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Science and the Army Officer.

THE degree to which applied science dominated the great War astonished even those who had previously predicted that, in the twentieth century, bravery and brilliant leadership would, without the aid of the laboratory, be powerless against continental armies. As a consequence of the development of new methods of warfare, and the increasing elaboration of older ones, the British officer, especially the senior officer occupying a technical post, often found himself handicapped by lack of scientific knowledge. The War is too recent for its lessons to have been forgotten entirely, and it is less surprising that the question of the education and training of the artillery and engineer officer should have come up for discussion than that it should have received the very perfunctory consideration which has been accorded to it in the recent report[1] of a committee appointed by the late Government.

To the casual reader this report may very likely commend itself by the moderation and apparent pertinence of its conclusions and the clarity of its presentation. Closer study reveals that, in spite of the efforts of its authors, the report suffers from deficiencies and misconceptions which must spring from either a deliberate neglect of certain aspects of the question, or from the fact that there was no one on the committee possessing a really intimate knowledge of the present-day needs of the technical officer and the means in existence for satisfying them. The Committee had an ideal chairman in Lord Haldane, to whose wisdom the modern army owes so much, and to whose presence the report must owe much of its merit: the members were Lieut.-Col. W. R. Campion; Lieut.-General Sir J. P. du Cane, the Master-General of the Ordnance; Major-General C. F. Romer, Director of Staff Duties; and a civilian member, Mr. W. Spens, a well-known Cambridge tutor whose main interest would seem to be controversial theology, if a prominent work of reference is trustworthy. It is to be noted that there is no man of science of conspicuous eminence on the Committee, and that Cambridge is the only educational institution represented. The Committee had before it nineteen witnesses whose names and status are not given.

The problem of the education of officers falls naturally into two parts, concerned respectively with the training of the regimental officer and with that of the technical or specialist officer, whose importance has so much increased in the last ten years. It is in the consideration of the former that the Committee appears to best advantage. One of its first concerns was to devise means to make the military profession more attractive,

[1] Report of the Committee on the Education and Training of Officers Printed and published by His Majesty's Stationery Office. 1924. Price 9*d.* net.

for there has been recently a marked shortage of suitable applicants for commissions. It is wisely recommended that County Council and other scholarships should be tenable at the Royal Military Academy and the Royal Military College, establishments which are designed for the training of artillery and engineering cadets, and of infantry cadets, respectively. With the object of securing a higher standard of general education it is proposed to raise the lower limit of the age of entry to these institutions, which was until recently seventeen and a half, to eighteen years, which involves the shortening of the period of training for a commission from two years to eighteen months. This implies that general education is better given at the average public school than at the army schools, and there is little doubt that this is so.

There are some admirable sentiments expressed in this part of the report, but even here there are indications that opinions have been sometimes founded on a superficial inquiry rather than a patient investigation. For example, reference is made to the military discipline at the Royal Military Academy, which is considered too strict. No mention is made of the excellent relations between cadets and officers at the Academy, which is the astonishment and admiration of certain foreign institutions, nor is there any suggestion that officers who had recently passed through the Academy were questioned on this point. We ourselves have spoken on this subject to more officers than the whole number of witnesses heard by the Committee, without being able to elicit any suggestion that they found the discipline irksome. Rather, it is the most valuable part of the training at the Academy, and officers who enter a regiment through other channels miss in it something of real value, which can scarcely be said of the scientific teaching at that institution.

However, the question which more closely interests readers of NATURE is that of the higher education of the artillery and engineer officers. It is important that the best of these officers (who compare well with those that win honours degrees at universities) should be given opportunities of making full use of their powers, and encouraged to take up the more technical studies of the profession. For the sake of precision we may devote the main part of our consideration to the artillery, which offers so good an example of the multiplicity of technical qualifications involved to-day. Not only are a certain number of officers required in each department of artillery studies (we may cite, to take examples at random, range-finding, sound-ranging, gun-construction, external and internal ballistics, and fuse design), but also—a fact too commonly overlooked—it is much to be desired that there should be a body of officers with a good general scientific training, destined, especially in time of war, to take an intermediate position between the civilian experts and the ordinary staff officer. Few will deny that during the War much unnecessary trouble and delay arose because the officers appointed to work in conjunction with the men of science of the country had, in most cases, no knowledge at all of scientific method, and so, in spite of the best will in the world, were generally at a loss to know what to encourage and what to restrain, what was feasible and what impossible, who was eminent and who little better than a charlatan. While it is inadvisable, because impossible, to provide military experts in every branch of science which may be involved in modern war, there is certainly a place in every division for a few officers who can talk to experts in their own language without an interpreter. Finally, the few exceptionally gifted and scientifically inclined men who are to be found to-day (and no doubt will be found in the future) in the army, should have every opportunity and encouragement to acquire training in research which may fit them to take up the many important problems in ballistics and kindred subjects which are awaiting solution.

There is no indication in the Committee's report that the members have considered in any detail the nature of the technical training required for artillery officers—in fact, there is no indication that any one with either detailed knowledge of the subject or practical experience in teaching such officers ever came before the Committee. The most astonishing fact, however, is that the one army college of university rank, the one place in the British Empire where, for example, advanced instruction in theoretical ballistics is given, is not mentioned at all in the report, except in a single sentence, possibly copied from some army regulation, in an appendix. The Artillery College at Woolwich, known until a few years ago as the Ordnance College, was not entirely negligible even before the War, since it had on its staff at different times mathematicians of the calibre of the Rev. Francis Bashforth, Major P. A. MacMahon, and Sir George Greenhill. Since the War it has been entirely reorganised, and there have been appointed civilian professors of high academic standing in mathematics and ballistics, physics, engineering and chemistry, as well as expert military instructors in range-finding, gun-construction, design, and kindred subjects. The mathematical staff of the college are among the very small number qualified to speak on general ballistic problems; the physics and chemistry courses have been specially designed to bear upon service instruments and service requirements, and are supplemented by practical instruction much of which is upon lines not practicable in the average university; the engineering

branch has at its disposal a variety of apparatus, such as tank engines, especially installed for detailed study; the range-finding branch has mounted the most elaborate types of modern range-finder, including many taken from the Germans; the so-called arsenal branches, which deal with gun-construction, ammunition, and so on, give efficient instruction by keeping in the closest possible touch with the vast resources of Woolwich Arsenal. Much time and thought have been spent on making the instruction attractive and accessible to the officers, from lieutenant-colonels downwards, who pass through the college—and the type of instruction suitable for the undergraduate is not always best adapted for officers of some seniority.

Yet, *mirabile dictu*, a Committee dealing with the higher training of artillery officers as one of its chief concerns has apparently never heard of the Artillery College, which implies that among the nineteen witnesses whom it saw good to call, not one was connected with the institution which has far more experience in such training than any other. After realising this astounding situation, and the constitution of the Committee, it is scarcely surprising to read: "With a view to raising the technical qualifications of a number of artillery officers for special duties in connexion with research, experiment, *design and inspection of artillery material, ballistics, survey, sound-ranging and the science of gunnery generally* we consider that a small percentage of Royal Artillery officers should be sent to Cambridge to undertake a course analogous to that of the Royal Engineer officer" (the italics are ours). There seems to have been no one to point out to the Committee that this programme, which covers only a part of the necessary instruction, would involve the transportation to Cambridge of very many tons of range-finders and other instruments, guns, carriages, ammunition, and so on, the transfer of many experts whose particular knowledge is not represented at Cambridge, and, in short, practically the rebuilding at Cambridge of the whole organisation already in existence at Woolwich. The University authorities at Cambridge probably do not realise what was involved in their "very generous and advantageous offer."

It is extraordinary—or should be—that the War Office, having been at considerable expense to reorganise and re-equip the Artillery College since the War, and having succeeded in assembling an efficient and highly qualified staff, should, apparently, fail to recognise that it had within its own organisation civilian experts whose particular experience and scientific distinction render them eminently qualified to advise on all matters pertaining to the technical training of the artillery officer. Further, that it has an institution which might be made the nucleus of something greater, an army university for all branches of the service. That Lord Haldane and Mr. Spens should not have had their attention directed to the existence of the Artillery College by any of the nineteen witnesses indicates that these witnesses were ill-acquainted with the general problem under consideration; that the army members of the Committee never referred to an institution of which they have some right to be proud argues either exceptional modesty or exceptional forgetfulness. In any event, all that part of the report which deals with post-graduate courses is rendered nugatory by the failure to realise the organisation already in existence.

The Committee has also singularly failed to point out in clear terms what is the real weakness of the Royal Military Academy, namely, that the scientific instruction which is given there has long been a subject of mirth rather than of interest to the cadets under instruction, a fact which would have been elicited by questioning, say, a few present-day captains. In spite of an excellent tradition which includes the names of Hutton, Faraday, Bloxam, and in more recent days MacMahon, the cadet has not hitherto been encouraged to take this part of his instruction very seriously. The Committee recommends new laboratories, and, typically, suggests that the plans be submitted to the Board of Education rather than to the experts whom the War Office possesses but values not.

The recommendations that there should be greater encouragement offered to university candidates for commissions are excellent. The general spirit which lies behind the report is praiseworthy. There is, however, no purpose to be served by overlooking the fact that the Committee, assembled under such distinguished chairmanship, was defective in its constitution, hasty in its methods, and superficial in its inquiries, so that, particularly on the question of the higher education of technical officers, it has probably retarded rather than hastened the satisfactory solution of a difficult problem.

Clocks, Watches, and Chronometers.

(1) *Time and Timekeepers: including the History, Construction, Care, and Accuracy of Clocks and Watches.* By Prof. Willis I. Milham. Pp. xix+609. (London: Macmillan and Co., Ltd., 1923.) 30*s*. net.

(2) *The Marine Chronometer: its History and Development.* By Lt.-Comdr. Rupert T. Gould. Pp. xvi+287+40 plates. (London: J. D. Potter, 1923.) 25*s*. net.

(1) PROF. MILHAM tells us that for twenty years his lectures on descriptive astronomy have included the topic of time and timekeepers, and that

during this period he has lost no opportunity, by visiting public and private collections, by searching the literature, by spending his time in clock and watch factories and with private workers, in short by every possible means, of collecting information upon the subject. The knowledge thus amassed he has set out in a very interesting book, profusely illustrated, ranging over the whole history of clocks and watches, the inside and the outside, the personal narratives of outstanding makers, and the feats of timekeeping accomplished. "It is hoped that the answer to every question that may be asked will be found in this book, or that the exact way of gaining the desired information will be pointed out in the extensive classified bibliography." The bibliography referred to is a valuable one, and the book has besides a good index.

The field surveyed is so extensive, and in detail the book contains such a quantity of information, gathered first-hand, which it would be impossible to find elsewhere, that it would be pedantic to quarrel with a statement here and there. One may, however, point out that stellar observations are still far from giving sidereal time within a few thousandths of a second, as is claimed on p. 8. For short periods of time the modern clock is much more consistent than direct observation of the earth's rotation. Again, the description of the wireless time signals from the Eiffel Tower is very inadequate. So is the chapter devoted to electrical clocks, which is a pity, for the Americans have used them widely. But one cannot have everything. A British reader will naturally look for most fresh information to the chapters on American clock and watch making, and will not be disappointed. The early American makers, it seems, owed nothing to European influences and craftsmanship. For that matter their best observatory clocks are at the present day the work of Riefler. Nor have they ever developed an inventor like Graham, or an artist like Leroy or Ditisheim, or produced a time-keeper like the Shortt clock at the Royal Observatory, Edinburgh.

The story is, indeed, one of native mechanical genius necessarily directed to strictly practical ends, the first of which was to create a public that would buy a clock. Eli Terry struck the note when he used water power to drive his tools, in 1800, and soon after developed the factory idea to what was then the gigantic scale of working on five hundred clocks at once. It was a straight road, though not an untroubled one, from this to the monster watch factories that are illustrated in this book, where automatic machines set the jewels in high-grade watches and fit them each to its pivot, stopping and ringing a bell when anything goes out of order. True, the very best work can never be got merely by a perfect machine, nor indeed can the very best work ever "pay," but machines raise enormously the general standard of accuracy as well as of cheapness. We learn that it was Chauncey Jerome, about 1842, who first invaded England with the really charming cottage shelf clocks, still so familiar, with gaudy pictured and glazed fronts, their cheerful tick bespeaking the good conscience of sensibly simplified works. The book fills a vacant place in horological literature, and should be widely appreciated and used.

(2) Lt.-Comdr. R. T. Gould's book is one which may be set in pleasant contrast with Prof. Milham's, without depreciating either. A field restricted to the marine chronometer can be treated in detail. The story is one of astonishing conquest of difficulties. The imperative practical need for this machine led to the offer of large rewards for its improvement, and the outcome is an instrument almost miraculous in performance, when the circumstances of handling, support, and exposure are considered. If clocks had had the same purposeful attention for the last two centuries, we should have already attained the standard anticipated by Lord Kelvin, when they should be used to check the rotation of the earth, in place of the converse procedure. Moreover, the book comes at an appropriate moment. The chapter of the marine chronometer may now be said to be closed. There are very few regions and very few circumstances from which wireless signals have not already ousted it; and it has been almost stationary in development for a good part of a century, though the use of invar and elinvar have recently given it a fillip.

Lt.-Comdr. Gould is peculiarly qualified to write this book. He is a navigator, he is an enthusiast, he has manual skill himself in high degree, and he has spent immense pains in studying minutes of the Board of Longitude and other records published and unpublished, and in examining historical timepieces in Great Britain and in France. The very numerous illustrations, both photographs and line drawings—the latter his own—are particularly excellent. The index is full and good. The notes, which are very numerous, are what notes should be—a mine of interesting asides.[1] Nothing from cover to cover of the book appears to be borrowed from previous authors. It is to be regretted that a bibliography, which was prepared, is deferred for inclusion in a second edition, soon, one hopes, to be asked for.

The exciting part of the chronometer's history clusters around the rewards offered by the Admiralty—first 20,000*l.*, and, after that had been won, a further 10,000*l.* for specified standards of performance. These

[1] Thus on Newton's evidence before an Admiralty Committee in 1714 there is the note: "Actually, he read a written statement. His verbal replies to the Committee's enquiries indicate that he was suffering from mental fatigue." One wants to know more. Was Newton the man he had been, in 1714? We know next to nothing of his talk.

were accompanied by not illiberal grants for experiment. Earnshaw was one of the best and cleverest of the competitors, and, as he said, at that time "he never had a guinea beforehand." He had to put upon his work the names of the shopkeepers that sold it. The number of cranks that essayed the problem was legion. Hogarth's madhouse has a "longitude" man in it, and the Board found that the problem to certain minds was inseparable from the quadrature of the circle. Before the eyes of such men a glittering prize was suspended during the greater part of the eighteenth century. One outcome was that most of them quarrelled, among themselves and with the Board, rather bitterly. Lt.-Comdr. Gould has told us perhaps a little too much of these quarrels. When all is said, they only want forgetting.

John Harrison may in some sense be said to be the hero of the book. Opinions differ somewhat as to Harrison. To some he appears, in comparison with those among whom he stands, incurably clumsy. His taste for making clocks of wood, his complications, his retrograde inventions like the grasshopper escapement and the gridiron pendulum, when the all-but-perfect thing was already in existence in Graham's dead-beat escapement and compensation by a jar of mercury, stand to his debit. On the other hand, the temperature curb on the balance spring was a great invention.

Anyhow, no one has so good a title to an opinion as Lt.-Comdr. Gould, for he recently took Harrison's machine No. 4 to pieces, cleaned, repaired, and set it in going order, in which state it was exhibited to the Board of Visitors at Greenwich. This was the great watch that proved the longitude problem to be soluble by a timekeeper, and ultimately, after much wrangling, with George III.'s sympathetic intervention, won the Government reward of 20,000*l*. It was a wonderful feat. None the less, as the author shows, all Harrison's ideas were of the nature of misdirections, and the modern form of the chronometer traces its genealogy back to two Paris makers, Pierre Le Roy and Ferdinand Berthoud.

Lt.-Comdr. Gould is to be congratulated on this book. A few omissions may be noted that might be inserted in a second edition. The residual acceleration of the moon cannot be called unexplained (p. 8); it is now clear that it is merely a slackening of the earth's rotation. Huyghens's "Horologium" of 1658 should be mentioned as well as his work of 1673. The award by the Admiralty to the representatives of Tobias Mayer and Euler for lunar tables is interesting, and does not appear to be mentioned. The present firm of horologists in Paris is spelt Leroy (p. vii).

R. A. S.

Lessons of Antarctic Glacial Geology.

British (*Terra Nova*) Antarctic Expedition, 1910–1913. *Glaciology*. By C. S. Wright and R. E. Priestley. (Published for the Committee of the Captain Scott Antarctic Fund.) Pp. xx+581. 30*s*. *The Physiography of the McMurdo Sound and Granite Harbour Region*. By Prof. Griffith Taylor. Pp. xvi+246. 24*s*. (London: Harrison and Sons, Ltd., 1922.)

THE country around McMurdo Sound in South Victoria Land has become, in spite of its high latitude, the best known area in the Antarctic, and these two instructive and superbly illustrated monographs on it make important additions to our knowledge. They contain detailed descriptions of the ice formations and processes of ice action in that district; and the explanations adopted are based on prolonged study of a specially instructive field, after full discussion on the spot by experts in many branches of knowledge. Both monographs are important contributions to the literature of glacial geology.

The larger volume is entitled "Glaciology," ignoring the protests against that mongrel term. It is not self-explanatory, and the authors do not define it; as they devote long chapters and an appendix to the physics of snow and ice, they apparently use the term in a wider sense than as a synonym of glacial geology. Messrs. Wright and Priestley describe all the forms of ice and glacial deposits found in the McMurdo Sound region, discuss the classification of glaciers, coast ice and sea ice, and conclude with an interesting essay on the geological history of climate and the cause of ice ages. The volume deals with so many subjects that the absence of an index, other than a list of sub-headings of chapters, will lessen its usefulness. Dr. Griffith Taylor's volume is entitled the "Physiography of the McMurdo Sound and Granite Harbour Region"; but it deals only with the glacial physiography, though in connexion therewith it describes South Victoria Land as bounded to the east by faults.

The chief general interest of these monographs depends on the light they throw on the former glaciation of some north temperate lands, and especially of the British Isles. One significant feature in both works is their evidence of the trend of opinion to a more moderate view of glacier action than was in vogue some years ago. Dr. Griffith Taylor states that he formerly inclined to the views of Prof. W. M. Davis as to the extreme vigour of glacial erosion. As a result of his Antarctic studies, however, he remarks that his "views have swung backward from the extreme opinion of those who credit ice alone as the chief agent in the sculpture of a glaciated region, to the view that

ice plus water is the effective agent." The three authors give their weighty support to those who agree with Prof. Garwood that glaciers protect the underlying land. Messrs. Wright and Priestley state (p. 231) that " with the suggestion that at the present time the Antarctic ice mantle, considered as a whole, exercises a predominantly conservative influence, the writers are in accord." Dr. Taylor attributes the characteristic sculpture of glaciated lands to nivation or " thaw and freeze " action ; and he assigns to glacier erosion a relatively insignificant part. In agreement with the late Prof. Bonney he attributes corrie formation to the alternate freezing and thawing of rocks beside a sheet of ice or snow ; and according to Dr. Taylor the basins and expansions in glacial valleys are hollows made by frost in pre-glacial time. According to his view the main relief of a glaciated country is pre-glacial, and the glaciers merely smooth and mould the pre-glacial contours. Dr. Taylor shows that this explanation, which is that adopted by Prof. Bonney, Prof. Garwood, Prof. Fairchild, Prof. Hobbs, and by the writer in his book on fiords, is fully consistent with the evidence from the Antarctic.

