete and made valuable contributions to the knowledge of its natural history.

Mr. Trevor-Battye was editor of natural history in the "Victoria History of the Counties of England," and of Lord Lilford's book on British birds. His own works included "Icebound on Kolguev" (1895); "A Northern Highway of the Tsar" (1897); and "Camping in Crete" (1913). "Crete: its scenery and natural features" was a recent contribution to the *Geographical Journal* (September 1919).

Dr. Fridolin Krasser.

A few weeks ago Dr. Fridolin Krasser was found dead in his laboratory at the Deutsche Technische Hochschule at Prague, where for several years he had occupied the chair of botany. He was widely known as a palæobotanist who had devoted himself to the investigation of Mesozoic floras, more especially to the study of the large collections of Upper Triassic plants from the well-known Lunz beds in the Hof Museum of Vienna. In 1887, Dr. Krasser published a note on heterophylly inspired by the work of Baron Ettingshausen, with whom he was closely associated. In 1891 he wrote on the Rhætic floras of Persia; a few years later he turned his attention to the Cretaceous plants of Moravia, and in 1900 and 1905 made some interesting contributions to our knowledge of Palæozoic and Mesozoic floras of the Far East.

Dr. Krasser published several papers on Upper Triassic floras, and it was hoped that he would eventually produce an adequately illustrated account of this important but still very imperfectly known period of botanical history. It would be a fitting recognition of the value of Dr. Krasser's work if the authorities of the Vienna Museum could see their way to entrust the material to which he was devoting his vacations to some palæo-botanical colleague with a view to the publication of a comprehensive memoir. Among other contributions reference may be made to papers on the genus Williamsonia and other Jurassic plants from Sardinia.

Dr. Krasser was a man of attractive personality, a good friend, and an enthusiastic investigator.

PROF. RHYS DAVIDS.

BY the death on December 27, in the fulness of years and honour, of Prof. T. W. Rhys Davids, England has lost a great oriental scholar. Son of a Congregational pastor at Colchester, and born on May 12, 1843, Prof. Davids was educated at Brighton School, and studied Greek and Sanskrit at Breslau University. He spent eight years in the Ceylon Civil Service, where he mastered Pali and commenced his Buddhistic studies. Returning home he became, from 1882 to 1912, professor of Pali and Buddhist literature at University College, London, and from 1904 to 1915 professor of comparative religion at the University of Manchester. He was secretary and librarian of the Royal Asiatic Society from 1885 to 1904, and he shared in the foundation of the British Academy, of which he was a fellow.

Prof. and Mrs. Rhys Davids—the latter also an accomplished Pali scholar—were the leading agents in spreading a knowledge of Buddhism in this country. An inspiring teacher and an indefatigable worker, he produced a number of books on the subject which he had made his own; the best known of which are his manual of "Buddhism," "Buddhist India," and "American Lectures on Buddhism." He also did good work in establishing the Oriental Translations Fund and the Indian Text Series. His death leaves a gap in the scanty ranks of oriental scholars which will not be easily filled.

WE regret to announce the death on December 30, in his sixty-sixth year, of Dr. J. B. Haycraft, emeritus professor of physiology in the University of Wales.

Current Topics and Events.

SCIENTIFIC workers are too well acquainted with the value placed on their services to be surprised at an advertisement for a university assistant lecturer in a department of science at a salary of 300*l.* a year. Recently, however, such an offer provoked an indignant protest from a disinterested member of the general public, who stated to us that the remuneration of his chauffeur was on a more liberal scale. While it is true that any educated man with aspirations would prefer a university teaching post, with its vague promise of an interesting and useful career, to the more mundane occupation, it is nevertheless a matter of the gravest concern that those educational institutions which are engaged in the task of increasing and disseminating knowledge are in such a parlous financial position that they are forced to offer salaries bearing no relation to the status of the posts, and imposing on their holders an unfair burden of financial sacrifice. The greatest benefactors of the universities are still the members of the teaching staffs themselves.

THE story of Shackleton's last Antarctic expedition on the *Quest*, as presented at the New Scala Theatre, is a little disappointing, inasmuch as considerable interesting material is not explained. It is a difficult task for Commander Frank Wild to supply anything more than a running commentary with so much film shown. The curtailment of some of the "Departure" film and "Ports of Call" film, such as a bull fight in Portugal, all of which occupy considerable time, would, perhaps, be advantageous, and the audience taken as quickly as possible to the lonely sub-Antarctic islands with their fascinating bird life—to South Georgia and its whaling industry, and to the southern ice fields. A few still pictures introduced here and there would afford the lecturer an opportunity of giving more information, which is badly needed, of the natural history pictures. The natural history films are extraordinarily interesting, and commence with a landing through the heavy surf on St. Paul's Rocks on the equator. In the midst of these small dangerous rocks there is a lagoon of wonderfully clear water, with many species of fish to be seen in its pellucid depths. The rocks provide a nesting place for hundreds of sea birds. Excellent films are shown of the rookeries of the great wanderer Albatross, the Cape hen, the giant petrel, the Gentoo penguin, and the sea elephant, all taken at South Georgia. Ascension Island provides a moving picture of a great rookery of terns. The lengthy film of the whaling industry in South Georgia is shown with the film running at high speed, commencing with the harpooning of the rorqual, or blue whale, and showing the whole process of "trying out." This film is full of interest and instruction, but, unhappily, bears eloquent testimony to the extermination of southern whales. Soon these rorquals and fin-back whales will become as scarce as the sperm and southern whalebone whale, if the industry is allowed to continue uncontrolled. Zavodovski Island, to the south of South Georgia, was next visited. This ice-covered, rock-bound, and forbidding island is the home of countless penguins. Round its coast are numbers of deep caves which belch forth dense sulphurous fumes. The three months spent in the ice pack with constant vigilance and toil in battling the floes, are not of special interest from a lecture point of view, though no doubt useful scientific data was collected.

THE duration record in gliding established at the recent contests on the South Downs has already been broken in a rather sensational manner, and by another

Frenchman, Lt. Thoret. The event took place at Biskra in Algeria on Wednesday, January 3, and Lt. Thoret stayed in the air more than seven hours, from 9.3 A.M. till 4.4 P.M. It is interesting to note that the flight was carried out on an ordinary aeroplane in which the power had been shut off completely, and not in a specially designed glider. The loading was 3·8 lb. per square foot instead of 2·2 lb. per square foot as in the specially constructed gliders used during the summer. The machine was a Hanriot 14 biplane, weighing 1364 lb. including a motor of 80 H.P.

APPLICATIONS are invited for the Theresa Seessel Research Fellowship of Yale University, value 300*l.*, for the promotion of original research in biological studies. Preference will be given to candidates who have already obtained their doctorate, and demonstrated by their work their fitness to carry on successfully original research work of a high order. The holder must reside in New Haven during the college year, October to June. Applications, which should be accompanied by reprints of scientific publications and letters of recommendation, and a statement of the particular problem which the candidate expects to investigate, should be made to the Dean of the Graduate School, New Haven, Conn., before May 1 next.

A SPECIAL meeting of the Royal Society of Medicine will be held on Friday, January 26, at 8.30, to commemorate the centenary of the death of Edward Jenner. There will be an address by Sir W. Hale-White on "Jenner and his Work," and objects of historical interest will be shown.

THE Trueman Wood lecture of the Royal Society of Arts will be delivered by Sir William Bragg at the Society's house, Adelphi, at 8 o'clock on Wednesday, January 24. The subject will be "The New Methods of Crystal Analysis, and their Bearing on Pure and Applied Science."

A NEW section of the Royal Microscopical Society has been formed for the purpose of dealing with the practical use of the microscope in connexion with industrial research. The inaugural meeting of the section will be held at 20 Hanover Square, W.1, on Wednesday, January 24, at 7 o'clock.

THE following free public Gresham lectures will be delivered at Gresham College, Basinghall Street, at 6 o'clock, on the dates named :—Physic, by Sir Robert Armstrong-Jones (January 23, 24, 25, and 26); Astronomy, by Mr. A. R. Hinks (January 30, 31, and February 1 and 2); Geometry, by Mr. W. H. Wagstaff (February 6, 7, 8, and 9).