The monograph by Messrs. Wright and Priestley further supports the reduction in the share of glacial phenomena attributed to glaciers by demonstrating the importance of sea ice as a geological agent. The application of Antarctic ice action to the problems of European glaciation is limited by two differences—the small amount of drift material in the Antarctic, and the absence from the area studied, of low-level plains and shallow sea.

The first difference is probably due to the completeness of the ice cover in the Antarctic and its long duration. That it was even more extensive so long ago as the Oligocene is shown by some remarkable volcanic agglomerates containing glacial material. Hence nearly all the loose decayed rock has been swept off the land. The amount of earth and stones in the glaciers is much smaller than in those of Europe and Spitsbergen. Moraines in the Antarctic are therefore surprisingly scanty. The silt bands are due mainly to wind-blown material, and the authors adopt the term " cryoconite " for wind-blown sand in the ice, although some recent authorities on Greenland support Nordenskjold's belief that it is of meteoritic origin. If not, the retention of the term seems unnecessary. Dr. Taylor refers to some glacial deposits as " Eskers " ; but they are identified by Wright and Priestley as " stranded moraines," and there appear to be neither osar nor kames in the area described in these volumes. The second difference is due to the steepness of the margin of the Ross Sea ; the shore drops steeply to the depth of about 200 to 600 fathoms, and there are no wide drift-covered plains like those which, in north-western Europe, bear the glacial deposits, of which the origin is most uncertain.

If due allowance be made for these differences, the two monographs throw much light on some of the most vexed questions of glacial geology. They show, in spite of early suggestions to the contrary, that the Antarctic barrier ice does not support the view that unbroken sheets of land ice can pass over deep sea, such as the Norwegian Trough ; for Messrs. Wright and Priestley consider (p. 222) that the Ross Ice Barrier " did not, at its maximum, extend further north than the edge of the continental shelf." They also give an instructive account of the transport of boulders along the coast by floating ice and note the resemblance of the distribution by it of the kenyte boulders in South Victoria Land to that of the scattering of boulders of rhomb-porphyry from the Christiania Fiord along both sides of the North Sea. Upon the origin of boulder clay the evidence of this monograph is very suggestive. The authors remark (p. 230) the absence of scratched boulders in the moraines and their abundance on the sea bed, where they are distributed by ice-bergs (p. 411) ; and the high proportion of ice-scratched stones in boulder clay is one of its most striking differences from moraines. The authors do not appear to have seen any boulder-clay on land in the Antarctic, while the one dredge haul off the Ross Barrier (p. 231) " consisted of two crinoids and several hundredweight of typical raw material for the formation of boulder clay or perhaps a coarser till." The evidence from Antarctica is therefore in favour of the subaqueous and not of the terrestrial origin of boulder clay.

The uplift of material by glacier ice does not appear to be common in the Antarctic, for Messrs. Wright and Priestley remark that they observed only one case of a moraine due to this process (p. 225 : cf. p. 229).

The volume concludes with a discussion of the history of climate and the origin of glacial periods. The authors are favourable to the theory of Huntington and Visher that climatic variations are caused by changes in the sun due to the interaction between members of the solar system. They also accept the great climatic effect of dust in the atmosphere, a view due to Humphreys. Considering that author's recent pronouncement on the work of his two fellow-countrymen, it is surprising to find their views thus combined. The conclusions in this chapter rest on some doubtful foundations. Thus the authors quote the theory of Pettersen on climatic variations without reference to the weighty rejoinder by Hildebrandsson. They adopt the conclusion that ice covered Scandinavia to the southern shore of Sweden in 10,000 B.C., and only

disappeared between 5000 and 4000 B.C., without awaiting the publication of the evidence for that startling hypothesis, which was announced thirteen years ago. The authors reject zonal distribution of climate as the rule in geological time. The statement (p. 422) that "corals cannot at present exist outside of tropical seas" repeats a common misconception; the restriction is true only of reef-building corals. The presence of Archeocyathids does not prove that the climate of the Antarctic was tropical in Cambrian times. The evidence of the fossil plants, however, shows that the conditions there were temperate in the Carboniferous and Permian Periods. The authors are favourably impressed by Wegener's theory of continental drift.

The volumes are richly illustrated with maps, a large series of excellent photographs, and Dr. Taylor's instructive diagrammatic sketches. J. W. G.

History of Science.

The Development of the Sciences. By Ernest William Brown, Henry Andrews Bumstead, John Johnston, Frank Schlesinger, Herbert Ernest Gregory, Lorande Loss Woodruff. Edited by L. L. Woodruff. Pp. xiv+327+28 plates. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 16*s.* net.

THIS substantial volume is a welcome sign of the growing interest in the history of science. In 1920 the Yale Chapter of the Gamma Alpha Graduate Scientific Fraternity invited representatives of the various sciences at Yale University to co-operate in inaugurating a series of public lectures on the history of science. The lectures were readily provided. Prof. Brown dealt with mathematics, Prof. Bumstead with physics, Prof. Johnston with chemistry, Prof. Schlesinger with astronomy, Prof. Gregory with geology, and Prof. Woodruff with biology. The substance of those lectures is contained in the handsome volume under review, published by the Yale University Press on the Amasa Stone Mather Memorial Publication Fund. Yale University is certainly fortunate in having old students who suggest new subjects for lectures and furnish funds for the publication of such lectures.

The task undertaken by the several contributors to this collection of essays was undoubtedly a very difficult one. To sketch the history and development of any science, in an easily intelligible manner, in about forty pages, is an undertaking which very few would care to attempt. One or two of the writers, indeed, appear to have been rather overwhelmed by the thought of the difficulties, and did not do themselves full justice. Some got round the difficulty by frankly confining themselves to the eighteenth and nineteenth centuries—a course which may well commend itself to many. Still, the essays on astronomy and biology show how much can be done even in such limited space. They are admirable in every way. The account of the history of chemistry is nearly as good. The author evidently enjoyed his share in the enterprise. In one passage he is perhaps unwittingly amusing, namely, when he speaks of history as a science concerned essentially with general predictions about the future. How nice it would be if historians wrote histories of the future instead of the past only! But prediction is not an essential feature of science; and history is not a science (except in a very loose sense of the term); and there are highly respectable and valuable studies outside the sciences strictly so called. The essay on geology shows much wisdom in the arrangement of its topics and in the grouping of the main points in the history of the science round these problems. The account of the history of physics is perhaps not quite so happy as the other essays already mentioned. The historian of mathematics probably had the most difficult and, from the point of view of the general reader, the most thankless task of all. On the whole, however, all the contributors to the volume, and all connected in any way with its publication are to be congratulated on the notable result.

In addition to the main narratives the volume also contains about three hundred brief biographical accounts and ninety-four portraits of eminent men of science; a fairly full bibliography; a table of the chemical elements arranged in the chronological order of their discovery, with remarks as to the discoverer and the original source and derivation of the name or symbol; a list of the terms of the geologic column with indications of their origin and significance; and a thirteen-page index. From the table of chemical elements there emerges the interesting fact that about 25 per cent. of the elements were discovered by British men of science.

A few suggestions may perhaps be permitted, not in a spirit of captious criticism, but in view of possible improvements in a new edition. The omission of all reference to what may be called the specifically human sciences is rather remarkable. Psychology, at all events, is a well-established and a very old science, and should not have been ignored in an account of the history and development of the sciences. Some of the contributors to the volume rather exaggerate the purely theoretical character of science, and so underrate the earliest contributions to science. In reality there is probably always some practical motive at work in science, even if it is more latent, because

longer views are taken in the course of time. The biographical notes might be improved, at least to the extent of mentioning the best English biography, when there is one. The bibliography also might be made more valuable, both by omissions and by additions. It is rather a sorry jest to include Libby's "Introduction to the History of Science" while omitting Dannemann's "Geschichte der Naturwissenschaften," which is the best book of its kind.

Our Bookshelf.

An Introduction to the Principles of Mechanics. By J. F. S. Ross. Pp. x+400. (London: Jonathan Cape, 1923). 12*s.* 6*d.* net.

THIS book is roughly of the intermediate standard of the universities and deals with most of the general principles of mechanics usually studied by engineering students prior to embarking upon the more highly specialised engineering subjects. The author has some very decided views upon the teaching of mechanics, and does not lay stress upon laboratory work since "it seldom achieves the results intended—too often students treat it as routine work, to be struggled through by following imperfectly comprehended instructions." This denunciation is too sweeping, and we are inclined to believe that in those cases where experimental work fails in its object, the cause may often be found in the lack of that inspiration which a competent teacher may communicate to his students. The author has compiled his book for the use of engineers, and we cannot welcome too strongly his courage in throwing over so-called "engineers' units" and his use of absolute units throughout in the development of the principles of the subject. The confusion which has resulted from engineers' units has become deplorable. There are several recent text-books on engineering subjects which are almost unreadable on this account. We have therefore every confidence in recommending this book to all teachers who have to handle engineering students and desire that their fundamental knowledge of this important subject shall be sound.

Principles and Practice of Wireless Transmission. By G. Parr. Pp. vi+163. (London: Ernest Benn, Ltd., 1923.) 5*s.* net.

THE author gives a popular account of the principles underlying the art of radio transmission and radio reception. He confines himself, however, closely to the scientific theory of the subject and does not give loose analogies. He states that mathematical treatment is "apt to irritate" the non-technical reader, but nevertheless he introduces the main formulæ. No attempt is made to prove the formulæ, but their practical use is explained with sufficient clearness to help the amateur. In no branch of electrical science is the theory of electrons more helpful than in radio communication. Hence although the author starts with discussing the electrifications produced by rubbing a stick of sealing-wax with a piece of fur, yet the phenomenon is pictured as giving or depriving atoms of the materials of their electrons.

It is a pity, however, that no attempt is made to describe the modern molecular theory of magnetism, which is based on the electron theory of matter. We think that students and amateurs who are familiar with the practice of radio communication will find this book helpful. There is every prospect that in the immediate future radio-telephony for everyday commercial purposes will be widely adopted.

History of the Great War: Based on Official Documents. Medical Services: General History. Vol. 2: *The Medical Services on the Western Front, and during the Operations in France and Belgium in* 1914 *and* 1915. By Maj.-Gen. Sir W. G. Macpherson. Pp. x+510+17 maps+14 charts. (London: H.M. Stationery Office, 1923.) 21*s.* net.

THE present volume deals with the medical services of the British Expeditionary Force in France and Belgium and is a study in the methods of medical organisation on active service. Special chapters are devoted to the administration of the medical services on the western front, medical units in army areas and on lines of communication, medical services of the Indian contingent and of the labour corps. The organisation of nurses and women workers is also considered. The medical aspects of the actual engagements constitute interesting reading and include the retreat from Mons, the advance to the Aisne, the period of trench warfare and the battles of the Aisne, Neuve Chapelle, Ypres, Festubert, and Loos. A large number of charts, diagrams, maps, and illustrations help to make this volume one of the most interesting in the series.

The Fundamental Ideas of Chemistry. By Dr. Alfred Benrath. Translated by Jethro Bithell. (Harrap's Bilingual Series, German-English, Text and Translation on Opposite Pages.) Pp. 160. (London: G. G. Harrap and Co., Ltd.; New York: Brentano's; Sydney: The Australasian Publishing Co., Ltd., 1923.) 2*s.* net.

THE content and purpose of this book are clear from the title. It is sufficient to say that the text is interesting and that practically all the words and idioms of theoretical chemistry are covered. The book may be warmly recommended to chemical students. The translation is generally fairly accurate, but in several places could have been improved by a chemist. *E.g.* "Wage" is "balance," not "scales"; "Schwefelverbindungen des Eisens" does not mean "sulphuric compounds of iron," etc. The editor of the series would do well to see that the translations are revised by specialists.

Südamerika. Von Bernhard Brandt. (Jedermanns Bücherei.) Pp. 140. (Breslau: Ferdinand Hirt, 1923.) 2.50 marks.

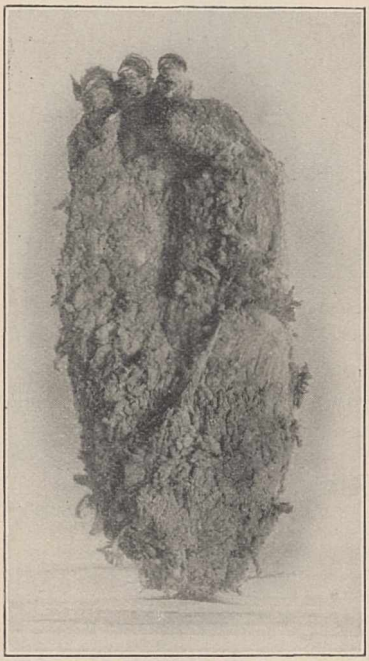
DR. BRANDT has written an interesting sketch of South American geography which appears to be one volume in a series of handbooks of geography. The book is short but covers most successfully the important aspects of the continent and deals particularly well with questions of population and immigration to Brazil and temperate South America. There are diagrams, sketch maps, and a few well-chosen illustrations. A list of works for further reference includes a few in English but omits others of equal or greater value.

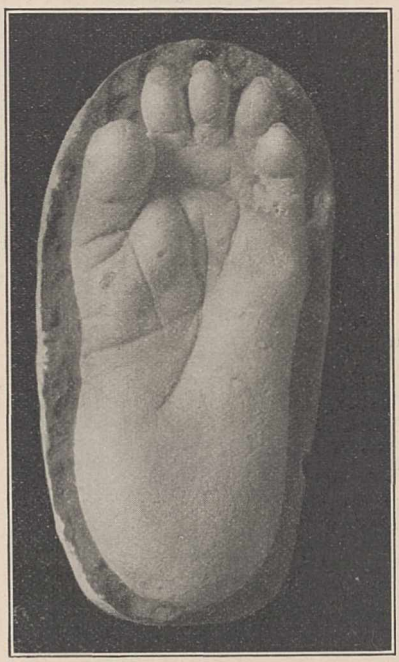
Letters to the Editor.

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

The Gorilla's Foot.

IT is a truism that misunderstandings and disagreements often develop through identical terms being used by the disputants in different senses and through the raising of new questions not originally recognised as involved in the point at issue. When Sir Ray Lankester first applied the words "distorted" and "misleading" to the photograph of the cast of the dead gorilla's foot, originally published by Mr. Akeley in *World's Work*, I perhaps mistakenly inferred from the context that Sir Ray Lankester had reference chiefly to the position of the great toe, which in the photograph was shown as directed forward rather than in the position of abduction made familiar in numerous earlier pictures of the gorilla foot. With the original cast and a print from the original negative before me, I was confident that the photograph gave "a very fair representation" of the cast, with special reference to the contour of the foot as a whole, to the position of the great toe, to the partial twisting of its plantar surface toward the other toes, to the relative positions of all the toes, to the form of the heel and other points. As it was a casual photograph of a dead-white plaster cast, I did not expect it to show the finer details of the surface, especially in a small half-tone reproduction.





Photos: American Museum of Natural History, New York.

FIG. 1.—Right foot of one of Mr. Akeley's adult female gorillas preserved in solution. The left foot of the same animal was used in making the cast shown in Fig. 2.

FIG. 2.—Cast of the left foot made by Akeley in the field.

Mr. Pocock introduced what appeared to me at first to be a wholly new issue by centring attention upon the undoubtedly poor representation in the *World's Work* photograph of the deep crease that separates the great toe from the other digits. Mr. Pocock, like his distinguished colleague, did not await the arrival of the cast that we sent, but on the evidence of the half-tone reproduction vigorously condemned it for not showing the crease in question, and then in a footnote added later explained that the crease showed perfectly in the cast. Sir Ray Lankester then very effectively followed this up by publishing two photographs of the same cast, one in which the modelling of the foot and the depth of the creases are accentuated, the other with opposite lighting, in which they are flattened out. On this point we do not hesitate to admit that Mr. Akeley's original picture was inadequate and in that respect misleading, but in justice to us it may not be improper to direct attention to the fact that our *bona fides* was evidenced by the promptness with which we submitted a duplicate cast to the scrutiny of our critics.

Sir Ray Lankester asserts his belief that the great toe of the "flabby" specimen was distorted by post-mortem changes and pressed into alignment with the other toes, while Mr. Akeley again states that the foot was not "flabby" but in a perfect condition of preservation, and that great care was taken to allow the relaxed foot to assume a natural position without pressure. Sir Ray Lankester accepts the photograph by Mr. Akeley of another foot (reproduced as Fig. 2 in Sir Ray Lankester's letter of January 5) as showing the great toe in its natural position, but neither the metatarsal nor the phalanges of the great toe in this picture are widely abducted in the other position approved by both Mr. Pocock and Sir Ray Lankester. On the contrary, the first metatarsal is adducted to approximate the second metatarsal, thus compressing the soft structures so as to emphasise the deep hallucial crease. The chief difference between this foot as figured and that of its fellow on the opposite side (it happens that this is the right foot belonging to the same animal whose left foot was cast) lies in the strong flexure of the phalanges of all the digits, while in the cast the digits are partly relaxed. After the skin was removed in the field, the right foot (the original of the above-mentioned Fig. 2) was preserved in a weak solution of salt and formalin and brought to the museum.

I now submit four photographs: the first (Fig. 1), showing the right foot (Lankester's Fig. 2) exactly as it is now preserved; the second (Fig. 2), showing the now famous cast of the left foot of the same animal; the third and fourth (Figs. 3, 4), showing the skeleton of the left foot of a large male still in its "roughed out" condition. I dare to hope that a close study of the originals might shake Sir Ray Lankester's confident belief that the great toe in these specimens had been forced into an unnatural alignment with the other toes.

As it is our purpose solely to discover the facts in this matter and to make proper amends if we are in the wrong, Dr. D. J. Morton, Mr. Akeley and myself

have carefully gone over the whole question with the evidence before us. Our judgment is that, while certain of Mr. Akeley's statements in the *World's Work* article require retraction or serious modification, the general drift of his conclusions (namely, that the gorilla foot is in certain respects becoming adapted in the human direction) appears to be well supported by the evidence. In coming to our conclusions we have had the advantage not only of the invaluable data secured by Mr. Akeley in the field, but also of some fairly detailed studies of the gorilla and other primate feet that have been made during the past few years in this laboratory.[1] We have studied the feet of a very young female gorilla, of a half-grown male, of several of Mr. Akeley's specimens, as well as of several skeletons at Columbia and Yale Universities and elsewhere. From this material we draw the following conclusions :

Photos : American Museum of Natural History, New York.

FIG. 3.—"Roughed out" skeleton of the foot of a large male gorilla, showing the hallux adducted in a position not dissimilar to that of the cast.

FIG. 4.—Another view of the specimen shown in Fig. 3.

1. In very young gorillas the foot is more slender and chimpanzee-like in structure and in manner of use than in the heavy-bodied old males.