THE Silvanus Thompson Memorial Lecture will be delivered at the Technical College, Leonard Street, E.C.2, on Thursday, February 1, at 7.30 P.M., by Sir Oliver Lodge, who will take as his subject "The Basis of Wireless Communication." The chair will be taken by Sir Charles Parsons. After the lecture a conversazione and re-union of old students will be held. A collection of Prof. Thompson's paintings and apparatus will be shown and a number of demonstrations will be given in the laboratories.

A COMMITTEE, consisting of representatives of the Institutions of Mechanical Engineers and Naval Architects, has been appointed with the object of carrying out tests on oil engines and of reporting on the performance of motor-driven vessels. The Engineer-in-Chief of the Fleet has, with the approval of the Admiralty, joined this committee. In scope, the proposed trials will include economy and thermodynamic tests ashore and manœuvring tests at sea. Wherever possible the behaviour of the propellers and the hull will be examined. It is intended to test engines of as many representative types as possible. The first actual testing work will probably be carried out about April next.

THE National Institute of Agricultural Botany is now accepting entries for its second series of yield and quality trials of new varieties of potatoes from breeders who are willing to entrust the Institute with the marketing of their productions on a profit-sharing basis. The trials are planned to last for five years, at first in Scotland only, but in the later years also in the English potato districts. Only those varieties which do sufficiently well in the trials will be placed on the market. Full particulars of the conditions of the trials can be obtained from the Secretary, N.I.A.B., Huntingdon Road, Cambridge, to whom those intending to enter new varieties for these trials should apply not later than February 28.

WE have received a copy of the programme, rules, and regulations of the International Exhibition for Photography, Optics, and Cinematography, which is to be held at Turin during next May and June in the Newspaper Palace at the Valentino Park, under the initiative of the Board of Trade and Industry at Turin, and under the high patronage of H.M. the King of Italy. The photography section is divided into seven classes, and each class into several sub-classes. Photography in general, optical projection, photo-mechanical methods, photography in its application to science, photographic materials and literature, are all included. The optical section includes optical glass, machinery for making lenses, prisms, etc., spectacles of all sorts and oculists' apparatus, microscopes, telescopes, opera glasses, optical instruments in general, bibliography, and schools. The cinematography section is similarly classified. Applications to exhibit must be made on forms that will be supplied and which must arrive, duly filled in, not later than March 1 at the General Commissary, Via Ospedale, 26, Turin (the head office of the executive committee.)

THE character of the primitive Crustacean limb was disputed between Mr. E. W. Shann and our reviewer in our issue of December 2 (p. 736). In fairness to the former, a statement of the present state of knowledge seems called for. It is now generally held by the leading authorities that Trilobites represent the ancestral group from which Crustacea were derived. All investigated species of these appear to have had biramous limbs, while some of the most primitive had the posterior region of the body relatively soft and uncalcified, and were in process of evolution

from Annelids. Hence if the Apodidæ (and all other Crustacea) arose from Trilobites possessing biramous limbs, their own foliaceous appendages must be presumed to be derived from the biramous type, notwithstanding the similarity of their structure to the foliaceous uniramous parapodia of some Annelids. It is possible that the bilobed type of parapodium possessed by many Annelids may have given rise to the biramous Crustacean limb. On the other hand there is the objection felt by a few that the descent of the Apodidæ and other Crustacea from an ancestral group of Trilobites does not necessarily follow from the fact that Trilobites are the earliest known Crustacea. The Apodidæ themselves have many structural affinities with Annelids. Thus it is conceivable that the Crustacean-Annelid may have produced divergent branches of which the Trilobites (biramous-limbed) represent one, and the Apodidæ (foliaceous-limbed) the other. This view, however, is not regarded with favour by the chief authorities.

AT the sitting of the French Academy of Sciences held on October 23, 1922, a note was presented by MM. Constantin, Joessel, and Daloz "concerning a boat which travels against the wind while using the wind itself for motive power." An article on the same topic, entitled "Un bateau paradoxal," appears in *La Nature* of November 11. An ordinary sailing-boat cannot use the wind for directions which are too near that directly opposite to the wind, and it was long ago suggested that if an arrangement like the sails of a windmill were substituted for ordinary sails, the boat could travel even against the wind. Napoleon was urged to use this as a means of surprising the British fleet. Scientific work on the idea was initiated in 1901 by Constantin, who constructed a model car on wheels which advanced against a current of air blown on it. The publication of Drzwiecki's theory of propellers in 1909 encouraged Constantin to proceed further. He attracted the attention and approval of many French men of science, and a syndicate was formed for the development of the method, but the war interrupted the work. In 1917 work was resumed, and since then the idea has been applied successfully. Joessel (son of the well-known investigator in aerodynamics) put an air-screw—like the sails of a windmill—of 5 metres diameter into a 2-ton sloop, *La Drésinette*, connected with a marine propeller of 60 cm. diameter, and successful journeys were made on the Erdre, near Nantes, and on the Loire. This was in 1918. Later on a 9-metre air-screw was installed in the 5-ton boat *Bois Rosé*, connected with a marine propeller of 105 cm. diameter, and on September 15, 1922, this boat sailed successfully on the Seine, between Saint Cloud and Sèvres, in all winds and against the wind, without causing any derangement in the ordinary traffic. It was estimated that the speed was 2 metres per second against a wind of 7 metres per second. The investigations were conducted with the help of the French *Direction des recherches scientifiques et industrielles et des inventions.*

Our Astronomical Column.

THE PLANET MERCURY.—This planet reaches its easterly elongation on January 13 and will be favourably placed for naked-eye observation at about that date.

The best time to obtain a glimpse of the planet will be at about an hour after sunset, when it may be seen at a low altitude over the west-south-west horizon. The planet may be expected to be about as bright as a first magnitude star would appear in a similar position and involved in twilight. Mercury does not shine with the same steady light as some of the larger planets, but often exhibits a sparkling fitful lustre.

Being rarely visible owing to its proximity to the sun, it is necessary for intending observers to look for the planet at special periods like the present, when its apparent elongations from the sun enable it to be perceived with the unaided eye.

THE JANUARY METEORS.—A brilliant full moon and passing clouds somewhat interfered with observation of this event. The maximum display was expected on January 3, and Mr. W. F. Denning writes that at Bristol fine meteors were visible occasionally, and indications were that had the conditions been favourable, the shower would have been fairly conspicuous and plentiful.

At Stowmarket, Miss A. Grace Cook and Mr. J. P. M. Prentice obtained independent observations on the night mentioned, and remarked some fine meteors from the usual point of radiation at 232° +52°.

The sky was not watched after midnight and the maximum seemed to have been attained in the earlier part of the evening. Miss Cook recorded bright meteors from the special shower of Quadrantids at $6^h\ 58^m$, $8^h\ 10^m$, $8^h\ 43^m$ and $10^h\ 18^m$, and there were others of about mag. 1. At $9^h\ 36^m$ there was a fireball from the direction of Aquarius.

On the night of January 4, the shower of Quadrantids seemed to have become nearly extinct. At $8^h\ 48^m$, however, Miss Cook witnessed the appearance of a remarkable stationary meteor. It was as bright as Venus, and shone for about 1½ seconds with a motionless aspect at the position 222° +77°. There is a known shower at this point in Ursa Minor and it corresponds with the point of radiation of Mechain-Tuttle's Comet on December 20.

COMING SOLAR ECLIPSES.—The eclipse of September 10, 1923, will be total in California and Mexico. The sun's altitude will be more than 60°, and the duration of totality 3½ minutes. The weather prospects are very hopeful. There is little doubt that the Einstein problem will again be studied. Mr. F. Slocum (*Astr. Journ.* No. 809) gives a list of the stars within 2½° of the sun's centre down to mag. 9·0. They are mostly faint, especially those nearer the sun, and it will need skilled photography to record them. It is proposed to photograph a check field, some 5° distant, on the same plates during totality, thus giving an independent determination of scale value, and enabling the whole Einstein displacement to be utilised. Otherwise much of it is lost, only the differential shift being available.

The succeeding totality, on January 24, 1925, crosses the north-eastern states. Four observatories —Vassar, Yale, Van Vlack, and Nantucket—enjoy total eclipse; its duration is 1½ minutes, but the sun's altitude is less than 20°. The star field is better than that of 1923 but not so good as 1919.

Research Items.