2. The field evidence indicates that the heavy-bodied adults live mostly on the ground and use the foot chiefly for locomotion on the ground rather than for grasping and climbing in the trees.

3. The great toe may be abducted in the position of Pocock's figure, or adducted in the position of Akeley's cast, both positions, as well as the intermediate ones, being perfectly normal in the relaxed condition of the foot.

4. A study of the detailed structure and mechanism of the gorilla foot indicates that the hallux is abducted in locomotion as a means of counteracting a strong inward thrust of the body weight upon the inner side of the foot. In this particular Akeley probably went too far in his *World's Work* article, in suggesting a sub-human position of the great toe in walking.

5. The feet of gorillas, while varying widely in details, are definitely more man-like than are those of monkeys in respect to the apparent shortening of digits II-V, relative increase in massiveness and strength of the great toe, twisting of the under sides of all the toes toward the ground, blunting of the peroneal tubercle, as well as in certain details of the entocuneiform and other elements. The heel bone and astragalus of the gorilla are distinctly more man-like than are those of the monkeys. These differences from monkeys are more pronounced in old males than in young specimens.

Sir Ray Lankester in his book "Great and Small Things," page 7, concludes that "the difference in form and mechanism of the foot of man and of the man-like apes is more profound than any other structural difference which separates them. We have no knowledge," he says, "of any intermediate condition of the foot—no trace of any connecting link nor of the history of the development of the human foot," but our studies lead us to the following conclusions :

1. With the sole exception of man, primates of all known families and higher divisions have a "grasping hallux" (Fig. 5). This fact affords evidence that adaptation to arboreal life took

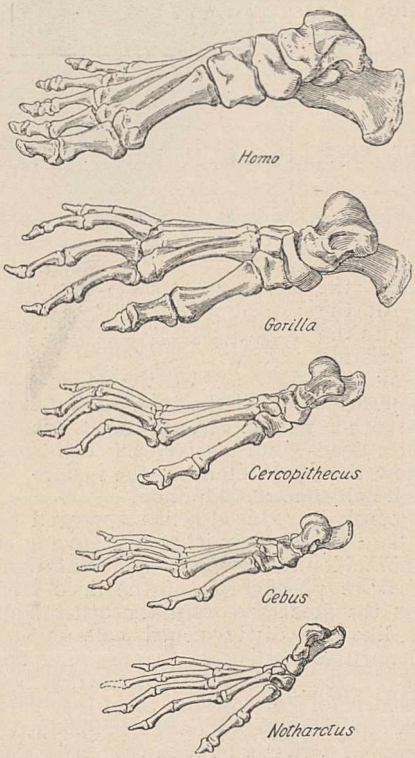


FIG. 5.—Comparative series of feet (after Gregory, 1920). The gorilla foot is that of a young specimen. The human foot is reduced in scale.

[1] Gregory, W. K., Bull. Amer. Mus. Nat. Hist., 1916, pp. 329-336 ; Mem. Amer. Mus. Nat. Hist., 1920, pp. 94-107, 239-241, pls. xxx, xxxi. Morton, D. J., *Amer. Journ. Phys. Anthropol.*, Nov. 1922 ; *Journ. of Bone and Joint Surgery*, Boston, Jan. 1924 ; *ibid.*, Apr. 1924.

place at a very early stage of the primates as an order.

2. This inference is supported by the discovery that the grasping hallux, with a very large flat nail

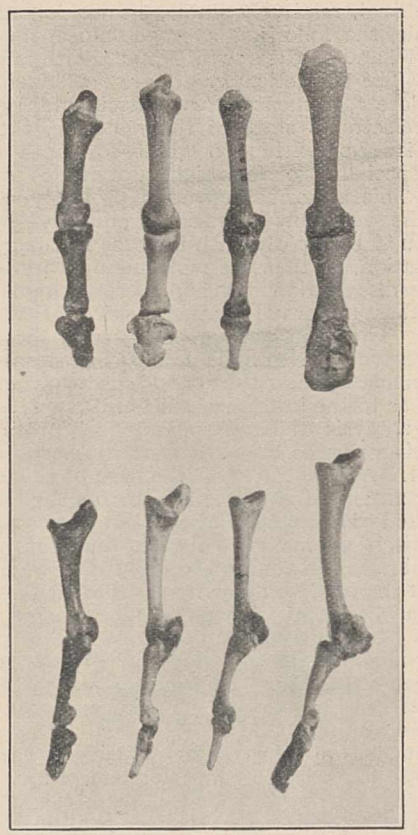


FIG. 6.—Comparative series of halluces (after Gregory, 1920): Notharctus (Middle Eocene), Lemur, Cebus, Macacus.

and a widely projecting tubercle for the attachment of the peroneus longus muscle, was well developed so far back at least as Middle Eocene times, it being the only type of hallux known in primates of that age,

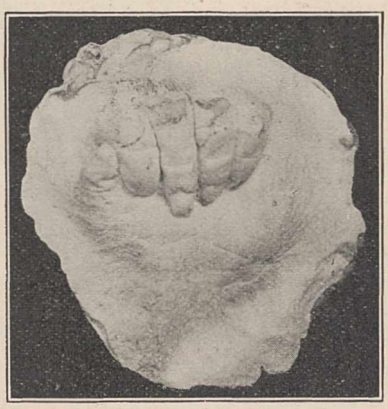


Photo: American Museum of Natural History, New York.

FIG. 7.—Cast of hand of old male gorilla by Akeley.

and being characteristic of the relatively primitive families Notharctidæ (Fig. 6), Adapidæ, as well as of the more specialised family Anaptomorphidæ.

3. The structural affinity of man to the anthropoids is so profound throughout the organism as to afford cogent evidence in favour of Darwin's conclusion that man represents an early offshoot of the "anthropomorphous subgroup of Old World primates."

4. The fundamental adaptation of the anthropoid-man group was for progression in the upright position, with brachiation, as long maintained by Keith and others.

5. The hand and forearm of man are so intimately related in structure to that of the gorilla (Fig. 7) as to strengthen the conclusion that the whole human motor apparatus, including the foot, has been derived from a primitive anthropoid type, a grasping hallux being the natural complement of the brachiating forearm.

6. The permanent adduction of the human great toe resulted from a continuation of modifications similar to those now observable in an early stage of evolution in the gorilla.

WILLIAM K. GREGORY.

Isotope Effects in the Band Spectra of Boron Monoxide and Silicon Nitride.

IN 1914 Jevons[1] made measurements on a band spectrum which he attributed to boron nitride. He correlated most of the bands into two systems ("α" and "β"); a number of weaker bands remained. Recent investigation by the writer[2] shows that the spectrum—which is probably due to the compound BO—really consists of two superposed spectra.[3] These are related to each other exactly as would be predicted by the quantum theory of band spectra if the more intense spectrum is due to the more abundant isotope $B^{11}O$, and the less intense to the less abundant isotope $B^{10}O$. Every one of the approximately 80 bands of $B^{11}O$, including those both of the α and of the β systems, is matched, so far as can be determined,[4] by a corresponding $B^{10}O$ band of about the expected intensity.[5] In each system, the central band, corresponding to an electronic change alone in a vibrationless molecule, is practically coincident for the two isotopes.[6] From this centre the bands extend both toward lower and toward higher frequencies, the *pattern* being exactly the same for both isotopes, the *scale* or spacing of this pattern, however, being *larger* for the *lighter* isotope in a ratio approximately equal to the ratio of the molecular vibration frequencies. This is exactly as predicted by the quantum theory. The maximum separation between corresponding bands of the two isotopes is more than 300 wave-number units in each system (this amounts to about 200 Å.U. near $\lambda 8500$ in the α system).

Quantitatively, the theoretical value of ρ (ratio of vibration frequency of the less abundant to that of the more abundant isotope) is 1·0276 for BN and 1·0292 for BO. The average experimental value from measurements on the β system is 1·0283 for the initial electronic state of the molecule, and 1·0294 for the final state, the latter figure being much more trustworthy than the former; both are preliminary.

An entirely independent check on the origin of the two related band spectra is afforded by a study of the structure of individual bands. According to the

[1] W. Jevons, Roy. Soc. Proc. A 91, 120-134 (1915).

[2] Preliminary results based chiefly on Jevons's data were given in *Science*, 58, 164-166 (Aug. 31, 1923). This contains a somewhat fuller discussion of theory than is here given.

[3] The relative simplicity of both systems indicates that the emitter is diatomic, not polyatomic.

[4] In some cases, of course, the superposition of a heavy band makes the detection of a weaker band impossible.

[5] From the atomic weight, 10·82, the intensity ratio should be 4·5 : 1 in favour of $B^{11}O$. Dr. George R. Harrison, of this laboratory, and the writer are now making quantitative photometric measurements in an endeavour to check this.

[6] There seems, however, to be a small but appreciable electronic isotope effect. Discussion of this will be postponed until more accurate data are obtained.

quantum theory, the coefficients involved in the series representation of the lines of a band, and the spacing of the lines, should to a first approximation be inversely proportional to the moment of inertia of the emitting molecule, and so should be greater for the lighter isotope. On this basis, it can be shown that the spacing of corresponding lines in corresponding bands of two isotopes should differ in the ratio ρ^2. Comparative measurements on three bands of the β system for each isotope give for this ratio an average experimental value of 1·0587, as compared with a theoretical value of 1·0593 for BO, and 1·0560 for BN.

The various quantitative agreements obtained are probably within experimental error for BO, although the possibility of BN is not yet altogether excluded.[7] More accurate measurements on both α and β systems are being made, in order to test the details of the theory. The results as they stand, however, furnish strong support for the main features of the quantum theory of band spectra, and at the same time leave no reasonable doubt as to the isotopic origin of the two related band spectra.[8] In agreement with positive ray results, there is no evidence of more than two isotopes of boron in appreciable amounts.

The BO bands show several remarkable features in addition to the isotope effects. For example, each band of the β system appears to consist of an isolated positive branch,[9] instead of the usual pair or triplet of branches. Such a possibility has been predicted by Kratzer in considering the mutual effect of the motion of an excited electron and of the molecule as a whole. Further discussion of this and other effects will be postponed until the experimental study is more complete.

In the further study of isotopy by means of band spectra, a spectrum ascribed by Jevons[10] to silicon nitride seemed promising, although his measurements contain no record of possible isotope heads. Aston's positive ray method has indicated the presence of an isotope 29, and a possible isotope 30 (uncertain because of the presence of hydrogen compounds), in addition to the predominant 28. According to the atomic weight 28·063 (Baxter, Weatherill, and Scripture), if isotopes 29 and 30 are present in equal amount, each must be about 2 per cent. as abundant as isotope 30. The emitter of the band spectrum is without much doubt diatomic (cf. note 3). Photographs of the bands taken by the writer show that each sufficiently intense $Si^{28}N$ head on the red side of the central band of the system (and sufficiently far from the central band to permit resolution with the dispersion used) is accompanied by two very much weaker heads, one at double the distance of the other. In agreement with theory for the heavier isotopes $Si^{29}N$ and $Si^{30}N$, these weak heads lag behind the corresponding $Si^{28}N$ heads more and more with increasing distance toward the red from the central band. On the ultra-violet side of the central band, the isotope heads are concealed by the heavy shading of the $Si^{28}N$ bands. Isotope 29 appears to be a little more abundant than isotope 30. There is no evidence of other isotopes in appreciable amounts. Comparative measurements on 13 sets of heads give, for the final, relatively stable, electronic state of the molecule, the following average values of ρ: 0·9887 for $Si^{29}N$, and 0·9941 for $Si^{30}N$, both with reference to $Si^{28}N$. The theoretical values are 0·9888 and 0·9942. (The close agreement is *partly* accidental.) For the initial electronic state of the molecule, the isotope effect is apparently too great for both isotopes, and especially so for high amplitudes of vibration. This abnormal effect is probably correlated with the very low vibration frequency—which, in addition, falls rapidly with increase in the amplitude of vibration, so that the molecule appears to be not far from dissociation in its highest states of vibration—and other abnormal characteristics of the initial state.[11] The complete agreement with theory in all other respects leaves little doubt as to the validity of the evidence from the band spectrum of silicon nitride as to the isotopy of silicon.

The analysis of band spectra may prove of considerable value as a supplement to the positive ray method. As illustrated in the case of silicon, it has the advantage of unambiguity as to what masses are associated with a single element, but it does not permit comparison of masses between different elements. It should also be adapted to quantitative determinations of the relative amounts of different isotopes.

From the point of view of the theory of band spectra, the presence of isotopes may prove of much value by its introduction of mass as an independent variable. Information as to differences between the properties of isotopes may also be expected.

In conclusion, the writer wishes to express his gratitude to Profs. F. A. Saunders, E. C. Kemble, and T. Lyman, for much valuable advice and assistance, and to Prof. G. P. Baxter for the boron and silicon chlorides used.

ROBERT S. MULLIKEN,
National Research Fellow.
Jefferson Physical Laboratory,
Harvard University,
Cambridge, Mass.

[7] Additional evidence that the bands are due to BO is given by the fact that, when generated by the reaction of BCl_3 vapour with active nitrogen (freed from oxygen by means of phosphorus), they are far more intense when a small amount of oxygen is present than when the nitrogen used is purified so far as possible; whereas the reverse is the case with the similarly produced SiN bands (see below). Another argument for BO is the presence in the molecule of one unused boron valence electron, which might well be easily excited and give rise to the observed bands.

[8] The existence of the vibrational isotope effect in one of the infra-red bands of HCl has previously been pointed out by Loomis and by Kratzer. An effect, probably vibrational, of very small magnitude, presumably because of the high atomic weights of the atoms involved, has been found (Grebe and Konen, *Phys. Zeit.*, 22, 546 (1921)) in the visible band spectrum of lead. The present results apparently contain the first verification of theoretical predictions as to the *rotational* isotope effect. An additional verification is to be found in some recently published data on the band spectrum of copper hydride, as will be pointed out by the writer in a subsequent communication.

[9] There is some confusion in the use of this term; here a branch starting toward *higher frequencies* is meant; in the present case, this very soon reaches a head and returns on itself.

[10] W. Jevons, Roy. Soc. Proc. A 89, 187-193 (1913).

The Elastic Limit and Strength of Crystals.

SOME English newspapers appear to have published notes on the increase of strength of rock salt observed by one of us. The notices are obviously based upon a preliminary communication made to the Petrograd Academy of Sciences and not yet printed. It may be of interest, therefore, to explain the chief results of our investigation.

In the *Phil. Mag.* for January 1922 one of us (A. Joffé) described a Röntgenographic method for observing the change of structure accompanying the residual strain of crystals and their elastic constants. This method has been applied to measure the elastic limit at different temperatures and in different directions. Fig. 1, in which the elastic limits are plotted as ordinates and the temperatures as abscissæ, shows the results. Curve I gives the limit in compression (square points) and tension (small crosses) in gm./mm.^{2} if the axis of the rock salt bar is oriented in the direction [100]: Curve II relates to [110], and Curve III to [111]. It will be evident that the elastic limit becomes zero when the melting point (810° C.) is reached. This seems to be a very common property of crystals.

[11] A fuller report of these will be given elsewhere.

If the stress is a little below the elastic limit, no change of structure can be noted on the Laue's diagram during a period of six hours. When, however, this limit was passed, a well-marked stretching

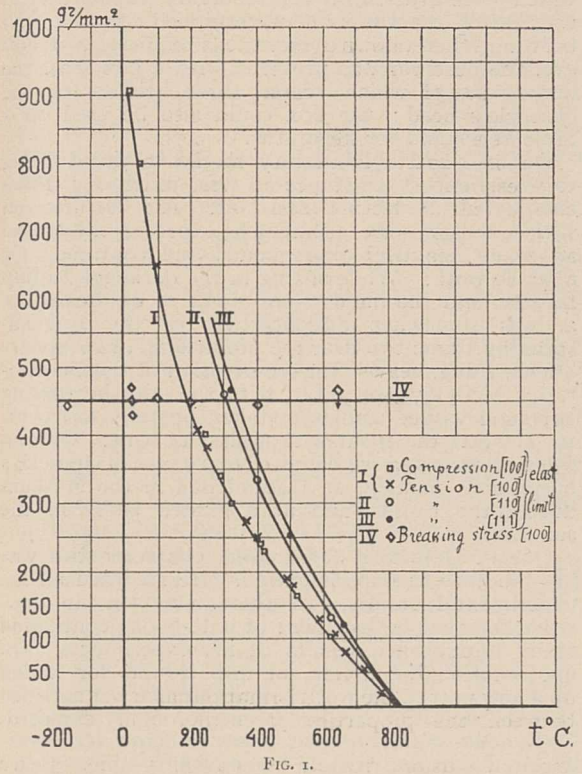


FIG. 1.

of the spots was observed on the fluorescent screen after one minute. The melting point is instantly visible by the appearance of diffuse Röntgen light on the screen.

The straight line IV relates to the breaking tensile stress of rock salt. There is no appreciable change from −190° to +650° C.; the errors were within from 5 to 10 per cent. At 200° C. the curves I and IV cross one another. For temperatures below 200° C. the breaking stress is reached before the flow of crystal begins; and thus the rock salt becomes brittle. Above 200° C. the crystal flows before reaching its breaking point, becomes strengthened, and the salt seems to be plastic. The temperature dividing the brittle and the plastic state of the crystal depends upon the kind of strain and the orientation of rock salt. It seems that in every solid body there is a brittle and a plastic state.

FIG. 2.

The residual strain consists in a slip and turn of the parts of the tested crystal. The strength of rock salt increases rapidly with the increasing change of structure. Instead of 450 gm./mm.² the breaking tensile stress reaches 5000 gm./mm.²

The investigation of the changes accompanying this phenomenon by the method of Röntgen analysis had shown that a new arrangement of small crystals, making them stronger, takes place; there appear also to be amorphous layers between the crystal grains, which are not changed themselves. It is impossible, however, to explain the whole rise of strength in this way. The real strength of rock salt may be many hundreds of times greater than that usually observed; it may be near to the value given by the electric theory of crystal lattices (200 kgm./mm.²). As Griffiths suggests, the cause of the rupture may be found in the crevices at the surface of the tensile bar. If the observed early failure has its cause at the surface, the rupture can be prevented by dissolving the surface of rock salt with water during the stress. In fact, in spite of the low temperature (below 100° C.) the rock salt began to flow and was broken at a very thin section only at a stress of 150 kgm./mm.² (instead of 0·45 kgm./mm.²); this is not far from the theoretical value.

Fig. 2 shows a crystal of rock salt, which was stretched in such a way that its middle portion was surrounded by hot water. The cross-section of this part was 5 mm.²; nevertheless, the crystal was broken by a force of 25 kgm. at a dry section of 56 mm.² area. The dry part was torn by a stress of 440 gm./mm.² at the same time as the wet part supported without breaking a stress of 5000 gm./mm.² It is interesting to note that a saturated solution of salt had no influence upon the ductility and strength of rock salt.

A. JOFFÉ.
M. KIRPICHEWA.
M. LEVITZKY.

Physical-Technical Röntgen Institute,
Petrograd, January 12.

Origin of Solar Systems.

I WISH to express respectful admiration for the dynamical analysis which has enabled Mr. Jeans to give such a discourse as you have happily reproduced in the issue of NATURE of March 1 on the genesis of stars. His tentative deductions about a possible mode of origin for our solar system are also of profound interest, and I may be permitted to ask a question.