THE PILOU FEAST IN NEW CALEDONIA.—A valuable account of the festival known in New Caledonia as *Pilou*, a word which seems to mean "repetition, rhythm," in connexion with the ritual dances forming a leading part of the ceremonial, is given in *L'Anthropologie* (vol. xxxii. Nos. 3-4) by M. Maurice Leenhardt. The object of this elaborate series of dances and ritual seems to be the periodical expulsion of evil spirits and other dangers, which has been fully discussed by Sir James Frazer in "The Golden Bough," 3rd ed., The Scapegoat, chaps. iii. iv. This article, fully illustrated by drawings and photographs, deserves the attention of anthropologists.

PENCIL PIGMENTS IN WRITING.—In the issue of *Discovery* for January, Mr. C. Ainsworth Mitchell discusses the question of the identification of pencil pigments in writing. He shows that the microscopical appearance of lead and its alloys is quite distinct from that of graphite, the lines showing a disconnected series of patches irregularly distributed, uniformly and brilliantly lit up, and each patch is marked with regular vertical striations. Writing in different pencil pigments may sometimes be differentiated by chemical tests. For example, the graphite and clay used for the pigment frequently contain very varying amounts of iron or of chlorides, and the markings with them show reactions of different intensities when tested with the respective reagents. Titanium is also a common constituent of natural graphites, but seldom sufficient to give a distinct reaction in the markings on paper. In that case, however, a colour test alone was sufficient to distinguish the marks made with that pencil as compared with others examined.

GLANDS OF THE MICRODRILI.—Dr. J. Stephenson (Trans. R. Soc. Edin., liii. pp. 241-265, 1 plate, 1922) has investigated the septal and pharyngeal glands of the four families of Microdrili (Oligochæta)—Tubificidæ, Enchytraeidæ, Naididæ, and Lumbriculidæ. In the anterior segments are numerous deeply staining cells associated with the blood vessels, muscular strands, septa (forming the "septal glands"), body-wall, and pharynx and œsophagus (forming the "pharyngeal glands"). Only in the Enchytraeidæ do the cells discharge into the lumen of the pharynx; their products—largely disintegration products—penetrate between the cells of the dorsal wall of the pharynx. In none of the species examined do cell processes of the "glands" penetrate the alimentary wall. The cells (except in the case of the Enchytraeidæ) appear to constitute ductless glands and their secretion mixes with the coelomic fluid. The cells arise from the peritoneal lining of the coelom and not from the alimentary epithelium.

OOSPORE FORMATION IN PHYTOPHTHORA.—A note of considerable interest to mycologists is contributed by S. F. Ashby to the *Kew Bulletin* (No. 9, 1922, pp. 257-261) upon the formation of oospores in a species of Phytophthora, *P. Faberi* Maubl. The author has isolated from the cacao plant in Jamaica and Grenada, from rotting cotton bolls in St. Vincent, and from the coconut palm in Jamaica, strains of Phytophthora, apparently this species, which appear identical in growth in pure culture save that the strain from cacao seems less vigorous. In pure cultures oospores are not formed upon any of these strains, but if the strain from cacao is grown in mixed culture with either of the other two strains, oospores appear regularly in the culture as the mycelia interpenetrate and persistent antheridia are present. So far these interesting observations would admit of interpretation upon the assumption of heterothallism so thoroughly worked out by Blakeslee for the Mucoraceæ, but Ashby's observations upon the result of mixing strains of this species with a strain of the distinct species *P. parasitica* Dast. isolated from Ricinus in India are totally unexpected. Oospores are developed in such mixed cultures but are throughout of the diameter characteristic of *P. Faberi*, the smaller oospores of *P. parasitica* not being detected. The further development of this interesting work will be followed with great interest.

PHILIPPINE EARTHQUAKES.—We have received a reprint of the *Weather Bulletin* (for December 1920) of the U.S. Weather Bureau containing the catalogue of Philippine earthquakes for the year 1920. The number of shocks recorded (147) is close to the average (150) for the last eighteen years, though only one (the Benguet earthquake of October 8) was strong enough to cause slight damage to buildings. In two useful tables are given the monthly numbers of earthquakes felt in the Philippines for every year from 1903 to 1920, and also similar numbers of earthquakes recorded at Manila, the total numbers being respectively 2699 and 5781. An interesting result obtained from these tables is that, as in other insular seismic districts, the earthquakes of the Philippines are subject to a very slightly marked annual period.

OIL IN RUSSIA.—Some aspects of the occurrence of oil in Russia formed the subject of a paper read by Mr. T. G. Madgwick before the Institute of Petroleum Technologists on December 12. The author considered briefly the geology and structures of the principal fields, and by a generalised correlation of these widely distributed occurrences, attempted to forecast the future possibilities of the country as an oil producer, both as regards existent and potential resources. While it may be doubted whether such prolific pools as those of Baku will ever be struck again (the conditions here being peculiarly favourable to oil accumulation), so much unprospected territory, at least technically favourable, remains to be examined, that he would be a bold man who prophesied a non-recurrence of industrial achievements which at one time rivalled even those of the United States. The cure for the present ills of the Russian petroleum industry lies in the establishment of political and economic stability, in reorganisation of existing fields, and in a business-like system of production. The author also stressed the necessity for giving serious attention to certain technical problems, in particular water troubles, which even before the Revolution were causing anxiety to many producers. Developments of existing fields may be expected in the Caucasus (Terek region), in the eastern end of the Apsheron peninsula, and in the lower part of the Kura river. The unknown factor, however, is unquestionablyTranscaspia; the Emba district, N.E. of the Caspian Sea, is already a producing field, but vast areas, at present almost inaccessible, await exploration, both to the east and north-east; these prospects have the added merit of being scientifically favourable, at all events in so far as our present geological knowledge of Asiatic Russia is concerned. The author left out of consideration the Sakhalin and Eastern Siberian prospects; these isolated occurrences are only imperfectly known and in any case they can have no relationship with the main resource-area under review; from the geological point of view, they are more closely allied to the occurrences in Japan, and may ultimately be expected to reveal similarities both in development and economic magnitude to that country.

ELECTRICAL DISTRIBUTION ON TWO SPHERICAL CONDUCTORS.—In a recent paper to the Physical Society Dr. Alexander Russell returns to the electrostatic problem of two spherical conductors. The most interesting feature of the investigation is the fact that Kelvin's method of images is not the best way to attack the problem. The author shows how Poisson's method can be made to yield useful results, amenable to easy and accurate numerical computation. The principle of the method is as follows. A functional form is postulated for the potential at any point of the actual but unknown electrical distribution on each sphere, and the constancy of the potential on each sphere is used, coupled with the theory of inverse points. The two cases, (1) one sphere inside the other and (2) the spheres outside one another, are discussed in detail, and applications are made to find the force between the spheres, the energy, and the stress in the medium.

AN AUTOMATIC VOLTAGE REGULATOR.—For electric lighting it is essential that the voltage of the dynamo should vary only between very narrow limits. In country house lighting where the direct current dynamo is driven by a petrol motor the voltage variations sometimes cause serious and very objectionable fluctuations of the light. Messrs. Isenthal and Co., Ltd., now manufacture an automatic rapid action voltage regulator suitable for use with dynamos up to 50 kilowatt capacity. The device is extremely simple, and by its use the voltage can be maintained practically constant even when the driving speed and the load vary very suddenly. The principle employed is practically the same as that used in other vibratory regulators some of which, the Tirrill regulator, for example, are extensively used in electric lighting stations. Messrs. Isenthal's regulator is, however, applicable to quite small machines, and should prove very useful.

GLIDING FLIGHT.—*Die Naturwissenschaften* of October 6, 1922, contains an article by Prof. C. Runge, of Göttingen, entitled "Uber den Segelflug," reproducing a lecture delivered at Wasserkuppe during the German gliding contests last August. Prof. Runge gives a clear account of the main principles underlying gliding or sailing flight. After emphasising the point that a steady horizontal wind is useless for the purpose, the author divides useful winds into two categories, (1) steady winds in upward directions, and (2) variable winds. The former can be used in gliding flight if the vertical component is at least equal to the rate of vertical fall of the glider, and Prof. Runge points out that upward winds are of frequent occurrence; that, in fact, ordinary air movements in the form of wind are primarily vertical, but are horizontal more or less to us because we live at that stratum of the atmosphere affected by the earth's solid crust. In the case of variable winds, several kinds of variations are possible: thus different air layers may have different speeds, or the air in any one layer may have different speeds at different times. An attempt is made to explain non-mathematically how such variation can be used for flight. The effect of dimensions is also considered briefly.