Assuming the consequences of a passing stellar visitor to be as stated, is it superfluous to consider whether during the act of formation of a double star, in the giant stage, anything of the same kind could happen? I know that no leisurely action could achieve the result, but I believe that the initial stages of budding or gemmation are accompanied by rapid recession of the twin masses to a definite distance from each other, under tidal forces, before the leisurely recession begins; and it is during this jerk away that there seems good chance of a drawn-out or linking jet from each of the gaseous masses. If that were so, the formation of a solar system—though of a variety somewhat differing from ours—need not be an exceptional or rare occurrence.

OLIVER LODGE.

Normanton House,
Lake, Salisbury,
March 2.

A DEFINITE answer to Sir Oliver Lodge's interesting question is still, I fear, quite outside the range of exact dynamical analysis. We know that the formation of a binary star begins with a cataclysm, we know the stage of the star's evolution at which this cataclysm occurs and the direction in which it starts, but we have very little detailed knowledge as to subsequent events. We connect up the final product and the initial star mainly through mere general principles

such as the conservation of mass, energy and momentum, and I cannot see any way of positively ruling out a final product of the type suggested by Sir Oliver Lodge.

Nevertheless, the probabilities against the suggested occurrence would appear to be overwhelming. The "drawn-out jet" of which Sir Oliver Lodge speaks could be at best of meagre length. Sir George Darwin calculated the configurations at which stability could first be resumed and found that the length of gap available for the jet would be substantially less than the radius of the smaller star, at least so long as the mass-ratio lies within the limits observed in actual binary stars. (Diagrams are shown in Darwin's "Collected Works," iii. p. 508, or my "Problems of Cosmogony," p. 64.) In these calculations the stellar matter is assumed to be of uniform density; when allowance is made for the heterogeneity of actual matter, the length available for the jet is reduced almost, if not quite, to vanishing point. In confirmation of this, observation indicates very strongly that the two components of new-born binary stars are practically in contact. Thus I think Sir Oliver Lodge's process must probably be ruled out, not because it is dynamically impossible, but on the simpler grounds that there is no room for it to occur.

A further consideration seems to point forcibly in the same direction. Theory and observation agree in suggesting that fission into a double star cannot take place until the gas-laws are substantially departed from—*i.e.* somewhere about type B. But as the gas-laws are left behind, so also is the possibility of the formation by condensation of bodies with masses small in comparison with those of the bodies out of which they have come. If Sir Oliver Lodge's process could occur at all, it would not, I think, result in a "solar system," but in a multiple star in which all the constituents would be of comparable mass. The smaller masses ought at least to be susceptible to observation. But Russell has shown, quite convincingly, that known multiple systems satisfy the rather exacting criteria for systems which have been formed by successive fission, each fission forming only two bodies.

J. H. JEANS.

March 7.

Reminiscences of Prof. G. H. Quincke.

THE obituary article on the late Prof. Quincke of Heidelberg in NATURE of February 23 gives an interesting review of the scientific activities of that very able experimenter. Readers of NATURE may be interested in a few personal reminiscences of a former student under Quincke.

The University of Heidelberg is housed in buildings in different parts of the town, the Physical Institute being situated on the High Street. There Quincke had not only his laboratory and lecture theatre, but also his private residence, to which he could retire at a step from the laboratory. The periods for practical work were from 9 A.M. to 1 P.M. and from 3 P.M. to 6 P.M. for those who took a full experimental course; the ordinary course was set forth in a list of more than 120 experiments, and before being allowed to proceed to research one had to do those experiments in the ordinary course which had not been done previously.

At that time (1894–95) Quincke had two assistants, whose emoluments were little better than those of Goldsmith's village preacher. The method of performing an experiment was described on an instruction sheet, a method not then in general use in our universities at home. It has been said that Quincke's apparatus consisted largely of "tin cans, glass tubes and sealing wax," but although much of the apparatus used by the student was of a simple character, there appeared to be no lack of good instruments when these were required. The wires necessary for electrical experiments had pins soldered on their ends which were stuck into cork mercury cups when in use; after use, the wires were pinned up on a wall board. When taking observations requiring a steady eye, the observer was provided with a box seat, the dimensions of which offered three heights for the observer's head; the box could also be used on a table as a stand for apparatus.

Quincke had a laboratory mechanic called Pflug to whose expert assistance all were indebted; Pflug also acted as lecture assistant. The lectures on surface tension were, as might be expected, illustrated by many beautiful experiments, and continued for a whole week. While sitting in the darkened lecture theatre, and the blinds were about to be drawn up, it was somewhat disconcerting to the English-speaking student to hear the professorial order given: "Hell, Pflug, hell." On the occasion of the Geheimrath's birthday, we joined with the staff in offering our good wishes, and were taken upstairs forthwith to celebrate the event with a glass of wine. On two other occasions we were invited to partake of Quincke's hospitality, namely, at a grand ball in the Museum during the winter, and at a garden party in the summer.

One of Quincke's outstanding characteristics was his assiduity in experimenting. He recorded all his experimental results. In this connexion he once remarked that he had piles of note-books containing many unpublished results of his experiments. On one occasion the writer got into trouble for taking up a new part of the work before Quincke was satisfied that the previous part had been thoroughly explored.

Quincke followed out his principle "Immer arbeiten" to the ripe old age of eighty-nine. Peace to his ashes.

GEORGE E. ALLAN.

Natural Philosophy Institute,
The University, Glasgow,
February 29.

The Twinkling of Distant Light-points.

REFERRING to Prof. Conrad's letter on "The Twinkling of the Stars," etc., published in NATURE of March 8, it may be of relevant interest to refer to the twinkling of the lights of coastal towns, as seen from a few miles at sea, on dark nights when the atmosphere is clear. Such pulsations are very conspicuous at times. I was under the impression that differences in the densities of air-layers produced the effect, but might not the wave-movements of the sea produce corresponding oscillations in the air above it, thus creating disturbances which would destroy optical continuity? Such twinkling of artificial lights at, practically, sea-level cannot be due to nitrogen-dust.

C. CARUS-WILSON.

March 9.

Srinivasa Ramanujan.

IN a letter in NATURE (Jan. 20, 1921; vol. 106, p. 661) I took occasion to point out that the year of Ramanujan's birth was given in some notices as 1887 and in others as 1888. I wrote at the time to Prof. Seshu Aiyar, of Madras, but my letter miscarried, and the question has only recently been put to him. He writes explicitly and emphatically, under date Feb. 20, 1924: "The correct date of Ramanujan's birth as given in his horoscope preserved in his family is the 9th day of Margasirsha in the Samvat Sarvajit, answering to the English date of 22nd December, 1887."

E. H. NEVILLE.

University College, Reading,
March 4.

Lapicque's Investigations on the Chronaxie of Excitable Tissues.

By JOHN F. FULTON.

AS there is no account in English, either in text-book or journal, of the fundamental researches of Lapicque and his co-workers upon the physiology of nerve and muscle, any attempt to give such an account, however imperfect it be, carries with it its own justification. The need for a review of the work on chronaxie is the more pressing among nerve-muscle investigators, as many of Lapicque's most fundamental contributions, so often overlooked by English-speaking physiologists, lie scattered in the literature. The account which follows is taken from about sixty papers which have appeared largely in the *Comptes rendus* of the Paris Academy of Sciences (*C.R. Acad. Sc.*) and the Société de Biologie (*C.R. Soc. Biol.*) between 1908 and 1923. The nature of the article forbids a complete bibliography.

Many physiologists, especially Waller and Keith Lucas, have determined the total kinetic energy required to elicit a nerve impulse, and also the rapidity with which such an impulse springs into existence. In England the most fruitful results have been obtained by Lucas using a pendulum for the determination of absolute time of excitation. The use of the condenser discharge for this purpose, though at one time employed with great promise by Waller, has been developed with pre-eminent success by Lapicque. In the course of his investigations he has introduced certain new terms which require elucidation. "Rheobase" and "chronaxie" are the first which demand consideration.

In a paper (*C.R. Soc. Biol.*, 67, 280) entitled "Définition expérimentale de l'excitabilité," "rhéobase" is defined as "l'intensité du courant constant à début brusque, à durée prolongée, qui donne le seuil [threshold] de l'excitation" (p. 283), and "chronaxie" as "la durée du passage du courant constant à début brusque, qui atteint le seuil de l'excitation avec une intensité égale au double de la rhéobase, soit pratiqué avec le voltage double du voltage rhéobasique." In other words, the rheobase is the intensity in volts of a constant current closed instantaneously which will just excite if continued indefinitely; while chronaxie is the *time* required for excitation by a current of intensity just double that of the rheobase. The rheobase may be very simply determined with a battery, a voltmeter, and an appropriate rheostat. The chronaxie, on the other hand, is determined, as already mentioned, by the discharge of a condenser, the procedure for which will be explained later.

Apparatus.—The apparatus devised by Lapicque, though in reality extremely simple, must be considered in some detail. For ordinary determinations of chronaxie on the nerves of frogs or mammals, a two- or four-volt accumulator is used as a source of current. This is led into an accurate potential reducer equipped with two hundred equal points of division (see Fig. 1). Such *réducteurs de potentiel* may be obtained from G. Boulitte in Paris.[1] The current is led from the potential reducer by way of a double-contact Morse key to a condenser of variable capacity, so arranged that the condenser is charged when the key is pressed down, and discharged when the key is released. The condenser[2] contains a series of capacities ranging from 0·5 to 0·001 microfarads. Connected in parallel (by a key) with this condenser is a less accurate condenser of a capacity of two microfarads. This is put into the circuit for the purpose of determining the rheobase, since its time of discharge is so long that it approximates to a constant current. In this way much laborious wiring is rendered unnecessary. It must be remembered that the wiring and mounting of this apparatus should be entirely non-inductive.

The condenser discharges (effected by the double-contact key mentioned above) are led to the tissue through an ingeniously arranged resistance. The time required for the effective portion of a condenser discharge varies with the external resistance. Obviously the resistance of the nerve fibre or of the muscle substance of a frog varies enormously with the distance between the electrodes, the state of moisture of the preparation, size of fibre, etc., and it would be a hopeless task to redetermine a new resistance for each experiment. This difficulty has been overcome by interpolating a shunt of such low resistance (3000 ohms) as to make the resistance of the tissue excited much greater in comparison, and hence negligible. Other resistances are placed in series with the electrodes as shown in Fig. 1. This resistance (in France *la shunt de Lapicque*), as well as the two-microfarad condenser and the non-polarisable electrodes about to be described, may also be obtained in Paris from Boulitte. The resistance is of graphite so as to have a very low temperature coefficient. When this is used the value R in the equation $\tau = CR \times 0{\cdot}37$ for the determination of the chronaxie in σ, may be taken as 10,000 ohms, and it is never altered for ordinary determinations. For further details on the external resistance Bourguignon's monograph (pp. 80-82) must be consulted (Paris: Masson et Cie, 1923).

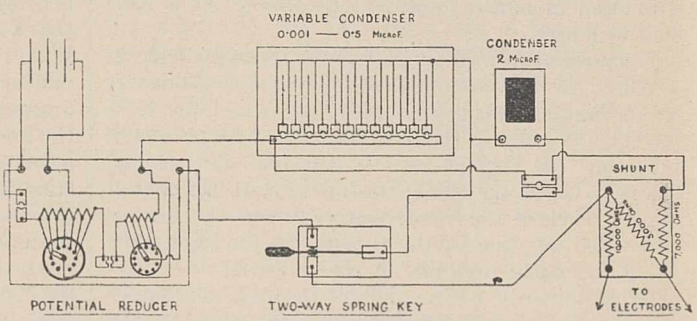


FIG. 1.

As the rheobase determinations involve constant current of long duration, non-polarisable electrodes must be used. For the nerve a convenient small

[1] G. Boulitte, 15 Rue Bobillot, Paris. Price, 900 francs.

[2] Much difficulty has been experienced in obtaining accurately constructed condensers of low and variable capacity at a reasonable price. A *de luxe* instrument may be had from the Cambridge Instrument Company for 30*l.*-40*l.* I find also that Beaudouin, 31 Rue Lhomond, Paris, V, is willing to supply, for 700 to 800 francs, a modest but accurate design in two months from receipt of order. J. Carpentier (20 Rue Delambre) supplies, for 1787 francs, a more elaborate instrument of proper range of capacities in three months from receipt of order.

hard-rubber chamber has been devised by Lapicque containing grooves for kaolin, upon which the nerve may be placed; other non-polarisable electrodes, provided they are not too large, serve quite as well. For the muscle, electrodes of thin silver wires, which have previously had deposited upon them by simple electrolysis a coating of silver chloride, are inserted directly into the muscle at convenient distances (0·5 cm. approx.). These may be made very simply by attaching the silver wire to the *positive* pole of a 4-volt accumulator and dipping it in Ringer solution for two minutes, the current being led away from the solution by a platinum wire. Such silver chloride electrodes must be renewed daily. Other more complex electrodes have been devised by Bourguignon (1923) for stimulation through the skin.

Procedure.—To determine the chronaxie of the sciatic nerve of the frog, it is preferable to leave the parts so far as possible intact. On a pithed preparation, brain only or cord and brain, the uncut sciatic nerve is exposed and lifted with glass hooks on to the electrodes. Any excess kaolin or moisture between the electrodes is carefully removed and the preparation is allowed to remain quiescent preferably for a half-hour or longer.

To determine the rheobase the two-microfarad condenser is placed in the circuit with the variable condenser (at its highest capacity – 1 microfarad) and the least current necessary to excite is then found by gradually increasing the current in the *réducteur de potentiel*. The rheostat on the left of this instrument has twenty points; each of the twenty intervals may be further subdivided into ten by the rheostat on the right, thus giving 200 equal divisions of the potential. A voltmeter is ordinarily used to give the rheobase in absolute units, 0·2 to 0·3 volts being a reasonable value for the nerves of a frog, but it may be much higher. In a single experiment there is frequently considerable variation in the value of the rheobase, but this does not affect the value of the chronaxie. For more accurate determinations of rheobase and chronaxie, as in Bourguignon's (1923) experiments on man, the amperage is also controlled by an additional variable resistance.

To find the chronaxie, the rheobase just determined is doubled by means of the rheostat, or if it is preferred, by the voltmeter. However, with a Boulitte potential reducer it is always safe simply to double the reading of the rheostats. The two-microfarad condenser is withdrawn from the circuit, and the plugs of the variable condenser are arranged for a small capacity, usually 0·02 or 0·05 microfarads. The capacity is then gradually increased until a response is just visible, or if the muscle is attached to a writing lever, until the unloaded lever is just moved. This is the critical capacity from which the chronaxie is calculated by the formula: $\tau = CR \times 0{\cdot}37$. If the critical capacity proved 0·082 microfarads, and R as usual is 10,000 ohms, we have (C being calculated in farads):

$$\tau = 0{\cdot}082 \times \frac{10{,}000}{1{,}000{,}000} \times 0{\cdot}37$$

$$\tau = \frac{0{\cdot}082}{100} \times 0{\cdot}37 = 0{\cdot}000303 \text{ or } 0{\cdot}3\sigma, \text{ three ten-thousandths of a second,}$$

which is normal for the sciatic nerve of the frog when not in connexion with the higher centres. The constant 0·37 is purely empirical (*C.R. Soc. Biol.*, 68, 797), and comes from a comparison of CR with the absolute time determined on the same preparation by means of a ballistic rheotome. For a discussion of this factor see Bourguignon's monograph (p. 10).

When the chronaxie of a muscle is determined, silver chloride non-polarisable electrodes are used as explained above. They are inserted just into the muscle substance separated by 0·5 cm. or less, and the index of adequacy of stimulation is not the complete contraction of the muscle but rather the first visible twitch at the cathode. Otherwise there is a great spread of current and the chronaxie appears much larger than it is (Davis). Theoretically, the most satisfactory electrodes for determining the chronaxie of muscle are the sodium chloride pore electrodes used with success by Davis (*J. Physiol.*, 57, lxxxi. 1923), which stimulate but a single muscle fibre (observed under the microscope).

Curarisation.—In the method just described for chronaxie determination in muscle, one might object quite justly that it is the chronaxie, not of the muscle fibres, but of the nerve fibres within the muscle which is being determined, and indeed Lapicque's contention that a skeletal muscle has normally the same chronaxie as its nerve has been criticised because of this technical difficulty. But such criticism comes from a failure to examine his evidence completely. It is admitted that the intra-muscular nerves *are* stimulated in this way; however, after curare has just caused a block for stimulation by the nerve, the chronaxie of the muscle is found to be double that of the nerve, and if the curare continues to act the chronaxie of the muscle continues to increase (*C.R.Soc.Biol.*, 68, 1007). If, on the other hand, the curare-effect is brought about by strong strychnine (1 in 1 to 2000) applied peripherally, the chronaxie of the nerve trunk, when the block is just effective, is found to have sunk to 0·15σ or less, while that of the muscle remains "normal," *i.e.* at 0·3σ or thereabouts, which is the chronaxie previously possessed by the nerve (*C.R. Soc. Biol.*, 74, 1012). From this the conclusion is drawn that normally there exists a condition of *iso-chronism* between a motor nerve and a voluntary muscle which it innervates, and that curarisation is brought about when the time relations are disrupted to such an extent that the chronaxie of one differs from the other by a hundred per cent.; in other words, heterochronism results in curarisation.

There are four possible ways in which curarisation might be brought about (*C.R. Soc. Biol.*, 72, 283):

		Chronaxie.
1. Curare	Muscle	Augmented.
	Nerve	Unaffected.
2. Strychnine	Muscle	Unaffected.
	Nerve	Diminished.
3. Strong Veratrin, Nicotine or Physostigmine	Muscle	Diminished.
	Nerve	Unaffected.
4. ?	Muscle	Unaffected.
	Nerve	Augmented.

It will be seen that only three methods for producing curarisation are realised practically, as there is no way as yet known for increasing the chronaxie of the nerve

at describing the apparatus and procedure for chronaxie determination, one cannot treat in detail the results which have thus far been obtained. One might mention the beautiful experiments with repetitive stimulation of known intensity, duration, and interval, which have been employed with such success by the Chauchards in analysing the action of the chorda tympani and the vagus, and by Koenig in his investigations on the excitability of the vaso-motor and "pigmento-motor" nerves. These investigations have shown that a difference in chronaxie between a nerve and its effector is overcome by repetitive stimulation. Bourguignon in his monumental work on chronaxie in man has shown that the extensors have in general one chronaxie ($0{\cdot}10$-$0{\cdot}16\sigma$) while the flexors have another ($0{\cdot}44$-$0{\cdot}72\sigma$).

Lapicque has refrained as yet from any detailed consideration of the application of the work on chronaxie to the theories of the functional activity of the central nervous system. He has, however, made several suggestions (*J. Psychol. norm. path.*, 8, 1), one of which (*Rev. gén. Sci.*, 21, 103) must be mentioned. With double condensers the ascent of the discharge, instead of being instantaneous as with a single condenser, is gradual, not unlike a sine curve. If, therefore, two sciatic-gastrocnemius preparations, one from a toad (chronaxie $1{\cdot}3\sigma$), the other from a frog (chronaxie $0{\cdot}3\sigma$), are placed side by side across the same pair of electrodes, each receiving in consequence the entire effect of the discharge, when the condensers are charged at a small capacity, only the frog's muscle will contract, and only the toad's at a higher capacity. This is the effect when the intensity is small; if now the intensity of the discharge is increased, both muscles will contract simultaneously at either capacity. "Cette expérience est pour moi une image de la façon dont pourrait fonctionner un centre nerveux quand il y a quatre neurones, deux centripètes et deux centrifuges" (p. 116).

Another fact of singular importance, which must be taken into consideration in enunciating a theory of central action based on chronaxie, is the influence which the higher centres (the region in front of the optic lobes in the frog) have on the chronaxie of the sciatic nerve (M. Lapicque, *C.R. Soc. Biol.*, 88, 46, 1923). In a normal frog when these centres are intact the chronaxie may be as small as $0{\cdot}19$ or $0{\cdot}2\sigma$, but *immediately* the brain is sectioned behind the optic lobes the chronaxie rises as high in some experiments as $0{\cdot}4$ or $0{\cdot}42$. Usually the effect of cutting off the higher centres, or of cutting the nerve itself, is to double the chronaxie. This obviously represents a type of nervous influence which, wholly unlike the propagated disturbance, has never before been described. It is akin to a polarisation which, if it passes via the pyramidal tracts, must be able to exert its effect across synapses. Perhaps this accounts for the greater facility with which reflexes are elicited in the spinal preparation than in the decerebrate preparation.

I should like to take this opportunity of expressing my most sincere thanks to Prof. and Mme. Lapicque and to Dr. Laugier for their great kindness, especially in granting me the facilities of their laboratory at the Sorbonne in January 1924.

The Memorial to Lord Lister.

IMMEDIATELY after the death of Lord Lister in 1912, the question of a memorial to him was discussed by fellows of the Royal Society and of the Royal Colleges of Physicians and Surgeons. Some delay necessarily occurred before action could be taken, but eventually a provisional committee consisting of representatives of the Royal Society and the Royal College of Surgeons met and agreed to issue, not only to men distinguished in science and surgery, but also to men of eminence in public life and in various branches of knowledge, both at home and abroad, a request that they would consent to form themselves into a general committee for the purpose of considering the question of a suitable memorial and taking such steps as they might think fit to organise the collection of subscriptions. This invitation met with a ready response and a large and influential committee consisting of foreign ambassadors and ministers, representatives of universities, scientific and learned societies, city companies, and men eminent in every branch of knowledge was constituted.

An executive committee, with Sir Archibald Geikie, then president of the Royal Society, as chairman, Viscount Hambleden as vice-chairman, Lord Rothschild and Sir W. Watson Cheyne, treasurers, and Sir John Rose Bradford, honorary secretary, was appointed. This committee considered several proposals for a memorial and came to the conclusion that the most suitable would be one comprising:

1. A tablet with medallion and inscription to be placed in Westminster Abbey.

2. The establishment of an International Lister Memorial Fund for the advancement of surgery, from which either grants in aid of researches bearing on surgery, or awards in recognition of distinguished contributions to surgical science should be made, irrespective of nationality.

3. A monument to be erected in a public place in London.

This proposal was put forward at a public meeting held at the Mansion House and unanimously adopted. Subscriptions were received not only from all parts of the Empire, but also from Buenos Aires, Denmark, France, Germany, Greece, Holland, Hungary, Italy, Japan, Portugal, Sweden, Switzerland, and the United States. The Glasgow Lister Memorial Committee also contributed a substantial sum. The work of the committee was to a great extent held in abeyance during the War, but a memorial tablet was unveiled in the north aisle of Westminster Abbey in November 1915 without public ceremony. The unexpended balance of subscriptions received was invested, eventually increasing the sum collected for the memorial by 2600*l.*, making a total of nearly 12,000*l.* Towards the end of 1920, 5000*l.* trustee stock was handed over to the Royal College of Surgeons of England to provide a fund from which every three years a sum of 500*l.* is to be awarded, together with a bronze medal, in recogni-

without at the same time enhancing that of the muscle. Hypertonic saline augments the chronaxie of both (Laugier).

It follows from Lapicque's theory that a drug such as strychnine, which produces a block by diminishing the chronaxie of the nerve, should be counteracted in its action by a drug which diminishes that of the muscle. Experimentally it is found that veratrin, nicotine, and physostigmine restore a nerve muscle preparation curarised by strychnine (*C.R. Soc. Biol.*, 74, 1012). Curare itself is likewise antagonised by physostigmine (*C.R. Soc. Biol.*, 72, 674) and by nicotine (Langley; also Lapicque, *J. Physiol. Path. gén.*, 20, 488).

In all of the investigations on chronaxie, no evidence has been found in muscle for the existence of Keith-Lucas's β-substance, and it has been sought for by means of rectangular rheotome currents of short durations, such as Lucas himself used, as well as with condensers, yet in every case with strength-duration curves the points have been continuous. Either, therefore, Lucas was in error, perhaps as a result of using large non-polarisable electrodes on excised muscle (Davis), or alternatively the condenser discharge may give only the chronaxie of the β-substance without exciting the substance of the muscle itself; perhaps in the muscle there exists another curve altogether, such as one finds in muscle in which the nerve has degenerated; but this is unlikely, and one cannot as yet decide. Lapicque believes, in view of the theory of isochronism, that the action current of the nerve excites the muscle directly, without the intermediation of a junctional tissue, a view strongly upheld by Forbes (*Am. J. Physiol.*, 66, 553-617).

Chronaxie and the Morphological Structure of the Nerve Fibre.—It is not surprising that in the same animal there is wide variation in the chronaxie of different nerves. In general, the nerves to the rapidly contracting muscles have the smallest chronaxie. But a fact much more significant than this comes from a study of the histological structure of nerve fibres in relation to their respective chronaxies. If, in the frog, the *average* diameter of the fibres in various nerve trunks is tabulated beside their chronaxies, we see that the chronaxie decreases with an increase in diameter (*C.R. Acad. Sc.*, 157, 1163). Thus:

Nerve and Muscle.	Chronaxie (in σ).	Average Diameter (in μ).	Product: Chron. × Diam.^{2}
Sciatic-gastrocnemius . .	0·3	18-23	97-161
Brachial	0·6	12-13	86-101
Sartorius	1·0	10-11	100-110
Vagus (cardiac branch) . .	2·0	7	98
Nerve to stomach . . .	20·0	2	80

The product of the chronaxie and the square of the diameter gives a value which is very nearly constant, a fact the meaning of which is as yet unknown. It is interesting that stretching a frog's nerve by a weight of ten grams, which would tend to diminish the diameter, causes an augmentation of the chronaxie (*C.R. Soc. Biol.*, 69, 46). Further evidence comes from the rabbit, where one finds that the white rapid muscles, such as the adductor magnus and gastrocnemius, are innervated by fibres 13μ in diameter, while the slow red muscles, soleus and semitendinosus, possess nerve fibres but 8μ in average cross-section.

Of even greater importance, however, are the morphological changes shown to occur in nerve fibres when under the influence of anæsthetics, decalcificants, certain alkaloids, and extreme cold. Lapicque and Legendre, in a class demonstration of chronaxie determination, observed in the sciatic nerve of a frog which previously had been exposed to extreme cold, an extraordinarily short chronaxie[3] with a high rheobase. Microscopic examination of the nerve revealed the fact that the myelin sheaths were greatly swollen, in some cases almost to the obliteration of the axis cylinder. It happened that at the time Lapicque was himself studying the action of chloroform and the oxalates, which also produced in nerves abnormally small chronaxies associated with extremely high rheobases, the latter increasing to complete inexcitability in the case of chloroform and ether.

Microscopic observation of nerves subjected to the action of such reagents reveals the fact that, *pari passu* with the increasing rheobase and diminution of the chronaxie, there appear swellings of the myelin sheaths such as occur also after extreme cold. This interesting observation led to a perfecting of the techniques for examining the living nerve fibre under the influence of anæsthetics. Lapicque and Legendre (*J. Physiol. Path. gén.*, 21, 163, 1922) have found that the nerve must be observed without teasing out the separate fibres; for this purpose the peroneal or tibial of a pithed frog is dissected out carefully, and everything is cut away between the knee and the ankle except the nerve. To ensure that the nerve is in every way normal the sciatic trunk is stimulated in the thigh to see whether the digits move. A cover slip, the corners of which have been turned down with heat, is put over the nerve. The preparation, pinned to a cork stage with a glass window, is now made ready for observation with an oil-immersion objective. With blotting-paper various reagents may be sucked through under the raised cover slip. By this procedure Lapicque and Legendre have shown that as the threshold for stimulation gradually rises to complete inexcitability under the influence of ether, chloroform, novocaine and cocaine, there appears first a translucency of the myelin, followed by swelling of this sheath and the formation of protuberances, especially at the nodes. (Cf. the beautiful photomicrographs in Lapicque and Legendre's paper, 1922.) The condition is reversible, restoration taking place in normal saline. It follows from this that the "decrement" of the Cambridge School is accompanied by a morphological lesion of the nerve trunk.

The swelling of the myelin which occurs with ether and chloroform is believed by Lapicque to be due to the absorption of water. Mme. Lapicque has pointed out that the more rapid the chronaxie of a given muscle the more will be its imbibition when placed in *hypotonic* saline. In *hypertonic* saline the chronaxie of a nerve is augmented, owing presumably to the extraction of water from the sheath (Lapicque et Lapicque, 1921). Also curare, which causes the chronaxie of a muscle to rise, diminishes its imbibition.

In a short review such as this, which aims primarily

[3] Normally, however, the chronaxie increases when the temperature is lowered moderately, as one would expect.

tion of distinguished contributions to surgical science, irrespective of nationality, the recipient being required to give an address in London under the auspices of the college. A further considerable sum will be handed over to the Royal College of Surgeons to be devoted either to increasing the capital of this fund, or to the furtherance of surgical science by means of grants.

A site for the monument was secured in Portland Place, London, not far from Park Crescent, where Lord Lister lived for many years. The monument, which was designed by the late Sir Thomas Brock, R.A., consists of a pedestal of grey Aberdeen granite, surmounted by a bust of Lord Lister in bronze (Fig. 1). The pedestal is enriched with bronze cartouches and the Lister escutcheon, while in front is a bronze group consisting of two figures—a woman and a boy; the former symbolising humanity, with right arm uplifted, points to the great surgeon and man of science, while the boy offers a garland of flowers as the world's tribute to the greatest benefactor to mankind. Sir Thomas Brock was engaged on the monument up to the time of his death; and in the opinion of those competent to judge, it forms a fitting and worthy memorial to one of the greatest men of science and one of the most signal benefactors of humanity the world has ever seen.

Photo.] [*Millar and Scott.*

FIG. 1.—Lister Memorial, Portland Place, London.

The unveiling ceremony took place on March 13. Viscount Hambleden, vice-chairman of the executive committee, opened the proceedings and gave a brief outline of the history of the memorial: he said it was worthy of note that although the work of the committee had extended over a period of twelve years, the actual expenses of administration amounted to less than 400*l.*, and he concluded by asking Sir John Bland-Sutton, president of the Royal College of Surgeons, to unveil the memorial in the absence through illness of Sir Charles Sherrington, president of the Royal Society.

Sir John Bland-Sutton in a brief address said: "This memorial has been raised to the memory of a great surgeon, Lord Lister, who by his discoveries in science and his devotion to surgery united surgery and science, ennobled the art he practised, and launched it on the most wonderful era in its history. It is an honour to unveil this monument as a memorial to a genius who did so much to unveil the secrets of Nature, and taught surgeons safe methods for relieving men, women, and children from the dread consequences of septic infection. Veterinary surgeons apply the same principles when performing operations for the relief of physical suffering on horses, cattle, cats, and dogs. Lord Lister had the rare advantage of seeing his principles adopted by surgeons throughout the world. His influence will remain as long as surgery is practised as an art, and the principles he discovered will remain as a blessing on every race of mankind. He was inflexible in the pursuit of truth and may be truly described as patience personified."

Viscount Hambleden then requested the mayor of St. Marylebone to accept the custody of the monument. The mayor accepted, on behalf of the present and future Borough councils, the duty of doing everything that was necessary to maintain and preserve the memorial.

Among those present at the unveiling of the monument were Sir Rickman Godlee; Sir William Lister, the Misses Lister and other members of Lord Lister's family; Viscount Hambleden, vice-chairman of the executive committee; Sir John Rose Bradford, honorary secretary; Sir Frederick M. Fry, member of the executive committee; and the Mayor of Marylebone. The Royal Society was represented by Sir David Prain, treasurer; Mr. W. B. Hardy and Mr. J. H. Jeans, secretaries; Sir Arthur Schuster, foreign secretary; Sir David Ferrier, Sir Frederick Mott, and Sir Arthur Keith. The Royal College of Physicians, London, by the president, Sir Humphry Rolleston; the Royal College of Surgeons of England by Sir John Bland-Sutton, president, and several members of the council; the Royal College of Surgeons in Ireland by the president, Sir William de C. Wheeler; the Royal Society of Medicine by the president, Sir William Hale-White; the Lister Institute by Dr. C. J. Martin; the Medical Society of London by the president, Dr. H. R. Spencer; the University of London by Mr. H. J. Waring, vice-chancellor; the University of Glasgow and the Royal Society of Edinburgh by Prof. F. O. Bower. The Glasgow Lister Memorial Committee was represented by Lord Blythswood, Sir John S. Samuel, Prof. Robert Kennedy, and Prof. Magnus Maclean. There were also present Mr. Fred Brock and other members of Sir Thomas Brock's family, Sir Charles Ballance, Sir D'Arcy Power, Sir George Makins, Sir Cuthbert Wallace, Sir Alfred Fripp, Sir Anderson Critchett, Sir George L. Cheatle, and many others representing medicine, surgery, and the sciences.

Obituary.

PROF. J. SYMINGTON, F.R.S.

THE death of Prof. Johnson Symington on February 24 has deprived anatomical science of a keen and devoted investigator who has enriched its literature, especially in the domain of topographical anatomy. Born in 1851, he received his early education in Taunton, and his medical training in the University of Edinburgh, where he graduated in medicine in 1877. There was no doubt as to his choice of a career, and, within a short period after graduation, he became established as an extra-mural lecturer in anatomy in Minto House, Edinburgh. His reputation as an inspiring teacher attracted large numbers of students, and during this period, which extended over fifteen years, he played an important part in the development of anatomical teaching and research in Scotland.

In 1893 Prof. Symington was appointed to the chair of anatomy in Queen's College, Belfast, and for twenty-four years he devoted himself to the interests of the anatomical department and the general university administration in that centre. Shortly after his appointment to the Belfast chair, he was elected a member of the governing body, and from that time onward until his retirement it may be truthfully said that in every matter dealing with college administration his advice and assistance were sought and freely rendered. On the retirement of Prof. John Purser in 1901, Prof. Symington was appointed registrar, and in the same year he helped to found the Better Equipment Fund, acting as one of the honorary secretaries. As a fellow of the Royal University of Ireland he acted as examiner, and contributed in no small degree to the work of framing and carrying out the regulations and courses in anatomy. On the passing of the Irish Universities' Act, 1908, he became professor of anatomy and registrar in the Queen's University of Belfast. He was appointed one of the seven commissioners under the Act to frame the Statutes, and one of the eight members of the Joint Committee. The duties of both these offices he carried out most ably. As a member of the University Senate, Academic Council, Faculty of Medicine, etc., he proved himself to be invaluable. In 1916 he succeeded Sir William Whitla as the University representative on the General Medical Council, but his period of service was unfortunately a very brief one, as within less than a year he was stricken down by the illness which led to his retirement.

Prof. Symington's contributions to anatomical literature cover a wide field, mainly dealing, however, with splanchnology, and the anatomy of the central nervous system. In 1903 he described a method to illustrate the relations of the deeper parts of the brain to the surface, and from this time onwards, until the publication of the work in "Quain's Elements of Anatomy," he carried out a series of investigations in cranio-cerebral topography with which his name will always be associated. The numerous casts, endocranial, endodural, and arachnoid, which he prepared, were of outstanding merit, and the results of these researches have been of the greatest service to all engaged in the subject of cranio-cerebral topography. A set of these casts is now in the Museum of the Royal College of Surgeons, England. He also subjected to a thorough and careful analysis the value of endocranial casts in the study of prehistoric skulls. In September 1908, part 1, vol. iii. (Neurology) of "Quain's Elements of Anatomy," was brought out by Sir Edward Sharpey Schafer and Prof. Symington, the macroscopic section of this important work being left entirely to the latter. Part 2 of this volume was issued under the same joint editorship in the following year, and in 1914 there appeared part 2, vol. ii., on Splanchnology, under the sole editorship of Prof. Symington.

The wealth of anatomical material, upon which this valuable work was based, was the result of many years' collection and preparation by the Belfast Anatomical School. An interesting atlas of skiagrams, illustrating the development of the teeth in man, was published by Prof. Symington and Dr. Rankin, and a set of the original slides was presented to the Royal College of Surgeons, England. His most recent work was the preparation of a complete series of plates illustrating sections of the human body, the atlas being designed specially for the use of military hospitals. More than three hundred copies of this atlas were in use during the War, and proved of great service in the localisation and removal of foreign bodies.

Prof. Symington was elected a fellow of the Royal Society in 1903, president of the Anthropological Section of the British Association in 1903, and president of the Anatomical Society of Great Britain and Ireland, 1904–1906. It is truly a record of good and faithful service, forty years of active work in a subject which he loved so much and for the University of which he was such a distinguished member. Nothing gratified Prof. Symington more than the action of his old pupils in Edinburgh and Belfast in raising sufficient funds to endow a prize, the "Symington Prize," to be awarded by the Anatomical Society for research carried out by junior anatomists. He was delighted when the Society made its first award about a year ago. T. H. M.

HANS GEITEL.

BORN at Brunswick in July 1855, Hans Geitel spent his early years at Blankenburg, and at the local secondary school he formed a friendship with Julius Elster that was the dominant note in both their careers. Having studied at the Universities of Heidelberg and Berlin, Geitel gained his Secondary Teacher's Diploma in 1879, and proceeded to the Secondary School at Wolfenbüttel, where he rose to be senior science master in 1896. Elster became associated with the same school in 1881, and lived until his marriage at Geitel's home. After his mother's death, Geitel joined his friend, and they built themselves a house with a well-equipped laboratory. Here they laboured until Elster's death in 1920, followed soon afterwards by that of Mrs. Elster. Left alone, Geitel arranged for his cousin to keep house for him, and in July 1922 he married her.

In the spring of 1923, Geitel was taken seriously ill, and in spite of an operation he died on August 15.

The names Elster and Geitel are prominently engraved on the roll of modern science, and we shall doubtless search in vain for a similar instance of private scientific partnership throughout a lifelong friendship. Each ascribed to the other the credit for a discovery published jointly; they were above petty jealousies to which mortal man is prone. More than once, one or other of them declined the offer of a university chair, and at least on one occasion they were offered a dual chair, but preferred the quiet of their home laboratory. On the occasion of his sixtieth birthday, Geitel had conferred upon him the title of Geheimrat by the Duke of Brunswick.