LOSS OF HEAT FROM SURFACES.—At the request of the Engineering Committee of the Food Investigation Board, Dr. E. Griffiths and Mr. A. H. Davis of the National Physical Laboratory have carried out a series of measurements to determine the laws of gain or loss of heat by solid surfaces in contact with air at temperatures which differed from their own, and the results are embodied in the recently issued Report No. 9 of the Board (H.M.S.O., price 1*s.* 6*d.*). It is shown that the loss or gain is mainly due to the convection currents set up in the air close to the surface, and that the amount of heat transmitted per unit time and area is proportional to the 5/4ths power of the difference of temperature of surface and air, a law first stated by Prof. L. Lorenz in 1881. Unfortunately the factor of proportionality is not independent of the shape, size, and orientation of the surface, the loss for the same difference of temperature being greater per unit area and time for a small surface than for a large, and for a horizontal surface facing upwards than for one facing downwards. The authors give curves from which the proper value of the factor can be obtained in any practical case, so that the Lorenz law may be readily used by heating, ventilating, and refrigerating engineers.

UPPER-AIR WINDS IN INDIA.—Memoirs of the Indian Meteorological Department, vol. xxiii. Pt. III., which has just reached us, contains mean monthly characters of upper-air winds deduced from the flights of pilot balloons at thirteen stations in India during the period 1910 to 1919. The discussion has been carried out by Mr. J. H. Field, director of the Agra Observatory, and is published under the direction of the Director-General of Observatories. It contains nearly 100 foolscap pages of figures, with two pages of explanation. At many of the stations the observations are for a few months only and it is not easy to select a period with consecutive observations at several stations. The stations are distributed fairly well over India. Good comparisons can be obtained for the greater part of 1919, and these observations show a general increase in the speed of the wind with height, which is greater in winter than in summer, although this varies with the latitude, being more marked in northern India, according to the observations in February and August at Lahore, Agra, and Akyáb, than in the south as shown by Bangalore. Naturally there is also much variation in the direction of the wind of the upper air at different seasons. To plot graphically the observations for the several stations for the several months and for varying heights would involve considerable labour, but where air-ways are to be used such plotting seems essential. The data will supply much which is of interest relative to the movement of the upper-air over India, and associated with what is known at the earth's surface, it will afford most useful and instructive information.

A NEW BECK MICROSCOPE.—Messrs. R. and J. Beck, Ltd., 68 Cornhill, E.C., have submitted to us an example of their Model 22 "London Microscope." The instrument is simple in design and is supported on a modified horse-shoe base with widespread limbs, which gives complete stability even in the horizontal position. The coarse adjustment is of the spiral rack and pinion pattern, the fine adjustment is of the vertical type with milled head. The stage is a large one measuring 4 in. × 3½ in. With one eye-piece, and a low-angled ⅔ in. and a ⅙ in. objectives in canvas-covered case, the price is the moderate one of 8*l.* 17*s.* 6*d.* Double or triple nose-pieces are supplied at an additional cost of 1*l.* 1*s.* and 1*l.* 10*s.* respectively. A spiral, screw focussing, swing-out condenser of the Abbe type with centring screws, cell, and iris diaphragm costs an additional 2*l.* 7*s.* 6*d.* The instrument is well made and thoroughly efficient and is suitable for all ordinary microscopical work. Additional objectives and other fittings can be supplied if desired.

Exhibition of Physical Apparatus.

TIMES have changed since Lord Bacon had to complain that "the mechanic, little solicitous about the investigation of truth, neither directs his attention nor applies his hand to anything that is not of service to his business." The modern "interpreter of Nature" would contribute scantily to the advancement of learning were he bereft of the mechanic's services, and it is by a happy thought, therefore, that the Physical and Optical Societies bring together every year the manufacturers and users of scientific instruments. At their thirteenth annual exhibition, held at the Imperial College of Science on January 3 and 4, such a wealth of beautiful, and in many cases novel, apparatus was to be seen that we can only refer to a few of the particularly interesting exhibits, selected somewhat arbitrarily.

Of special interest to engineers was a micro-indicator (Cambridge and Paul, Ltd.) for high-speed engines, in which the dimensions of the parts eliminate inertia-errors. A specially designed stylus cuts on celluloid a minute indicator-diagram which can be enlarged photographically or examined at once with a microscope. The Elverson oscilloscope (Herbert Kennedy and Co.) by intermittent illumination made a machine at 1500 revolutions appear to be either stationary or working at 150 revolutions, enabling faulty action to be detected and located. A fine adjustment for speeds derived from a phonic motor was shown in a strobometer (Tinsley and Co.), and comprises a friction gear providing an infinitely variable speed. A tapered drum driven from the phonic motor engages an axially movable friction wheel which carries contacts controlling the intermittent illumination of a stroboscopic disc or the like, the position of the wheel indicating the frequency of the illumination as a percentage of that of the tuning fork which governs the phonic motor.

Much interest was expressed in the new celluloid mirrors (Adam Hilger, Ltd.), the thickness of which is equal to a few wave-lengths of light. These were applied to vertical illumination in a microscope (an arc lamp failing to heat the celluloid on account of its thinness), to acoustic purposes in an optical sonometer, and to the transposition of colour combinations in patterns in the chromoscope (The Chromoscope Co.). In the latter apparatus each element of the design is prepared as a stencil for use in conjunction with a Wratten colour screen which can be changed at will, and by means of an optical device the various elements are viewed in superposition by transmitted light. Other novelties by Hilger were an interferometer attachment for calibrating microscope racks, indicating backlash, and checking the fit of the slide; and some ultra-violet spectrograms on the new Schumann plates which, with a minimum of gelatine and a fluorescent component in their emulsion, require a remarkably short exposure. The latest "Demonstrator's Lantern" (Newton and Co.) could be arranged at will for projecting ordinary slides, for opaque objects, for vertical projection, or for microscopic, polariscopic, or spectroscopic projection. Among microscope improvements might be noted a stand and sub-stage (R. and J. Beck, Ltd.) designed to prevent mechanical disturbances from causing the disappearance of objects from the field of view under high power. The enhanced resolving power obtained by the use of crossed Nicols was demonstrated with this instrument. A new saccharimeter (Bellingham and Stanley) exhibited several novel features. The polarising prism is constructed without the use of cement, the visible edge of the half-prism is a natural edge of the crystal, and the quartz plate, compounded of right- and left-handed quartz wedges, is within the size limit for which flawless crystals are obtainable.

An annual feature of the exhibition is the display of radium apparatus for medical and demonstration purposes by Mr. Harrison Glew. Every year it is a pleasure to see this pioneer, to whom suffering humanity owes no small debt. A radiological ionometer (Watson and Sons) comprised an ionisation chamber connected to an electroscope and arranged for measuring the precise X-ray dosage administered to a patient. Another medical instrument was that for estimating the carbon dioxide content of alveolar air (Cambridge and Paul). It employs a Shakespear katharometer, the thermal conductivity of a breath sample being compared electrically with that of pure moist air. The smoke nuisance received attention in Dr. E. A. Owen's automatic air filter and his jet apparatus (Casella and Co.). In the former, samples of air are strained through white filter paper at regular intervals, the dust content being estimated from the colour of the resulting deposit. In the jet apparatus, a jet of moist air impinging normally on a glass slip is found to deposit its dust, which can then be examined microscopically.

Of electrical testing apparatus there was an immense variety, from the high-frequency low-voltage Moullin voltmeter (Cambridge and Paul), which employs a triode valve so arranged as to preclude disturbance of the circuits to be measured, to the "Meg" insulation tester (Evershed and Vignoles, Ltd.), a remarkably light and cheap megger running to 10,000 mgo. which should prove a boon to linemen. A multiversal test set by Elliott Brothers claimed to measure milliamperes, kilovolts, capacities and much else, besides functioning in Varley and Murray loop tests. A novel relay for radio signals was that designed by Mr. Anson (Tinsley and Co.), in which a neon lamp in the anode circuit of a triode valve intensifies current variations on account of its negative characteristic.