Elster and Geitel's earliest work on the production of electricity in flames (1882) led them to the study of atmospheric electricity and the production of electricity in thunderstorms, and in 1889 they noted that negatively charged bodies lose their charge not only in sunlight but also in diffuse daylight, thus extending the work of Hallwachs on the photoelectric effect. Their work on the unipolar conduction of gases in the neighbourhood of heated electrodes was followed by a study of the effect of the nature of the surface and the wave-length of the incident light on the photoelectric effect, and resulted in their recognising that the more electropositive a metal is, the more readily it can be excited photoelectrically by rays of longer wave-length. Further investigations on minerals indicated that photoelectric processes are a kind of resonance phenomenon, related to that of phosphorescence. Other work on the photoelectric effect and cathode rays was followed by investigations on the nature of the newly discovered Becquerel rays. Their scientific intuition is forcefully indicated in a paper published in January 1899, where they state "that the atom of a radioactive element, after the manner of the molecule of an unstable compound, passes over into a stable state under emission of energy." "Of course, this conception would involve the assumption of a gradual transformation of the active substance into an inactive one, with alteration of its elementary properties." They proved the non-identity of Röntgen- and Becquerel-rays by experiments in a magnetic field, and showed the presence of polonium in radio-lead from pitch-blende. They studied the ionisation of air on mountains, its dependence on temperature, and showed that air always contains emanation. They made exhaustive experiments on the distribution of radioactive elements in the earth's crust, and share with Crookes the discovery of scintillations on a zinc sulphide screen. Later, they returned to the study of photoelectricity, and carried out their well-known work on the photoelectric cell, and its photometric applications. Finally, mention should be made of their very delicate string electrometer (1909), capable of detecting currents of 10^{-14} ampere.

Elster and Geitel both celebrated their sixtieth birthdays in 1915, and this event was honoured by the publication in that year of an Elster-Geitel Festschrift, which contained numerous contributions to science from Germany, Austria, and neutral countries. Had the opportunity presented itself, many British men of science would have been proud to contribute to this volume, for these two men had earned the respect and admiration of men of science far beyond the confines of their own country. R. W. L.

DR. W. HATCHETT JACKSON.

BY the death, on February 21, of Dr. W. Hatchett Jackson, Radcliffe Librarian, subwarden and tutor of Keble College, students of natural science in Oxford have lost an old and trusted friend who played an important part during the last half-century in the development of the University Museum as a centre of scientific teaching and research. He died in his seventy-sixth year, at Weston-super-Mare, after an attack of influenza.

Jackson entered New College as an undergraduate, took his degree with first-class honours in 1873, and soon became assistant to Rolleston, the first Linacre professor. Those were the early days before specialisation, and the work in Rolleston's department covered not only the whole of zoology and comparative anatomy but animal physiology as well. Jackson devoted himself whole-heartedly to teaching, became a personal friend and took a sympathetic interest in the welfare of his pupils, among whom one may mention Prof. E. P. Poulton, the late Prof. E. A. Minchin, and Dr. Mervyn Gordon, whose name appears in this year's list of candidates selected for the Royal Society. Being a good classical scholar and an indefatigable reader, proficient in modern languages, he soon acquired and placed at the disposal of his pupils a vast store of learning comprising a truly remarkable knowledge of the ancient and modern literature of zoology, together with a detailed acquaintance with the large collections of specimens and preparations in the department. His instructive lectures ranged over many aspects of zoology and physiology. When Rolleston introduced the type system of teaching, he wrote a small book called the "Forms of Animal Life," and Jackson will long be remembered as the author of the greatly enlarged second edition of this work published in 1888. It is a monument of learning, and would no doubt have become the standard text-book on the subject had it been adequately illustrated. Even now it remains a valuable guide and work of reference.

Although Jackson helped others in their researches, he did not himself publish much original work. His chief contributions are a memoir on the embryology of insects in the Transactions of the Linnean Society (1890) and a description of the cranial nerves and brain of the shark Echinorhinus (*Jour. Anat. and Physiol.*, 1878) in collaboration with M. B. Clarke. This paper is important, for in it were first described the so-called ventral motor nerve-roots of the vagus region, a discovery which eventually led to the correct interpretation of the morphology of the occipital nerves.

Dr. Jackson was appointed Radcliffe Librarian in 1900, at a time when the library of scientific books was being transferred to its new quarters in the present building. The later years of his life were chiefly devoted to the organisation of this library, which, largely owing to his efficient and practical management, has been of such value to all scientific workers in Oxford.

Current Topics and Events.

A CIRCULAR has reached us referring to the formation of a History of Science Society in the United States. It is very fit that this new organisation, long overdue, should take the form of supporting Dr. George Sarton and his international publication *Isis*. Dr. Sarton's work for the history of science is well known all over the world. Before the War he was labouring at it in Belgium; afterwards, having lost a valuable library at the hands of the Germans, he took refuge in the United States, where he is now attached to the Carnegie Institution of Washington. He has been able there to attach to himself a number of scholars, all, in fact, who are interested in making the history of science an integral part of general history. This committee now appeals for wider support in the English-speaking world, and we cannot doubt but that it will be accorded. A subscription of five dollars now paid will qualify any one as a foundation member, and cover the issues of *Isis* for the year. It would be an excellent thing if enough members joined on the eastern side of the Atlantic to allow ultimately the swarming off of a separate British branch, which would naturally be associated with the British Association. The desirability of this in the end should not, however, deter any sympathiser from joining the American organisation. The object is admirable, indeed indispensable for the proper view of science as a social product and a cultural instrument. In Dr. Sarton we have the man in the whole world best fitted to carry it out, both by his own wide scientific training and by the devotion of years to his chosen cause. One may count with confidence on his fidelity to it for life, and it rests with the educated public to see that he does not live in vain. Correspondence may, for the present, be addressed to Prof. David Eugene Smith, 525 West 120th Street, New York City.

PROF. S. J. HICKSON is to retire next September from the chair of zoology in the University of Manchester, on reaching the age of sixty-five. When the late Prof. Milnes Marshall lost his life on Scafell, it was no easy matter to find a man who could take his place in the many-sided work which falls to a leading professor in the Owens College. In Prof. Hickson the College found a man not only with the Cambridge and London training, but an honours graduate of Oxford, where he had been a lecturer in zoology under Prof. Moseley, and later had been his deputy when Moseley had to give up work. A student of Ray Lankester's at University College, Prof. Hickson gained a scholarship at Downing College, Cambridge, where he worked under F. M. Balfour, Michael Foster, and A. Sedgwick. After graduation he became assistant in the Anatomical Laboratory at Oxford, and began under Moseley's inspiration the researches on the Cœlenterata which have made his fame as a zoologist. After three years' work at Oxford, he decided to study the marine fauna—especially the corals—of the Eastern Seas, and lived for a year in North Celebes exploring and collecting. With the handsome specimens of *Millepora Plicata* which he collected on the edge of the coral reef fringing the shore of Talises Island, he was able to prove that the species is hermaphrodite, both ova and spermoblasts being present in the canals, and to trace not only the movements of the cells, but also the early stages of their development—facts which had escaped all previous observers. At Manchester Prof. Hickson gradually built up an honours school, and besides taking his share in extra-mural lecturing, and in the management of the Manchester Museum, he has devoted much time to the study of injurious insects and bacteria, and taken an active part in the scheme for providing senior lecturers in the University on agricultural entomology and botany to act as advisers in the district under the Ministry of Agriculture.

THE Steinhart Aquarium of the Californian Academy of Science was formally opened in September last, and in the *Scientific Monthly* for February Dr. B. W. Evermann, the Director, gives some interesting particulars of the aquarium itself and of the circumstances which led to its foundation. The aquarium has cost upwards of 300,000 dollars, the proceeds of a legacy bequeathed to the Academy for that purpose by the late Mr. Ignatz Steinhart of San Francisco. It is situated in the Golden Gate Park and is under the management of the Academy, but funds for its maintenance are provided by the city of San Francisco and other institutions. There are more than one hundred tanks and several large outdoor pools, as well as a large indoor tropical swamp stocked with turtles, frogs, water-snakes, salamanders, and alligators. The closed circulation system has been adopted and the water is of four kinds: fresh water at the local temperature, fresh water cooled for the needs of salmon and trout, salt water at the local temperature, and salt water warmed for tropical fishes. There is in addition a fish-hatching equipment and a well-equipped biological laboratory for research purposes.

THE report of its proceedings shows that the fifth congress of the Far Eastern Association of Tropical Medicine held at Singapore last September was well supported: in addition to representatives of the various Malay States, delegates attended from all the Commonwealths and Empires of the East—from India and Ceylon to Australia and Japan. Of the subjects of public importance brought before the congress, that of the prevention of beriberi provoked most discussion. The congress having "re-affirmed its opinion" that this disease is a disorder of nutrition due mainly to the use of overmilled rice, a formal proposal followed that a recommendation should be made to the governments interested to exercise some concerted and appropriate control over the diet of rice-eating populations. It was urged against the proposal—as it has also been ably argued by Megaw in a recent number of the *Indian Medical Gazette*—that the causal connexion between rice that has been merely overmilled and beriberi is by no means conclusively settled. Outside the Philippine Islands delegation, the proposal seems to have had a very

tepid reception; which is just as well, since any measures, however well meant, that might be construed as an interference with a staple food, might lead to inconceivable trouble in countries where particularities of food are regulated by caste. Another subject that evoked much discussion was a proposal to eliminate the qualification "tropical" from the title of the Association, mainly on the ground that some of the generally notorious diseases of tropical countries are not restricted to the tropics. This proposal was rejected; and most people will agree with this decision, since, if the diseases in question are not peculiarly tropical in their geographical range, they are peculiarly fostered and disseminated by the imperfect sanitary conditions that are still prevalent in the tropics. They are not manifestly endemic and are of rare occurrence in countries, remote from the tropics, that maintain high sanitary standards.

THE loss of the French airship *Dixmude* last December is alluded to by Mr. M. A. Giblett, an Assistant Superintendent of the Forecast Branch of the Meteorological Office, in "Notes on Meteorology and the Navigation of Airships" in the *Meteorological Magazine* for February. Some three years ago Major G. H. Scott pointed out that electrical storms are a danger to rigid airships, chiefly on account of the violent air movement severely stressing the structure. The *Dixmude* left Toulon at 5 A.M., December 18, for a long cruise to North Africa. Special details are given by the author regarding the meteorological conditions existing. After a day or two of favourable weather at the start the Mediterranean was invaded by a strong cold wind current pouring through between the Alps and the Pyrenees, and blowing round an area of low pressure situated over the Adriatic. On the evening of December 20 the airship last signalled her position not far from Biska, Algeria. Some days later the body of the Commander was recovered from the sea off Sciacca, South-west Sicily. By the morning of December 21 the disturbance had reached its full intensity, and was centred over Southern Italy. The airship must have passed towards the centre of the storm. It is assumed that the airship was lost on December 21, some 150 miles west-north-west from Malta. In the communication, weather observations at Malta are given which show the occurrence of a thunderstorm on December 21, with rain and hail, at the surface, while at the height of 3000 feet the velocity of the wind was 60 m.p.h. The wind and airship navigation is discussed in the same communication.

A CONGRESS of Russian zoologists, anatomists, and histologists was held in Petrograd in December 1922; and the volume of Proceedings has just reached Great Britain. The congress was presided over by the late Prof. W. M. Schimkewitsch, with Profs. K. M. Derjugin, Kozhevnikov, Koltsov, Nassonov, Severtsov, and Tonkov as members of the Council. Three hundred and eight delegates, representing all the most important cultural centres of Russia, were present, and 267 papers were read. These were divided among the following seven sections: (1) systematics, ecology, and zoo-geography; (2) hydrobiology; (3) morphology of invertebrates; (4) morphology of vertebrates; (5) experimental zoology and genetics; (6) anatomy; and (7) histology. The large number of papers on various subjects read before the congress is a tribute to the vitality of Russian men of science under the most unfavourable conditions. As the president remarked in his address, Russian science has passed through a period "full of profound hardships and irreparable losses," and although they had overcome "physical famine," "spiritual famine was still handicapping Russian science." The "spiritual famine" referred to is due to lack of foreign literature, apparatus, etc., rendering normal scientific work impossible. The publication of scientific periodicals has been stopped, and numerous manuscripts awaiting publication for years are gradually losing their scientific value. The Natural History Societies which formerly played an important rôle in the development of science in Russia cannot exist, and the zoological stations (Sebastopol, Murman, Odessa, Ville-Franche) seem similarly destined to perish. These facts were brought to the notice of the Soviet authorities, and resolutions were passed by the congress, appealing to the Government for subsidies for the restoration of normal scientific work. The Proceedings of the congress were published in 1923 (edited by Prof. K. M. Derjugin), and contain summaries of the papers read and the resolutions passed.

THE meeting of the International Illumination Commission is to take place this year in Geneva on July 21-25, when it is anticipated that a series of papers on a variety of aspects of illumination will be presented. Immediately prior to the meeting there will be another interesting event, the International Conference on Industrial Hygiene, to take place on July 18-20. The Conference is under the auspices of the Institute of Hygiene of the University of Geneva, and the chairman of the organising committee is Dr. Cristiani, scientific director of the Cantonal Health Department and professor of hygiene and bacteriology at the University of Geneva. The proceedings will deal mainly with three subjects: (1) industrial lighting and eye-strain, (2) impure air in factories, and (3) the value of fatigue tests. Each subject will be dealt with by three reporters, and in section (1) a review of recent progress in industrial lighting will be presented by Mr. Leon Gaster, who is also attending the meeting of the International Illumination Commission as one of the British delegates.

THE annual report of the Scottish Marine Biological Association for 1922 shows that the Millport Laboratory has increased greatly its scientific activity since receiving more adequate financial support from the Development Commissioners. A series of useful observations on young herring in the Clyde area are recorded, including records of their food, and Mr. Elmhirst puts forward an interesting correlation between the prevailing winds in the estuary and the yearly catch of herring. Another subject of general interest at the present time upon which experiments have been made is the effect upon marine animals and

plants of oil discharged into the sea. The conclusion arrived at is that the effect of oil refuse is very local, and unless present in enormous quantities, the oil does not seriously affect the economy of the sea. At the same time its presence is most undesirable owing to the fouling of nets and of the foreshores. The bulk of the report is devoted to an account by Mr. Elmhirst of the breeding and growth of animals in the Clyde sea area, which will be of great use to naturalists working in that area, as well as to those who are working upon similar lines in other localities.

THE Martin Johnson Corporation, a body the directors of which consist of a number of men well known for their public activities in the United States, have entered into an agreement with the Board of Trustees of the American Museum of Natural History. By the terms of the agreement, Mr. Martin Johnson, who is about to proceed to Africa on a five years' expedition, has placed himself and his work under the scientific supervision of the Museum. He has undertaken to deposit with it all cinematograph films, photographs, and other material which may be obtained. The expedition proposes to make a correct record, complete so far as possible, of the life of the peoples and animals still extant on the continent. This record will be added to a large collection of photographs and films made by Mr. Johnson during twenty-six years of travel in various parts of the world, which has already been presented by him to the Museum.

IN 1902 the Institution of Civil Engineers published a Code with the object of systematising tests of boilers and steam engines, and in 1913 the Code was revised. In September of 1922 seven other Institutions interested in the subject, including the various engineering bodies and the Institute of Chemistry, were invited to co-operate in the revision of the 1913 Code and in the establishment of a Code for internal combustion engines. A joint committee was formed on which there were representatives of the British Electrical and Allied Manufacturers' Association and of the British Engineers' Association. The main committee is divided into sub-committees and panels, which are empowered to co-opt members to obtain advice on any special point. Sub-committee I. deals with boilers and steam-engines; sub-committee II. with internal combustion engines; sub-committee III. with the calorific value of fuels; sub-committee IV. with methods of measurement and the use of instruments; sub-committee V. with definitions and values as applicable to units of measurement, etc. The Committee is in close touch with the corresponding committee of the American Society of Mechanical Engineers. The whole of the secretarial work is being undertaken by the Institution of Civil Engineers.

PROFS. NERNST and WILLSTÄTTER have been elected corresponding members of the Russian Academy of Science.

MR. W. J. BERRY, Director of Warship Production, has been appointed Director of Naval Construction in succession to Sir Eustace H. Tennyson d'Eyncourt, who retired at the end of last year.

JUNIOR assistants are required at the Royal Aircraft Establishment, South Farnborough, Hants, for, respectively, experimental work upon instruments, and in the elasticity research laboratory. Applications for the posts should be made to the Superintendent of the Royal Aircraft Establishment.

THE radium industry of Cornwall is described in *Discovery* for March. Radium compounds are extracted from the mineral torbenite (phosphate of uranium and copper), which occurs near the surface: a deposit of black pitchblende near the works has not yet been worked. The radium is marketed as bromide, 700 milligrams of which have been produced to date. Sodium uranate is the most important by-product. The extraction is carried out by a French firm.

MR. WM. A. KNIGHT, writing from Sexey's School, Bruton, Somerset, says: "A brilliant sun-pillar was observed here on Thursday, March 13. It was first noticed about 5.30 P.M. and lasted until 6.30 P.M. The pulsations were very marked, the pillar repeatedly disappearing entirely for a fraction of a second. A similar pillar was observed again the next evening about the same time, but it was more beautiful. As the sun sank behind a light screen of cloud, the pillar changed slowly from a silvery appearance to a brilliant pink." The sun-pillar referred to by Mr. Knight was observed in many other parts of England.

AT the annual general meeting of the Geological Society of London on February 15, the following officers were elected: *President*, Dr. J. W. Evans; *Vice-Presidents*, Dr. C. W. Andrews, Dr. J. S. Flett, Prof. A. C. Seward, and Prof. W. W. Watts; *Secretaries*, Mr. W. C. Smith and Dr. J. A. Douglas; *Foreign Secretary*, Sir Archibald Geikie; *Treasurer*, Mr. R. S. Herries. *Other Members of Council*, Mr. F. N. Ashcroft, Prof. P. G. H. Boswell, Prof. A. H. Cox, Mr. H. Dewey, Dr. J. A. Douglas, Dr. Gertrude L. Elles, Dr. F. H. Hatch, Prof. H. L. Hawkins, Sir Thomas H. Holland, Dr. W. D. Lang, Mr. T. C. Nicholas, Prof. S. H. Reynolds, Dr. L. J. Spencer, Sir Aubrey Strahan, and Mr. H. Woods.

AT the first conversazione of the Natural History Museum Staff Association in the present year, which took place in the Board Room on March 5, a short address, illustrated by lantern slides, was given by Dr. C. W. Andrews on Deinosaurs, with special reference to the British Museum East Africa Expedition. Since it was necessary to make arrangements to darken the room for the purpose of the lecture, the amount of space available for exhibits was smaller than usual, and consequently the number of specimens shown was not so large as on previous occasions. The exhibits included a number of the specimens collected by the British Museum Australia Expedition under the leadership of Capt. G. H. Wilkins, an interesting flightless bird (Rail) from Inaccessible Island in the Tristan da Cunha group, a series of insects which in life display luminosity under certain conditions, and a remarkable X-ray

photograph showing pharyngeal jaws of Muræniдæ. Messrs. Davidson and Co. demonstrated the "Davon" micro-telescope.