Demonstrations of actual manufacturing processes were given by the Igranic Electric Co. (automatic winding of transformers) and Dallmeyer, Ltd. (lens-making shown by kinematograph); and examples of the daily work of the National Physical Laboratory aroused much interest. Each day Mr. W. Gamble lectured on the "Reproduction of Colour by Photographic Processes," an outstanding feature of his lecture being the projection of slides made by the new Eurochrome process, recently acquired from Germany by the Austrian State Printing Office. The results of this process, the nature of which is somewhat obscure, mark a substantial advance in the art. Prof. E. G. Coker lectured on "Recent Photo-Elastic Researches on Engineering Problems," giving a beautiful demonstration of his method, in which the distribution of stress in transparent models is traced by means of polarised light. In this way he showed the effect of shape on stress-distribution in chain links, tensile and compressional test specimens, and gear and worm wheels in action. He also demonstrated the stresses set up during turning, planing, and milling, showing that the cutting edge is preceded by a region of compression and followed by one of tension, the shaving itself being free from stress in the neighbourhood of its point of attachment. With a burred edge the stresses were seen to oscillate.

Mr. F. E. Smith, who made the necessary arrangements, is much to be congratulated on the success of the exhibition which failed to furnish any experimental evidence for the unluckiness of its number. Some fifty-six exhibitors participated. C. W. H.

Scientific Expeditionary Research.

A SMALL meeting, which was attended by representatives of several of the sciences more immediately concerned, was held in the rooms of the Linnean Society, on January 3, under the presidency of Sir Kenneth MacKenzie, Bart., to discuss the formation of a "Scientific Expeditionary Research Association"; and it was agreed that this action should be taken. The general objects of the scheme, as stated in a draft which had been prepared before the meeting, are to facilitate and promote scientific research by means of expeditions to all parts of the world. The association, which is to be precluded from making any distribution of dividends or bonus in money, is to consist of a body of fellows and members, and any profits which may accrue from its operations are to be devoted to the objects stated.

It is proposed to commence with an expedition to the Pacific, visiting islands which lie off the beaten track, and the journey is to be undertaken in a sailing ship. The necessary funds are to be provided by the contributions, at a fixed rate, of about fifty persons of either sex who may be expected to take a general interest in the work of a scientific expedition. A more definitely scientific nucleus is to be provided by the nomination, by scientific societies or in other ways, of from six to ten suitably qualified persons who would not be expected to make any contribution in money.

It is believed that the scientific members of the party would be able to carry out investigations during the cruise or at islands at which a halt was to be made, and that they would be able to interest and obtain assistance from the others. The itinerary, which would be decided beforehand, would be arranged so as to facilitate work of a serious nature, and the plan of the tour would be devised with special reference to the investigations it was proposed to carry out. This matter would be in the hands of an advisory council, in which it is hoped that it will be possible to include representatives of various sciences who could assist in drawing up a practicable scheme. It is believed that there would be a profit on the first cruise, and that this would be available for partly financing the next expedition, supplemented by receipts from other sources, such as the subscriptions of fellows and members, the profits of lectures and the sale of specimens and publications. The existence of an organisation which would be able to send out scientific expeditions as required, from time to time, would be likely to prove extremely useful in advancing natural knowledge.

The promoters of the scheme believe that they will have no difficulty in obtaining the support necessary to enable them to carry out their first expedition. If this can be done, it seems obvious that there should be many opportunities of obtaining valuable collections of animals, plants, and rock-specimens; and that the investigation of these collections is likely to yield results which will give the association the right to claim that a part of its objects has been accomplished. It was pointed out at the meeting that success in carrying out research-work during the cruise was likely to depend mainly on the possibility of finding qualified investigators who would be able to accompany the expedition, and of planning a tour which would give scope for the execution of the work on which they were severally engaged. The meeting can scarcely be said to have been in a position to decide how this could be done, and no definite scheme has at present been thought out. The difficulties were admitted, but the opinion was expressed by certain speakers that they could be surmounted, by the restriction of the efforts of each cruise to a series of investigations which would not be incompatible with one another.

The officers of the association are Sir J. Kenneth D. MacKenzie, Bart. (president), Commander D. Blair, R.N.R. (marine superintendent), and Mr. Frederick W. Kealey (organising secretary); and the offices are at 68 Pall Mall, S.W.1, from which further information can be obtained. Suggestions as to lines of work which could profitably be undertaken during the first cruise would be gladly received by the officers, and it is particularly desirable to receive the names of well-qualified scientific investigators who would be prepared, if appointed, to accompany the expedition and to carry out specified researches.

Geography in Education.

THREE matters of scientific interest were discussed at the annual meetings of the Geographical Association. Sir John Russell, of Rothamsted Experimental Station, gave the presidential address on "The Influence of Geographical Factors on the Agricultural Activities of a Population." Confining his illustrations to Britain, he pointed out that in earlier times each village community had to be self-supporting, and that agricultural systems were uniform all over the country. This implied that certain areas, mainly heavy clays and light sands, were perforce left vacant, and that the drier south and east were the most attractive for agriculture and settlement. With later improvements of transport and increased knowledge of how to combine animal production with the growing of grain and other vegetable foods, the action of the geographical factors was modified, and the modification seems now to be in process of being carried a step further, as different parts of the country are specialising in productions, mainly luxuries, for which they are specially suited.

Dr. Olive Wheeler, of the University of Manchester, spoke of "The Place of Geography in the Education of the Adolescent." She approached the matter from the point of view, not of subjects, but of the pupils. She considered specially the physical and mental development of young people between the ages of 12 and 16. She pointed to the quick growth in bulk and the rapidity of bodily changes, and emphasised also the extreme importance of the new emotional experiences, social, æsthetic, and religious, as well as sexual. Any education worth the name must take account of the fact that boys and girls of the ages considered are, consciously or unconsciously, attempting to find a philosophy of life. It is the business of teachers to arrange that the process is carried on with tolerance and broadmindedness. To do this it is necessary that education should deal with the study of matter on one hand and with the development of personality by means of the humane subjects on the other. Dr. Wheeler then emphasised again the position of geography as a correlating subject in which is considered not only how matter affected man but how man affected matter. Geography, probably, better than any other subject helped boys and girls to obtain a true philosophy of life.

Prof. Tower, American commercial attaché, American Embassy, lectured on "Geography in Business

Life." If Dr. Wheeler stressed the value of geography in living, Prof. Tower emphasised the value of geography in earning one's living, and gave examples. He referred to an institution in the United States, at which the finger of scorn was pointed because it took as its motto "Anything to catch the nimble nickel." It was significant that geography had been taught there for many years, is still being taught, and there is no suggestion that it should go out. Even more striking was the case of one of the great trade houses of New York—of international reputation—which looked for a trade adviser, not to get business himself but to help other heads of departments. They were advised by their chartered accountants to appoint a geographer as the most suitable man, and did so. Prof. Tower told also of a convention of eighty administrative heads of great business houses in the United States. In each of the last three years there have been discussions of the relations of geography teaching to trade and business, and most of the important geographers have contributed to the discussion. It is significant that this course was adopted by men who never were taught geography themselves as it is taught now, and knew only what modern teaching has done.

Mr. E. J. Bradford, of the University of Sheffield, read a paper at the annual meeting of the Geography Section of the Training College Association. The paper dealt with the results of a geography test given to various classes in secondary schools, and was noteworthy in that it was set neither by an external authority to pass or fail candidates nor by a teacher to find out what his pupils knew. The test was set for purely scientific objects. The methods bear some resemblance to those of intelligence tests, but were constructed with the view of finding, not the intelligence of the pupils but the effectiveness of the geography teaching from year to year. The results were extremely interesting, but admittedly the experiment is only in its initial stages, and it would not be fair to state the conclusions tentatively drawn, as they may be modified.

Paris Academy of Sciences.

PRIZE AWARDS FOR 1922.

AT the meeting of the Paris Academy of Sciences, held on December 18, the following prizes and grants for 1922 were awarded:

Mathematics.—The Grand prize of the Mathematical Sciences to Jean Le Roux for the whole of his work; the Poncelet prize to Jules Drach for the whole of his work in mathematics; the Francœur prize to Louis Antoine for his works on geometry.

Mechanics.—The Montyon prize to Farid Boulad; the Fourneyron prize to J. A. Farcot d'Albaret for his work on the gas engine; the Henri de Parville prize to Henri Béghin for his memoir on the theoretical study of gyrostatic compasses.

Astronomy.—The Lalande prize to Henry Norris Russell for his work in physical astronomy; the Valz prize to Jean Chazy for studies in celestial mechanics, and particularly for his memoir on the course of the movement in the problem of three bodies when the time increases indefinitely; the Janssen medal to Carl Störmer for his theoretical and experimental researches on the aurora borealis.

Geography.—The Delalande-Guérineau prize between Achille Lamotte and Charles Mailles (in equal parts); the Gay prize to Ludovic Gaurier for his explorations in the Pyrenees; the Binoux prize to Paul Le Cointe for his study of the river Amazon; no award was made of the Tchihatchef prize.

Navigation.—The prize of six thousand francs between Maurice Garnier (3000 francs) for his work on the calculation of trajectories by successive arcs, André Vinsot (1500 francs) for a contribution to the study of the tactics of loosing torpedoes, and Henri Roussilhe (1500 francs) for his hydrographical researches; the Plumey prize to Edouard Sauvage for his work on steam engines.

Physics.—The L. La Caze prize to Anatole Leduc for the whole of his scientific work; the Kastner-Boursault prize to Camille Gutton for his work in electricity, and more particularly on Hertzian waves; the Hébert prize to Charles Chéveneau for his work in electricity and magnetism; the Hughes prize to Camille Raveau for his work in various branches of theoretical physics; the Clément Felix foundation to Alexandre Dufour for the continuation of his researches on the registration of Hertzian waves.

Chemistry.—A Montyon prize (Unhealthy Trades) (2500 francs) to (the late) Charles Boulin for his researches on mustard gas; an honourable mention (1500 francs) to Louis Tampier for his work on the manufacture of poison gas; the Jecker prize between Marcel Godchot (5000 francs), Marc Bridel (2500 francs), and Georges Tanret (2500 francs) for the whole of their chemical work; the La Caze prize to Paul Thiébaud Muller for his physico-chemical researches; the Cahours foundation to Andrée Chaudun for her physico-chemical study on sugar inversion; the Houzeau prize to René Dubrisay for his work on solutions.

Mineralogy and Geology.—The Victor Raulin prize to Louis Longchambon for his researches on the relation between rotatory power and crystalline symmetry.

Botany.—The Desmazières prize to Edouard Chatton for his work on the Protozoa, Louis Emberger and Ethel Mellor receiving honourable mentions; the Montagne prize to Etienne Foëx for the whole of his work in mycology; the La Fons Mélicocq prize to Pierre Allorge for his memoir on the botanical geography of the French Vexim; the de Coincy prize to Marcel Denis for his work on the Euphorbiaceæ.

Anatomy and Zoology.—The Cuvier prize to René Koehler for his researches on the echinoderms; the Savigny foundation to Jacques Pellegrin for his memoir on the fresh-water fishes of Northern Africa; the Thore prize to Lucien Chopard for his work on the Orthoptera.

Medicine and Surgery.—Montyon prizes to Charles Dopter (2500 francs) for his book on meningococcic infection, Eugène Wollman (2500 francs) for his studies on life in the absence of micro-organisms, Edmond Lesné and Léon Binet (2500 francs) for their book on the normal and pathological physiology of the infant; honourable mentions (1500 francs) to Emile Weil and Jean Loiseleur for their works on pneumo-serous diagnoses and therapeutics, J. B. Piot-Bey for his work on the organisation and working of the veterinary service of the state domains of Egypt, and Philippe Lasseur and Louis Spillman for their book on antibody reactions, a quantitative study of the fixation of alexine; citations to André Feil for his memoir on the absence and diminution of the cervical vertebræ, to Serge Tchahotine for his researches on experimental cytology made with the microscopic radio-puncture method, to Maurice Fontoynont and Humbert Boucher for their contribution to the study of the mycoses of Madagascar; the Barbier prize to Edmond Delorme for his work on pulmonary decortication; the Bréant prize between

Marie Phisalix, for her book on poisonous animals and their venoms, and Edmond and Étienne Sergent, for their work on the etiology and prophylaxy of Debab, a trypanosomiasis of the dromedary of Northern Africa; the Godard prize to Jean Turchini for his studies on the cytological processes of elimination of colouring matters by the kidney; the Mège prize to Pierre Mathieu for his researches in experimental physiology; the Bellion prize between Giuseppe Favaro (700 francs), for his book "Lo spatium supragenuale e le formazioni in esso contenute," and Arthur Vernes (700 francs), for his researches on the measurement of flocculation by photometry; the Baron Larrey prize to Pierre Perrin de Brinchambaut for his book on the criteria of aptitude for flight in aeroplanes.

Physiology.—The Montyon prize to Gaston Giraud for his memoir on medio-cubital association in wounds of the upper member; the La Caze prize to Léon Fredericq for the whole of his work in physiology; the Pourat prize to René Wurmser for his memoir on researches on chlorophyll assimilation; the Martin-Damourette prize to Pierre Abrami for his researches on the pathogeny and treatment of marsh fevers; the Philipeaux prize to Costantino Gorini for his studies on the lactic fermentation.

Statistics.—The Montyon prize to Pierre Richard for his work on the mathematical theory of assurance.

History and Philosophy of Science.—The Binoux prize to Gino Loria for his historical works.

Medals.—The Berthelot medal to Charles Boulin, Marcel Godchot, Marc Bridel, Paul Thiébaud Muller, René Dubrisay.

General Prizes.—The Alhumbert prize to Charles Mauguin for his work on liquid crystals; the Bordin prize to Joseph Magrou for his memoir on symbiosis and tuber formation; the Lallemand prize to Paul Wintrebert for his work on the nervous systems of embryonic vertebrates; the Vaillant prize to Wladimir Vernadsky for the whole of his work in mineralogical chemistry; the Houllevigue prize to Rodolphe Soreau for his work on aviation and book on nomography; the Saintour prize to Serge Metalnikoff for his work in immunology; the Henri de Parville prize between Robert Lespieau (2000 francs), for his book on the chemical molecule, and Léon Toraude (500 francs), for his historical publications; the Lonchampt prize to Henri Colin for his work in plant physiology; the Henry Wilde prize to Carl Benedicks for his memoir on the homogeneous electro-thermic effect; the Caméré prize to Jules Bied for his researches on cement; the Victor Raulin prize between Philippe Schereschewsky and Philippe Wehrlé (1000 francs) for their memoir on cloud systems, and Augustin Boutaric (500 francs) for his work on the intensity of solar radiation; the Gustave Roux prize to Pierre Teilhard de Chardin for his work in palæontology; the Thorlet prize to Adolphe Richard.

Special Foundations.—The Lannelongue foundation between Mmes. Cusco and Rück; the Laplace prize to Louis Marcel Massenet; the medal is also accorded to eight other pupils of the École polytechnique; the L. E. Rivot prize between Louis Marcel Massenet, Louis Edmond Séraphin Charvet, Jacques Alexandre Morane, and Alexandre Georges Louis Delattre.

Funds for Scientific Research.—The Trémont foundation to Clément Codron for his book on cutting metals; the Gegner foundation (2000 francs) to Jules Geffroy; the Jérome Ponti foundation to Pierre Mahler for his work on combustibles; the Hirn foundation to Emile Schwoerer for his work in mechanics; the Henri Becquerel foundation to André Danjon for the application of his method of measuring the apparent diameter of the stars; the Charles Bouchard foundation to Georges Bohn for the continuation of his biological work; the Henry Le Chatelier foundation to Paul Riou, Ernest Toporescu, and Paul Mondain-Monval (5000 francs each) for researches bearing on the manufacture of sodium carbonate by the ammonia method, Pierre Lafon (5000 francs) for researches on the enamelling of iron.

University and Educational Intelligence.