AT the annual general meeting of the Ray Society on March 11, the following officers were re-elected :—*President*, Prof. W. C. M'Intosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Sir David Prain was elected a vice-president, and Dr. A. B. Rendle and Dr. G. P. Bidder were elected new members of council. In the report of the council it was announced that the second volume of the "British Charophyta," by Mr. James Groves and Canon Bullock-Webster, was in the press and would be issued to subscribers for the year 1923. The issue for 1924 will be the first volume of a monograph on the "British Hydracarina," by Mr. C. D. Soar and Mr. W. Williamson, the MS. and drawings for which are now ready for press. It was stated that the council were now prepared to consider offers of works for future publication. Communications for the Society should be addressed to Dr. Calman at the British Museum (Natural History), Cromwell Road, London, S.W.7.

UNDER the able guidance of Dr. Annandale, aided by his colleagues of the Zoological Survey of India and the Indian Museum, a large amount of valuable work has been done on the fauna of the fresh and brackish waters of India and other parts of the continent of Asia during the last ten years. Dr. Annandale has written a useful summary of this work (*Journ. Asia. Soc. Bengal*, vol. xviii. No. 10), to which is appended a complete bibliography for the years 1912–1922. It is difficult to overestimate the importance of the work which has been accomplished and is still in progress, and although much has yet to be done, the freshwater fauna of Asia, thanks to Dr. Annandale's stimulus, is more exhaustively known than that of any other continent except perhaps Europe. The valuable bibliography is eloquent of the far-reaching ramifications of the work of the Calcutta biologists, and forms a useful guide not only to the work done but also to that which still awaits the worker in this interesting field.

IN his presidential address to the Quekett Microscopical Club (printed in the Journal, ser. 2, vol. xv., No. 89) Mr. D. J. Scourfield deals with the physical factors involved in the problems of microscopic aquatic biology. He groups these factors under three heads, the physical properties of the medium (water) in which the organisms live, the physical characters of the organisms themselves, and the physical principles and apparatus used in the collection and observation of aquatic life. Under the first of these headings are discussed the effects of the density, viscosity and incompressibility of water on the organisms living in it, the limited extent to which it is penetrable by light, and the surface film. In the second group such characters of living organisms as size, shape, specific gravity, movement, and so on are dealt with. Mr. Scourfield illustrates the various points of his address by numerous examples culled from his own observations and experience extending over many years' active and enthusiastic work in this branch of biology. His address is a call for further inquiry, and should do much to stimulate direct observation on living organisms, by which means alone the effects of these important and neglected factors can be properly studied.

THE report of the Director of the Dominion Museum, New Zealand, apparently for 1922, has been received and indicates considerable work hampered by the illness of the Director, Dr. J. Allan Thomson, and the inadequacy of the building. The chief activities seem to have been connected with the Maori, who in their turn display a keen interest in that branch of the museum's work. The east coast natives, though they live in bungalow houses with modern conveniences, retain their old-time methods of catching fish and are skilled in making simple but effective nets and traps.

THE Dutch periodical *Wendingen* generally deals with art and architecture. A recent number (*Wendingen*, 5e Serie afl. 8 en 9, Schelpennummer door R. N. Roland Holst, H. Th. Wydeveld en Bernard Eilers. Prijs f. 7.—Uitgevers Mij. De Hooge Brug, Amsterdam) is devoted to a part of Nature's beauty, the tropical shells, which are illustrated by full-size photographs from different aspects, and in some cases by striking radiographs, revealing the special beauty of involute shells, such as Harpa, Cypræa, Triton, Pterocera, Nautilus, and Mitra. This work should be of great interest to artists, shell collectors, and teachers of natural history.

As a result of negotiations between the Councils of the Röntgen Society and British Association for the Advancement of Radiology and Physiotherapy, a close working relationship has been established between their respective journals. From January last, the *Journal of the Röntgen Society* will appear as the *British Journal of Radiology : Röntgen Society Section* and the *Archives of Radiology and Electrotherapy* as the *British Journal of Radiology : B.A.R.P. Section*. The January number of the last named (vol. xxix., No. 282) contains Revised Report No. 1 and Report No. 2 of the X-ray and Radium Protection Committee, which are of great importance for safeguarding those engaged on X-ray and radium work.

ATTENTION was directed in our columns (December 1, 1923, p. 808) to the publication of the Interim Report on Methods of Analysis of Coal compiled by a Committee of the Fuel Research Board. The report aims at collating agreed methods generally applicable, to secure uniformity in this field of analytical practice, now so important both scientifically and commercially. Messrs. A. Gallenkamp and Co., Ltd., 19 Sun Street, London, E.C.2, have just issued a pamphlet (No. 83) cataloguing a range of apparatus (usually heated electrically) designed to facilitate the carrying out of these proposed standard methods of proximate analysis of fuel as well as the Lessing coking test, and apparatus designed at the Fuel Research Station for

the low temperature assay of coal. The list will repay perusal of those interested in such work.

WE have received from Mr. W. H. Robinson, 4 Nelson Street, Newcastle-on-Tyne, a copy of his recently issued Catalogue No. 10 containing upwards of 1000 entries, many relating to books dealing with archæology, folk-lore, the occult, botany, natural history, etc. We notice that this bookseller has for sale a copy of the first edition of Newton's "Principia."

A USEFUL catalogue (No. 111) of new and second-hand books (upwards of 4000 in number) on botanical subjects has just been issued by Messrs. Dulau and Co., Ltd., 34 Margaret Street, London, W.1. It is classified as follows: Cryptogams and Plant Pathology; Agriculture and Economic Botany; Floras, Monographs, Systematic Works, Landscape Gardening, Herbals, Pre-Linnean Botany, and Serial Publications.

MESSRS. WHELDON AND WESLEY, LTD., 2 Arthur Street, W.C.2, have just issued a very useful catalogue (New Series, No. 12) of selected second-hand works on natural history, including most of the great faunas, floras, and monographs, with coloured plates. It is classified under the following headings, and is worthy of perusal: *Zoology*—General works, Voyages, and Travels; Aves; Insecta and Arachnida; Invertebrata; Mammalia; Pisces and Reptilia; and Sport, including Falconry. *Botany*—The general subject; and Horticulture and Agriculture.

Our Astronomical Column.

MINOR PLANETS.—The Stroobant object, mentioned in our issue of March 15, is a minor planet, not a comet. It may be a known planet, as the ephemerides for these do not extend so far from opposition. The planet (9) Metis was in the neighbourhood, but apparently not quite near enough to the place to make identity possible.

Another interesting planet has been found by Herr Reinmuth, of Königstuhl Observatory, Heidelberg: it is of magnitude 13·6, and is moving north at the unusual rate of 25′ daily, so that it is probably fairly near the earth.

THE MASSES AND LUMINOSITIES OF THE STARS.—An important paper on this subject was read by Prof. A. S. Eddington at the meeting of the Royal Astronomical Society on March 14. He provisionally assumed that absolute magnitude could be expressed as a function of the mass plus a constant; also that absorption in the star's interior varies as density/(temperature)$^{\frac{7}{2}}$. A curve was drawn in which Capella, the mass of which is accurately known, was taken as the standard star. The masses of the highly luminous stars were taken from Prof. Shapley's results for the Cepheids and Prof. Plaskett's recently published results for Algol-variables in which both spectra can be photographed. The other end of the curve was filled in from the masses of the binary stars of large parallax. Prof. Eddington noted that he had not expected that the results from dwarf stars would fit on the curve derived from giant stars, but to his surprise they did so. He concludes that the principle, enunciated when the giant-and-dwarf theory was started, that the dwarf stars do not obey the laws of a perfect gas, is unsound; that, in fact, these laws are obeyed even for densities much greater than that of the sun. He thought that this fact might be explained by the atoms in the interior of the stars being ionised and stripped of their outer electrons. Their bulk is thereby greatly reduced, and there is room for them to move freely, even when the density is considerable. The interior of the dwarf stars continues to get hotter and hotter, but the surface cools by radiation.

Prof. Eddington suggested that the small mass of the dwarfs might be due, as he had indicated some years ago, to the annihilation of matter within the star, colliding atoms destroying each other and liberating the large amount of energy locked up in them. The mass of a star would thus be less in its old age.

The results of the paper would necessitate considerable alteration in the manner of stating the giant-and-dwarf theory. Prof. Eddington did not anticipate opposition from the authors of that theory (Profs. Russell and Hertzsprung), as he gathered from recent communications that they were reaching conclusions similar to his own.

THE HUNDRED NEAREST STARS.—Prof. Eddington many years ago collected statistics on the stars (some 22 in number) that lie within 5 parsecs of our system. Mr. Willem J. Luyten has extended the distance to 10 parsecs, and prepared a monograph (Harvard Annals, vol. 35, No. 5) collecting and discussing all known data of the stars within this region. His list contains 104 stars, which is not much more than half the number to be expected; but many of the undetected stars are likely to be very faint. His table goes further than Eddington's in that he gives estimated masses of the stars based on the statistics of masses of different spectral types and absolute magnitudes. Arcturus and Vega are each given parallax 0·134″ and mass 3·50. The smallest masses are taken as 0·20. The great majority of the stars are dwarfs; the graph connecting spectral class with absolute magnitude approximates to a straight line, falling from 0·5 mag. for Ao to 11·5 mag. for Mb.

The sun's apex relatively to these stars is given as R.A. 278°, Decl. +36°, velocity 25 km./sec. The latter is higher than the value given from the whole star-system, probably because the dwarfs, which predominate in the local stars, are quick movers. There is a very distinct preference for motions in the plane of the Galaxy; very few apices are more than 30° from it. The high velocities appear in the region between galactic longitudes 340° and 100°, but strong reasons are given against the suggestion that these quick-moving stars are interlopers not belonging to our system.

Various points are discussed in the paper, such as the light thrown on Kapteyn's figure of the stellar universe from this sample of its nearer portion. An investigation is made of the number of stellar collisions per annum in the whole system. The result comes out $1{\cdot}4 \times 10^{-13}$, or, say, 1 in 6 billion years. This does not apparently take account of the mutual gravitation of the stars, which would have a considerable effect when they approached fairly near each other.

Research Items.

ANCIENT INDIAN CULTURES ON THE SAN JUAN RIVER.—A dispatch from the New York correspondent of the *Times*, published on March 6, gives some interesting details of the results of excavations conducted by Mr. Earl H. Morris in New Mexico and Arizona during a period of seven years. Five stages of culture were found, of which the most important were the first and third. To the first the high antiquity of 4000 B.C. is attributed, but on what ground is not stated. This culture came from the south; it corresponds in many respects with that of the present Indians of Northern Mexico, but although weaving and agriculture were practised, no pottery was made. In the third stage masonry appears, and a high degree of art in making pottery and in weaving and dyeing is shown. In the following decadent periods artistic skill disappeared with the loss of the earlier cultural standards. In the fourth or Chaco period the people became more essentially cliff dwellers, with large communal homes in caves containing as many as a thousand rooms. These cliff dwellers were sun worshippers and buried with their dead a supply of sandals, food, and weapons. A large number of skeletal remains and skulls were discovered, exhibiting divergences which will probably afford evidence as to the sequence of racial differences.

FRESHWATER AMPHIPODA OF THE BALKAN PENINSULA.—The researches of Dr. K. Schäferna (Mem. Soc. Roy. Sci. Bohême, 1921–22) have revealed an unexpected wealth of species of Amphipoda in this hitherto unworked region of Europe. Sixteen species in all are dealt with, of which no less than ten are described as new. The author discusses the various questions raised by the geographical distribution of this interesting Crustacean fauna, particularly with reference to its age, its fate during successive geological periods, and its derivation from marine ancestors.

SOUTH AFRICAN BIRDS.—Mr. Austin Roberts (Annals Transvaal Museum, vol. x. pt. 3, pp. 89-195) has brought together the results of his work on South African birds in the form of a synoptical check list, to serve the dual purpose of bringing the nomenclature up-to-date and to aid the field ornithologist in the identification of species and sub-species. Full keys to families, genera, and species are provided, with information on the known geographical distribution. Mr. Roberts has done a useful and laborious piece of work, which should prove invaluable to ornithologists both in South Africa and elsewhere.

THE RUDIMENTARY RIGHT SEXUAL GLAND IN THE HEN.—M. Benoit has previously shown that ovariotomy in the fowl is followed by the development of a functional testis in the normally rudimentary right genital gland. This, in conjunction with the evidence derived from a study of hermaphrodite birds in which the right sexual gland is developed as a more or less completely formed testis, suggests that this gland is in reality a rudimentary testis and not an ovary. M. Benoit (*Comptes rendus* of the Paris Academy of Sciences, January 14, 1924) now concludes that a histological examination of the gland confirms the experimental evidence of ovariotomy and of the conditions found in hermaphrodite birds. He finds that it is in all its essential cytological characters exclusively male in composition, and is derived entirely from that portion of the germinal epithelium which, from embryological evidence, is regarded as the homologue of that which in the male gives rise to the germ cells of the testis. He has never found female sex cells in the right sexual gland of the fowl.

NATURALISED PLANTS AND ANIMALS OF NEW ZEALAND.—The Hon. G. M. Thomson has published (*New Zeal. Journ. Sci. Tech.*, vol. vi., No. 4, December 1923) an additional list of naturalised animals and plants of New Zealand introduced since the publication of his book in 1922. The subject is one of vital interest to the naturalist, and it is most important that accurate records should be available both as to the time and manner of introduction. The majority of the new aliens are insects introduced accidentally with fruit, timber, and live-stock. It is, however, of extreme interest to learn that the Atlantic salmon (*S. salar*) has at last become definitely established in the South Island, after long-continued efforts on the part of the Fisheries Department. The introduction of trout has led to the gradual extermination of the native freshwater prawn, and it is now proposed to introduce prawns from Australia and Samoa as a food-supply for trout.

LIFE HISTORY OF HYMENOLEPIS.—In view of doubt which has been recently expressed as to whether the egg of *Hymenolepis fraterna* (*murina*) can develop into the cysticercoid and this into the adult in one host, attention may be directed to the experiments recorded by Dr. H. H. Scott (*Journ. Helminthology*, i., Dec. 1923, pp. 193-196). Two mice were kept in separate glass receptacles and their fæces examined for five weeks in order to make sure they were free from infection. These mice were then fed with ova of *H. fraterna*. Four days later one mouse was killed, and on examination of the intestine considerable numbers of cysticercoids were seen within the villi. The fæces of the second mouse were examined daily; on the twenty-fourth day ova began to appear, and when the animal was killed several adult tapeworms (*H. fraterna*) were found in the lower part of the ileum. Similar experiments with corresponding results were carried out with *H. longior* and mice. In order to test whether one mouse could act as intermediate host and another as the host, the mucous membrane of the first of the two mice with *H. fraterna* was fed to a third mouse, but no ova appeared in the fæces of this mouse, and when it was killed thirty days after feeding with the cysticercoids, no adult or developing cestodes were discovered. The cysticercoids are found in greatest numbers in the villi of the upper part of the small intestine, and when the scolices are liberated they are evidently carried down the intestine and undergo their further development in the lower part of the ileum.

FLORA OF WESTERN AUSTRALIA.—Prof. Karel Domin published in the Journal of the Linnean Society (vol. 41) the results of his studies of the monocotyledons and ferns in the Australian material collected by Capt. A. A. Dorrien-Smith and Dr. E. Clement, which were handed over to him by Kew. Prof. Domin has now published a short synopsis of new additions to the dicotyledons of the Flora of Western Australia in Mémoires de la Société Royale des Sciences de Bohême for 1921–22, pp. 33-125. A footnote states that the high cost of publication prevents the production of any plates or text illustrations, whilst for the same reason the plants of North-western Australia are not included.

"BIG BUD" OF BLACK CURRANT.—Details of an experiment on the eradication of this pest (caused by a mite, *Eriophyes ribis*) carried out at the Crichton Royal Institution, Dumfries, were given in NATURE of May 26, 1923, p. 719. Further progress of the

experiment is described in the annual report for 1923 of the Institution. In March 1922 the ground under the bushes was fired with lighted straw, and the bushes were cut down to within six inches of the ground. In March 1923 all the bushes had made good growth, and, with a single exception, were free from mite. This bush and its immediate neighbours were again fired and cut down, and within three months all showed vigorous shoots a foot long. The healthy bushes flowered well and gave promise of a crop estimated at 4 cwt. Owing, however, to the inclement weather, the crop was a failure, only 21 lb. being gathered. The bushes are at present healthy, vigorous, and mite-free, and a good crop is expected this year.

ARTIFICIAL INFECTION OF PLANTS WITH PARASITIC FUNGI.—Great ingenuity is being shown in Abderhalden's "Handbuch der biologischen Methoden" in discovering special subjects for monographic treatment. H. Klebahn now gives an account (Lieferung 113, Abt. xi.: Methoden der Erforschung der Leistungen des Pflanzenorganismus. Teil 1, Heft 5: Allgemeine Methoden. Methoden der Pilzinfektion. Von H. Klebahn. Pp. 515-688. (Berlin und Wien: Urban und Schwarzenberg, 1923.) 7.5. Schw. francs.) of the various methods adopted in order to infect the host plant with a parasitic fungus under carefully controlled conditions, which may prove of value to many workers in a field that is now well exploited because of its great economic importance. After a brief introductory general section, the literature dealing with infection experiments is summarised, with all the special groups of parasitic organisms, from bacteria to the higher fungi. The résumé will be the more useful because records of failures are carefully included, successful intentional infection of the host plant being often a difficult object to attain, although infection in Nature by the same fungus may frequently occur. This careful record of experimental inoculation with an analysis of the possible causes of success or failure may save time and labour to subsequent workers in plant pathology.

PHYSIOLOGICAL METHODS IN PLANT SURVEYS.—Under the title of "Researches on the Vegetation of Natal," Prof. Bews and Mr. R. D. Aitken have published a series of studies as Memoir No. 5 of the Botanical Survey of South Africa. It appears from the covering note that the work embodied by these studies was in part carried out by students of the M.Sc. classes in Natal University College; this fact may explain the somewhat preliminary nature of the results presented, which in large part appear to be reconnaissances in the possibility of applying various physiological methods in vegetation survey. A critical study of the injection method for determining the volume of intercellular spaces in the leaf seems to throw considerable doubt upon the earlier conclusion of McLean that the Angiosperms exhibit "uniformity of structural type" with regard to leaf aeration, as also upon the view of Haberlandt and Areschoug that a high degree of development of intercellular space is a response to mesophytic environment. Two studies of water loss are included, an interesting field method with tubes of calcium chloride applied to both leaf surfaces by a spring clip being tested. Leaves containing large areas of soft green tissues between the veins are found usually to lose water more readily when detached from the plant than other leaves with numerous small "islands" of soft tissue between a finely reticulate vein system. Mr. Aitken appears to be mainly responsible for a taxonomic study of the genus Cussonia (Thunb.), which includes some speculations upon the evolutionary history of the genus.