THE United States Public Health Service has, in co-operation with the Bureau of Education, collected information as to the present status of sex education in high schools, and the Bureau has published a statistical summary in Bulletin, 1922, No. 14. The proportion of the number of schools giving some sort of instruction in matters pertaining to sex to the number of schools from which returns were obtained (about half of the total number of high schools in the country) is 41 per cent., varying between 17 per cent., in New Hampshire, and 100 per cent., in Utah. Sex education is classified as "emergency"—through lectures or occasional talks by members of the school staff or by physicians, nurses, State health officers, social workers, or ministers, sex hygiene exhibits, pamphlets, etc.—and "integrated," *i.e.* given incidentally in teaching the subjects of the regular curriculum. Although the former method is more frequently resorted to, a large majority of the principals, including those who at present provide no sex instruction, are in favour of the latter. So, evidently, are the authorities of the Public Health Service. These hold the view that "sex education should not be restricted to a certain body of information given at a special time and place, but rather should it be spread over a considerable time and given in various relations." They believe, in short, in breaking down the sex taboo. They point out, however, that few teachers have the combination of mental maturity, poise, sanity, sympathy, accurate knowledge of facts and ability to present them impersonally, and tact, which are requisite for beneficent sex education.

HIGHER education in the maritime provinces of eastern Canada suffers from excessive dispersion of its resources, there being six universities and a technical college doing work of university grade for a population barely exceeding one million. This is partly due to religious particularism. Last year the Carnegie Foundation for the Advancement of Teaching commissioned two experts—Dr. Learned of its own staff and President Sills of Bowdoin College—to visit this area and report on the educational situation with the view of suggesting a constructive policy, for the treatment particularly of the principal higher institutions, all of which had applied to the Foundation for aid. The visits were made in October and November 1921, and the Commissioners presented a report, which has been published as one of the Foundation's bulletins. The report concludes with a recommendation involving complete reconstruction, bringing together into a single university at Halifax, which would include as one of its colleges the Dalhousie University already located there, all the other five universities. It would, the commissioners remark, provide a real solution of the problem and would "prove particularly effective in handling a genuine honors curriculum . . . one of the precious features of English and Canadian universities that should constantly be held uppermost in planning new departures in higher education." The cost is estimated at $4\frac{1}{2}$ million dollars. From an announcement in the *Times* of December 15 it would appear that the numerous difficulties in the way of realising the scheme have been surmounted, representatives of the corporations and governments concerned having arrived at agreement in regard to it.

Societies and Academies.

LONDON.

Linnean Society, December 14.—Dr. A. Smith Woodward, president, in the chair.—W. O. **Howarth**: On the occurrence of *Festuca rubra* in Britain. Representatives of three subspecies, three varieties, six subvarieties, and the forms of Hackel's *F. rubra*, occur in Britain.—H. W. **Pugsley**: British species of Calamintha and a species new to this country. The three recognised British species are said to be *Calamintha ascendens*, Jord., *C. Nepeta*, Savi, and *C. sylvatica*, Bromfield. The new form, first found near Swanage, in Dorset, in 1900, and again in 1912, was identified with *C. bætica*, Boiss. and Reut., although showing differences in minor features, which were attributed to climatic influence.—Lily **Batten**: The genus Polysiphonia; a critical revision of the British species, based upon anatomy. British species of Polysiphonia show great diversity of habitat. Four main types are distinguishable: (1) Ecorticate plant attached when young by rhizoids developed by longitudinal proliferation of basal siphons. Later, siphons of procumbent branches develop rhizoids, which may have discs at their distal ends, or may ramify among filamentous algæ, or may be swollen to form haustoria. (2) Species having a number of siphons or the beginning of cortication at the base, show elementary aggregation of the rhizoids to form one large disc. (3) Stunted procumbent branches develop at the base of the plant, which produce attachment rhizoids. (4) Corticate species having an upright habit develop a large disc-like expansion by the longitudinal proliferation of basal siphons and corticating cells. The genus is divided into thirteen ecorticate and eleven corticate species, and *P. spiralis* is described for the first time.

Aristotelian Society, December 18.—Prof. H. Wildon Carr in the chair.—Roy Wood **Sellars**: The double-knowledge approach to the mind-body problem. The motives which have worked for the exclusion of mind and consciousness from the brain appear upon examination to have been based upon hasty assumptions. We may call these the epistemological, the categorical, the methodological, and the theological methods. We must determine the reach and character of the knowledge gained by the science of external observation. This beginning is imperative. It seems that this knowledge consists of the critical deciphering by means of "scientific data" of the structure, order, composition, quantity, and behaviour of things and their parts. This is the kind of knowledge we have of bodies, but it is necessarily external. It cannot penetrate to the "filling" or content of being. But in our own case, our consciousness is just such a participation. A careful examination of the situation shows that changes in consciousness are indexes of operations which must also be attributed to the brain. Thus we know the brain in two ways. We should speak of it as the brain-mind. We must conceive the mind more substantialistically than we have done hitherto and make it mean a class of operations, and that which expresses itself in these operations. But we must also re-define consciousness. Leaving aside temporarily the structure of an adult consciousness let us define any element which we call the psychical. The psychical is not a stuff; that was the mistake of association psychology. It is merely a *quale*. Now a *quale* is not self-sufficient. It is a dimension of the content of being which can be given only by participation, not by external knowledge. It is indissolubly one with the responding brain-mind state. Its function is to guide the discharge of this state. Here we are partially on the inside of a high level of causality.

Royal Anthropological Institute, December 19.—Prof. J. L. Myres, vice-president, in the chair.—Cyril **Fox**: The distribution of population in the Cambridge region in early times, with special reference to the Bronze Age. The distribution in Britain of constructions attributable to the Neolithic and Early Bronze Ages suggests that the population was then limited to those areas, mainly upland, which must have been, under natural conditions, largely free from forest. A topographical analysis of finds and remains of all culture periods from the Neolithic to the Saxon in a limited area—the Cambridge region—was undertaken to determine whether this limitation was complete or partial, and when the clearing and occupation of forest areas commenced. The Cambridge region is very suitable for the inquiry, since it possesses a wide range of soils and has yielded numerous finds of all periods. The maps exhibited suggest (1) that the chalk belt and the eastern shoreline of the Fens were occupied from Neolithic times onwards; (2) that there was a gradual shift of population from N.E. to S.W., *i.e.* from the West Suffolk heathland to the fertile lands of the upper Cam and Ouse valleys, as agriculture developed; and (3) that the forest uplands were almost entirely unoccupied until the Roman period. The distribution of population in the Bronze Age is, generally speaking, of a character intermediate between that of the Age which preceded it and that which followed, but it presents features of special interest.

DUBLIN.

Royal Dublin Society, December 19.—Prof. J. A. Scott in the chair.—Six papers on the action of the oxides and the oxyacids of nitrogen on aromatic urethanes and ureas at low concentrations of the reacting substances.—(1) **H. Ryan** and **Anna Donnellan**: Diphenylurethane reacted with nitric acid much more slowly than diphenylnitrosamine. At the ordinary temperature it was slowly converted first into 4-nitrodiphenylurethane and afterwards into a mixture of 4·10-dinitro- and 2·10-dinitro-diphenylurethane. Concentrated nitric acid reacted with the urethane forming 2·4-8·10-tetranitrodiphenylurethane and finally sym. hexanitrodiphenylamine.—(2) **H. Ryan** and **N. Cullinane**: *o*-Tolyl-ethylurethane was oxidised by the oxides and the oxyacids of nitrogen yielding *o*-tolylurethane. The latter substance then underwent nitration, forming successively 4-nitro-2-methyl-phenylurethane and 4·6-dinitro-2-methylphenylurethane.—(3) **H. Ryan** and **Anna Connolly**: Ethylphenylurethane nitrated at the ordinary temperature gives 4-nitro- and 2·4-dinitrophenylurethane. In hot solutions, on the other hand, the urethane, like *o*-tolyl-ethylurethane, underwent oxidation in addition to nitration. In the latter case the products isolated were 2·4-dinitro- and 2·4-6-trinitro-phenylurethane.—(4) **H. Ryan** and **J. O'Donovan**: Phenylbenzylurethane was converted by nitrogen peroxide into 4-nitrophenylbenzylurethane and a trinitrophenylbenzylurethane melting at 110° C. Similar results were obtained by the action of nitric acid at low temperatures on the urethane. At more or less high temperatures and concentrations of the substances a tetranitrophenylbenzylurethane melting at 126° C., a pentanitro derivative melting at 274° C. together with 4-nitrobenzoic acid, 2·4-dinitro-phenylurethane and pentanitrophenylbenzylamine.—(5) **H. Ryan** and **P. O'Toole**: Phenylurea and as-diphenyl-

urea reacted easily with oxides of nitrogen, the former giving nitro-phenols and the latter diphenylamine derivatives; *s*-diphenylurea and triphenylurea under the same conditions gave a dinitro-diphenylurea and a trinitrotriphenylurea respectively. Nitrous acid converted phenylurea and *s*-diphenylurea into their nitroso derivatives. Nitric acid converted phenylurea into phenylurea nitrate, *p*-nitrophenylurea, and 2·4-dinitro-phenylnitrourea. With *s*-diphenylurea it gave mono-, di- and tetranitro derivatives, and with triphenylurea it formed di-, tri- and pentanitro derivatives.—(6) **H. Ryan and M. Sweeney**: Phenylmethylurea and nitric acid underwent no change in the absence of nitrous acid. In the presence of the latter acid it was converted into methylaniline, phenylmethylnitrosamine, and then successively into 2- and 4-nitrophenylmethylnitrosamine, 2·4-dinitro- and 2·4·6-trinitro-phenyl-methylamine. With concentrated nitric acid, tetryl was formed readily and in a pure condition from the urea.

Official Publications Received.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau), 1921–1922. Pp. iv+96+6 plates. (Calcutta: Government Printing Office.) 14 annas.

The University of Chicago. Bulletin of Information, Vol. 22, No. 4: Register of Doctors of Philosophy of the University of Chicago, June 1893–December 1921. Pp. 96. (Chicago: University of Chicago Press.)

Canada. Department of Mines: Geological Survey. Bulletin No. 35, Geological Series No. 42: Relationship of the Precambrian (Beltian) Terrain to the Lower Cambrian Strata of South-eastern British Columbia. By S. J. Schofield. (No. 1966.) Pp. 15. (Ottawa.)

Canada. Department of Mines: Geological Survey. Summary Report, 1921, Part B. (No. 1959.) Pp. 104B. Summary Report, 1921, Part E. (No. 1944.) Pp. 61E. (Ottawa.)

Field Museum of Natural History. Publication 208, Report Series, Vol. 6, No. 1: Annual Report of the Director to the Board of Trustees for the Year 1921. Pp. 75+16 plates. (Chicago.)

Sixtieth Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan, and Thirty-fourth Annual Report of the Experiment Station from July 1, 1920, to June 30, 1921. Pp. 636. (Lansing, Mich.)

State of Connecticut. Public Document No. 24: Forty-fifth Annual Report of the Connecticut Agricultural Experiment Station; Being the Annual Report for the Year ending October 31, 1921. Pp. xi+445. (New Haven, Conn.)

Department of the Interior: United States Geological Survey. Bulletin 722: Mineral Resources of Alaska; Report on Progress of Investigations in 1920. By A. H. Brooks and others. Pp. 266+xiii +3 plates. (Washington: Government Printing Office.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. Vol. 28: Procès-Verbaux (Septembre 1922). Pp. 74. (Copenhague: A. F. Høst and Son.)

Legislative Assembly: New South Wales. Report of the Director-General of Public Health, New South Wales, for the Year 1920. Pp. v+195. (Sydney: J. Spence.) 8*s*. 3*d*.

Diary of Societies.

SATURDAY, JANUARY 13.

GILBERT WHITE FELLOWSHIP, at 2.15.—Visit to the Geological Museum, Jermyn Street.

NATIONAL UNION OF SCIENTIFIC WORKERS (Annual Council Meeting) (at Caxton Hall), at 2.30.

MONDAY, JANUARY 15.

CHEMICAL INDUSTRY CLUB (2 Whitehall Court), at 8.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Lt.-Col. D. Cree: The Yugo-Slavia–Hungarian Boundary.

TUESDAY, JANUARY 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. F. G. Donnan: Semi-permeable Membranes and Colloid Chemistry (1). The Theory of Ionic Equilibria and Semi-permeable Membranes.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—Dr. R. Dudfield and others: Discussion on The Registration of Disease.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. C. Dollman: Address.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—C. E. Greenslade, J. E. S. White and others: Discussion on the Need for Suitable Training in Illuminating Engineering.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—F. W. H. Migeod: The Bedde Group of Tribes of N. Nigeria.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Prof. M. J. Stewart and Dr. J. le F. C. Burrow: Malignant Spheno-occipital Chordoma.—Dr. A. J. Eagleton and Miss E. M. Baxter: The Serological Classification of Virulent B. Diphtheriæ.—Dr. C. C. Okell and Miss E. M. Baxter: The Fermentative Reactions of Virulent B. Diphtheriæ.

WEDNESDAY, JANUARY 17.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—W. H. S. Jones: Medical Etiquette in Ancient Times.—Dr. C. Singer: The Hippocratic Oath.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. C. Chree: Aurora and Allied Problems (Presidential Address).

ROYAL SOCIETY OF ARTS, at 8.—C. A. Klein: Hygienic Methods in Painting: the Damp Rubbing-down Process.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—(Annual Meeting).

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 8.—Prof. F. J. Cheshire: The Petrological Microscope and its Optical Evolution (Presidential Address).

THURSDAY, JANUARY 18.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—J. Barcroft: Observations on the Effect of High Altitude on the Physiological Processes of the Human Body.—Prof. E. W. MacBride: Some New Light on the Inheritance of Acquired Characters.—C. F. Cooper: *Baluchitherium osborni* (? syn. *Indricotherium turgaicum*. Borrissyak).—J. A. Gunn and K. J. Franklin: The Sympathetic Innervation of the Vagina.—H. G. Cannon: The Metabolic Gradient of the Frog's Egg.—Basiswar Sen: The Relation between Permeability Variation and Plant Movements.—Dr. H. L. Duke: An Inquiry into an Outbreak of Human Trypanosomiasis in a *Morsitans* Belt to the East of Mwanza, Tanganyika Territorv.—Dr. L. Dollo: Le Centenaire des Iguanodons (1822–1922).

LINNEAN SOCIETY OF LONDON, at 5.—Capt. G. H. Wilkins: An Account of the Shackleton-Rowlett Expedition in the *Quest* to the Antarctic Regions.—Miss Helena Bandulska: The Cuticular Structure of certain Dicotyledonous and Coniferous Leaves from the Middle Eocene Flora and Bournemouth.—W. R. Sherrin: A Pocket Herbarium of the British Mosses.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—L. J. Mordell: Lecture on An Introductory Account of the Arithmetical Theory of Algebraic Numbers, and its recent Developments.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major J. D. Rennie: Flying Boats.

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

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—G. H. Nelson: Works Production.

CHEMICAL SOCIETY, at 8.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 8.30.—Dr. J. W. McNee and Dr. A. M. H. Gray: A Chemical and Histological Study of a Case of Sclerema neonatorum.—J. E. A. McDonah: The Use of Manganese as a Chemo-therapeutic Preparation.

FRIDAY, JANUARY 19.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—The Earl of Ronaldshay: A Clash of Ideals as a Cause of Indian Unrest.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—Dr. L. Turner and J. S. Fraser: Demonstration of Labyrinthitis as a complication of Middle Ear Suppuration.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—L. Pendred: The Problems of the Engine Indicator.—Prof. F. W. Burstall: A New Form of Optical Indicator.—W. G. Collins: Micro-indicator for High-speed Engines.—H. Wood: R.A.E. Electrical Indicator for High-speed Internal-Combustion Engines, and Gauge for Maximum Pressures.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. C. Saunders: Paraffin as Fuel for Marine Motors.—T. H. Sanders: Laminated Springs.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Soap Films as Detectors: Stream Lines; Vortex Motion, and Sound.

SATURDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Walford Davies: Speech Rhythm in Vocal Music (1).

PUBLIC LECTURES.

THURSDAY, JANUARY 18.

LONDON HOSPITAL MEDICAL COLLEGE, at 4.30.—W. A. M. Smart: The Mathematical Basis of Physiological Problems. (Succeeding Lectures on January 25, February 1, 8, 15, 22, and March 1 and 8.)

UNIVERSITY COLLEGE, at 5.30.—J. C. Flügel: The Psychology of Folklore.

KING'S COLLEGE, at 5.30.—Prof. W. Barthold: The Nomads of Central Asia. (Succeeding Lectures on January 25, February 1, 8, 15, and 22.)

SATURDAY, JANUARY 20.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Ancient Egypt and the Aegean Islands.