COAGULATION OF HEVEA LATEX.—The *Malayan Agricultural Journal*, vol. xi., No. 12, for December 1923 is almost filled by two interesting studies on Hevea latex, of which the first, upon the coagulation of the latex, by W. N. C. Balgrave, specially deserves attention. The writer examines fully two opposing theories, which assign to bacterial and to enzyme action respectively the main rôle in coagulation. As the result of a considerable amount of experimental work he concludes that latex must be regarded as a disperse system of caoutchouc globules enveloped in a protective protein film, this enveloping protein having an isoelectric point in the neighbourhood of P_H 4·9-5·4. Studying coagulation by electrometric and indicator methods, Balgrave concludes that coagulation normally occurs when the originally more alkaline latex has been brought to an acidity lying within these limits, usually as the result of bacterial decomposition if the latex is left after collection without antiseptic treatment. He points out that artificial coagulation by addition of acids is similar in nature, and also occurs when the reaction of the latex has been thus brought within these limits. The value of acetic acid in plantation practice lies in the fact that with this acid it is possible to produce a suitable reaction, whilst no excess of acid will increase the acidity to a point (about P_H 2·5) at which the excessively acid reaction tends to depress coagulation.

BARYTES IN IRELAND.—The Geological Survey of Ireland is continuing its descriptions of the mineral resources of that country and has just issued an interesting account of the occurrence of barytes in Ireland by Mr. T. Hallissy. He points out that Ireland was amongst the earliest barytes producers of the world, the extraction of the mineral having commenced nearly a century ago. Records of the output go back so far as 1854, and it would seem that since 1871 there has been a steady production of the mineral. All individual occurrences are described in detail, and an interesting section is devoted to the mode of formation of the mineral and to speculations as to the age of the barytes deposits. The author concludes that these have been formed in late Cretaceous or early Tertiary times, though it must be confessed that his conclusions are based upon a series of assumptions for which there is slender foundation.

VARIATION IN THE LEVEL OF LAKE VICTORIA (CENTRAL AFRICA).—In a paper recently published by the Meteorological Office (Geophysical Memoirs, No. 20. Variations in the levels of the Central African Lakes Victoria and Albert, by C. E. P. Brooks. London, 1923) it is shown that the level of Lake Victoria has a very high correlation (+0·87) with the number of sunspots; the correlation with the amount of rainfall during the preceding six months is not so high. The rainfall data used were based on ten stations in Uganda. Mr. P. Phillips, director of the Hydrological Service, Cairo, has now written pointing out that there is a very high correlation (+0·915) between the rainfall of the "Lake Plateau" (which includes parts of Kenya Colony and Tanganyika Territory with Uganda) and the change in the level of the lake from year to year. His rainfall data are more fully representative than those originally used, and this high correlation is of great interest, in spite of the fact that the observations cover only nineteen years. Mr. Phillips's amendment does not affect the main conclusion of the Meteorological Office publication, which was that the fluctuations in the level of the Central African lakes Victoria and Albert run closely parallel with the number of spots in the sun,

but it may necessitate a slight revision of the mechanism which was suggested to explain the relationship.

THE ORIGIN OF ATMOSPHERICS.—In a communication to the Paris Academy of Sciences on February 4, R. Bureau gives some interesting facts which have a bearing on the origin of the disturbances in radiophones which are due to meteorological conditions. By means of observations with direction finders it has been proved both in America and in France that "atmospherics" come from the direction of lofty mountain ranges. The author has noticed in France on several occasions that the disturbances notably increase when a layer of cold Polar air passes over the Alps. He considers that the production of a certain type of "atmospheric" was favoured by the volatilisation of snow-fields at a high altitude and at a temperature below freezing-point. It seems probable that the volatilisation of the snow at low barometric pressures when subjected to ultra-violet radiations produces an ionised state of the atmosphere which is peculiarly unstable; this leads to disturbances which cause the atmospherics. It has been noticed that atmospherics are much in evidence when a cold dry season follows a fall of snow; the temperature of the layer of snow is then below the freezing-point, and offers a large surface for volatilisation and the action of the solar rays.

DIRECTION FINDING BY WIRELESS.—Commander Slee read a timely paper on the development of the Bellini-Tosi system of direction finding in the British Mercantile Marine to the Institution of Electrical Engineers on March 5. He describes the various sources of error which were encountered, and shows the methods adopted for eliminating them. The direction finder takes relative great circle bearings with regard to the keel line of the ship. The operator rings a bell when the bearing is taken, and the direction of the ship's head is taken by compass. Considerable practice is required before this can be done satisfactorily. Direction finder bearings at distances of more than 50 miles are of little value, as they are rough in comparison with the older-established methods of navigation. When a gyro-compass repeater is installed in the radio room, so that the bearing can be at once read off on the face of the repeater, much more accurate results can be obtained. It is known that at certain land stations there is a deviation of the wave front and a consequent error in the direction. This should be taken into account by the navigating staff and not by the radio engineer. The night effect is shown by a lack of definiteness in the zeros, and this warns the operator. Up to the present no effects have been noted with respect to icebergs or fog banks. The author gives a table showing the results obtained by ninety-nine ships working with direction finders during the last two years. Of the directions of the radio stations found by this method, 90 per cent. were correct. In the case of the Ballygally Head, every direction found was correct. In the St. Lawrence and English Channel districts the "land effects" were so pronounced that the method had little value. It is also not of much use in deep-sea navigation.

SINGLE CRYSTALS OF TIN.—Messrs. H. Mark and M. Polanyi contribute a very interesting, illustrated article to the *Zeitschrift für Physik*, vol. 18, 2, 1923, in which they show that the phenomena of the slip planes and slip directions, with this substance, are similar to those observed with single crystals of zinc. The lattice arrangement was determined by means of rotation diagrams and the layer lines relations: $a = 5{\cdot}84$ Å; $c = 3{\cdot}15$ Å. The elementary cell is space centred, and contains 4 atoms. The slip directions are [100], [101], and [111], the last only when heated; [100] is the most frequent; the slip planes are (110) and (100), the first being more frequent. Photographs of the single crystal wires show the typical slip ellipses, the slip planes being very distinct in some of them; in one photograph the bending of the slip surfaces into the direction of the stretching force can be seen.

CALCIUM CHLORIDE AND CONCRETE.—The operation of concrete mixing and laying is being studied to-day on thoroughly scientific lines, and as a result there have been developed three valuable processes for improving concrete, hardening after setting with a dilute solution of silicate of soda, the addition of mechanically slaked lime to the cement, and the use of calcium chloride for "curing" and also for mixing in the cement. With regard to the curing of cement, concrete requires to set in a continually moist condition in order to give the best results. For this reason, therefore, curing consists in keeping it wet either by covering with water or spreading over it damp soil or earth which is moistened continually. This is an extremely costly, laborious, and tedious job in the case of a long stretch of road and is often not particularly efficient. The calcium chloride treatment consists in spreading the powdered material over the road as soon as it has set at the rate of 2-2½ lb. per square yard; its deliquescent properties keep the surface continually moist without any trouble, the net saving in cost being very considerable. Also calcium chloride is beginning to find a use for mixing with the cement, in the proportion of about 3 per cent., which results in a much quicker hardening of the concrete for given strength and a final increase in the compressive strength, although the matter in this respect is somewhat complicated because, for some unknown reason, different cements do not react to the same extent.

CRYSTAL STRUCTURE OF HYDROGEN CHLORIDE.—An article by Herr F. Simon and Fräulein C. v. Simson, in the *Zeitschrift für Physik*, February 8, 1924, describes an apparatus for determining the structure of solidified gases by the Debye Scherrer method. They direct attention to the fact that the investigation of the lattice structure of substances built up of the simpler atoms is of particular interest, since it is with these that one can hope to learn the connexion between the atomic or molecular model and the atomic structure; such substances, if they do not crystallise in ionic lattices, are generally gaseous at room temperature, and in the case of hydrogen chloride, liquid air had to be employed to solidify the gas. A thin metal tube was led down the middle of a vacuum tight X-ray camera connected with the X-ray bulb, and the cooled gas was passed through this tube into the exhausted camera. Here it condensed on the outer surface of the cold tube, forming a hollow cylinder of irregularly arranged crystals around it. It was thus unnecessary to cool down the whole camera to the low temperature required for solidification. The lines of the metal of the tube were scarcely visible on the radiographic film, owing to the strong absorption of the thin layer of hydrogen chloride crystals. The crystalline modification of hydrogen chloride which is stable above 98° A is cubical, face centred, with lattice constant $5{\cdot}50 \pm 0{\cdot}05$ Å; that stable below 98° A has much smaller symmetry. A further proof is provided that the lattice of hydrogen chloride is molecular.

The Royal Botanic Gardens, Kew.[1]

PRINCESS AUGUSTA of Saxe-Gotha, widow of Frederick, Prince of Wales, started a Botanic Garden, or, as it was then termed, a Physic Garden, at Kew in 1760, but it was with "the appointment of Sir Joseph Banks as Botanical Advisor . . . that the golden age of Kew may well be said to have commenced."

Sir Joseph initiated the practice of sending collectors throughout the world to collect seeds and living plants for Kew. After the death of Sir Joseph Banks in 1820, Kew languished for a time until, as the outcome of a Report presented by a Committee appointed by the Treasury and over which Dr. Lindley presided, in 1841 Sir William Hooker was appointed Director. Under the inspiring guidance first of Sir William Hooker and then of his son, Sir Joseph Hooker, Kew expanded into a great scientific institution, rising to its responsibilities as the centre to which scientific problems relating to horticulture might be referred as they arrive from all parts of the British Dominions.

The work has expanded so that, in addition to the beautiful gardens and houses with their wealth of plants, there are now available great museum resources. There are four buildings housing examples of the economic products of the plants of the world, one of the largest herbaria in the world, very completely organised and exceptionally rich in botanical paintings and drawings as well as in pressed plants, and the Jodrell Laboratory, which is equipped for investigations in physiology and mycology.

Dr. Hill cites one or two striking examples in which a little more knowledge, of the type only to be gained in such studies as are rendered possible at Kew, might have saved vast sums of money to the Empire. In the case of camphor, it has only recently become known that there are two varieties of this tree, closely allied botanically, but one almost useless in commerce because, instead of valuable solid camphor, it yields on distillation camphor oil. Unfortunately, when the effort was made to introduce camphor into the West Indies and to other British Colonies, owing to ignorance of this fact, the relatively valueless variety was usually planted. In the case of para rubber, similarly, planters have propagated seeds taken almost at random from trees of *Hevea Brasiliensis*, although the yield of latex may vary from tree to tree from 2 per cent. to 40 per cent.

The work done at Kew in the way of advice and investigation of problems dealing with the vegetable resources of the Empire has been frequently referred to in our columns. It is to be hoped that this compact statement of its work and possibilities of further work may be studied by those of our administrators who are alive to our Imperial problems. Throughout the Empire there is growing up a vast service of Botanic Gardens and Experiment Stations, conducted in the main by men whose training and inspiration derive from Kew, and if this work is to extend and to give its full harvest in co-operation with wise Colonial administration, then for many years to come it is a vital Imperial need that Kew, at the heart and centre of this work, should not lack for funds and for public support. Since the days of Sir William Hooker it has never lacked for disciplined scientific enthusiasm and for devoted service from both scientific and garden staff.

[1] Journal of the Royal Society of Arts, Vol. 72, No. 3710, December 28, 1923. "The Work of the Royal Botanic Gardens, Kew." By Dr. A. W. Hill.

Bottom Fauna of the North Sea.

THE economic study of fisheries and fish must always depend largely on quantitative methods such as the numbers of fish caught in relation to the fishing power employed, to the area of ground fished, and to the number of fish that can be adequately fed on this ground. The latter depends largely on the quantity of floating life in the waters at the depths in which the fish feed at different stages of their lives and on the quantity of bottom living organisms. Most fish are bottom feeders, so that the ground organisms are of prime importance. The bottom animals, however, feed mainly on the floating life, which reproduces with such rapidity that it is the chief builder of living matter in the sea. A cycle is thus created from man to the fish, to the bottom living organisms, to the floating forms, and so ultimately to the meteorological conditions, which alone can affect the ocean as a whole. Some of the bottom forms serve as food to fish, while others do not, thus cutting the economic cycle. Some are absolutely inimical to the fish, since they feed on the same food as that required by fish. It thus becomes clear how important and basal is the quantitative and qualitative study of the ground life in relation to economic questions connected with fisheries.

The North Sea has been selected for the first studies as the world's chief fishing ground. The way to these was paved in 1920 by arrangements for the publication of a full account of its bottom deposits and for obtaining the practical knowledge of the technique, invented by Dr. C. G. J. Petersen for use in Danish semi-inland waters. This consists of the utilisation of a grab, somewhat similar to that employed for clearing harbours, let down with wide open mouth with sufficient force to drive into the sand or mud for some little distance; its mouth and teeth close tightly on the uphaul and bring to the ship a sample of the surface of a measured area of the bottom, size one-tenth or one-fifth of a square metre. The contents are dumped into a series of sieves of different meshes made to fit tightly into each other. They are thus divided into different sizes, only the finest sand and smallest animals passing through to the tray below. By this means all the individuals from a certain area of the bottom can be easily graded and counted, so that quantitative methods become practical. The method is good, save only that the results relating to swimming, fast darting, and jumping animals may be inaccurate, while scantily distributed forms (less than 1 per unit area) have to be neglected.

The present paper[1] deals admirably with the Dogger Bank, an isolated plateau at about 15 fm., known to be a good growth ground for plaice, and may be regarded as a preliminary investigation. There are requisite "controls," and the trustworthiness of results is properly tested. Six voyages of investigation were made and samples taken from 533 stations. There are recorded 75 species of living animals with notes of interest relating to their natural history; of these, 47 specimens of Amphioxus, living only in gravel or shell patches, is of greatest interest, as clearly belonging to a form that prefers ground more or less kept in motion by currents. Worms, crustaceans, and molluscs form the more important fish

[1] Ministry of Agriculture and Fisheries — Fishery Investigations, series ii., vol. vi., No. 2: "Quantitative Studies on the Fauna of the Sea Bottom. No. 1. Preliminary Investigation of the Dogger Bank," by F. M. Davies. Pp. 54. (London: H.M. Stationery Office, 1923.) 6s. net.

food ; of these the last group are easiest to enumerate with accuracy, especially the scarcely motile bivalves. Much of the Report deals with two forms of the latter of the genera Spisula and Mactra. Of the former, 15,135 specimens of *S. subtruncata* were obtained in one voyage and afterwards measured. As examples, one station yielded 3301 specimens, 2-8 mm., and another 343 specimens, 12-21 mm., giving fairly regular curves round 5 and 17 mm. One station gave two curves round 4 and 20 mm., but otherwise the forms in this voyage from each station were all of one size and presumably one age. Work in this manner allows the plotting of areas according to the number and sizes (and thus weight and food value) and induces deductions as to mortality and growth. One bed of at least 1 year old forms covered 600 square miles and gave more than 83 million Spisula per square mile, while a second of a few months old extended to 700 square miles, 643 million for the square mile, figures which appear gigantic, but are relatively small as compared to layings of mussels and oysters in shallower waters. Omitting the first voyage, the figures range from 78 to 303 per square metre.

Enough, however, has been said to show the value, both scientific and economic, of this work, and Dr. Russell, as director, and Mr. Davis, as the naturalist concerned, are to be heartily congratulated on the very interesting investigations with which they commence a new serial publication, giving the results obtained by the Scientific Division of the Ministry of Agriculture and Fisheries. It is in every way up to the consistently high scientific standard that this Department maintains. Experience teaches that only by the submission of researches for criticism can such a scientific level of work be secured, but we fain would have in addition a popular publication of these and other fishery results perhaps more akin to the literature issued by the agricultural side of the same Ministry, not leaving the dissemination of knowledge solely to trade journals. J. STANLEY GARDINER.

The Radioactivity of Radium in Relation to Solar Radiation.

DR. A. NODON has carried out a series of experiments, which he interprets as showing the existence of solar radiations of shorter wave-length than the X- and γ-rays, and regards as the cause of radioactive disintegration. He has sent us papers on this work, one of which was presented to the Paris Academy of Sciences on June 11, 1923. A radiographic plate, protected by a lead screen with a small central hole, was enclosed in a black cardboard case, on the outer surface of which a small quantity of radium salt was fixed by an adhesive. The effect produced on the sensitive plate was found to be variable, depending on the electromagnetic activity of the sun ; in some cases direct exposure to the sun's rays produced strong impressions on the plate in a few minutes, while in others the impressions were weak after several hours' exposure, and this did not depend on differences in the heating effect of the sun's rays. During periods of solar activity the difference in the impressions produced in direct sunlight and inside a room or in a cellar was found to be very great, being much smaller indoors. The solar radiations do not affect the plate if no radium or other radioactive substance is present. The variations of the horizontal component of the earth's magnetic field were measured by means of a magnetograph, and it was assumed that these variations are closely related to the solar activity.

Measurements made with an electrometer confirmed those made by the photographic method ; these are described in an extract from *Ciel et Terre*, dated May 1923 ; they show very great differences in the action of the sun from hour to hour, and sometimes from minute to minute ; using uranium oxide on the screen closing the window of the electrometer, the deflexions during periods of low solar activity, in a certain series of experiments, varied from 10 to 45, while during periods of strong activity they varied between 100 and 150 divisions.

Dr. Nodon considers that these experiments prove that radioactivity is influenced by radiations emitted directly by the sun and indirectly by the higher atmosphere, which, to some extent, scatters the direct radiations ; and he supposes that, owing to this action of the atmosphere, some of the radiations are transmitted by diffraction from the molecules round the earth, so that even at night some effect is produced. The absorption of different substances for the ultra-radiations seems to be of the same order as that for the X- or γ-rays, the absorption being greatest in substances with a large atomic number ; large thicknesses of building material and of soil absorb a very large proportion of the rays, so that in the interior of a building, and particularly in a cellar, the effects are much smaller than in direct sunlight ; in spite of this the variations of intensity with different magnetic conditions were observed indoors and in cellars.

It is difficult to understand how such variations in radioactivity have hitherto escaped attention ; the radium " clock " is described as working at a uniform rate, indicating constant activity ; the spinthariscope has not been observed to work better at one time than another, and a good deal of important modern work depends on the actual counting of the impacts of the α-particles on a phosphorescent screen, the rate apparently remaining constant for the same preparation. Measurements of the saturation current due to the ionisation caused by radioactive preparations do not appear to have shown any trace of this effect, and it will be interesting to see the results of further investigations into the phenomena observed by Dr. Nodon.

University and Educational Intelligence.

CAMBRIDGE.—Mr. John Pierpont Morgan has presented to the University a set of fifty-three volumes of the photographic reproduction of the Coptic manuscripts belonging to the Pierpont Morgan library.

The Statutory Commissioners have replied to various representations made to them by the Colleges. They propose to require Colleges to carry into effect the recommendations of the Royal Commission with regard to pensions ; they also adhere to the recommendations of the Royal Commission making all College scholarships and exhibitions for undergraduates eleemosynary. Further, they have given notice that they intend to institute a University Entrance Examination, to be passed before a student comes into residence.

A first list of universities has been submitted to the Senate for approval as institutions, the graduates of which may claim the privileges of affiliation under the new regulations. The list includes most universities of the British Empire, a select but by no means complete list of American universities, and two Continental universities, Basle and Berne. To meet the case of students attending certain colleges in Great Britain and graduating in the University of London, the University Colleges of Exeter, Nottingham, Reading, and Southampton are also added to the list.

LONDON.—Prof. P. Zeeman is to deliver a lecture, in English, on a subject connected with physics, at the Imperial College of Science and Technology on Wednesday, May 21, at 5.15. No tickets will be required.

Applications for grants from the Dixon Fund should be made to the Academic Registrar not earlier than April 1 and not later than the first post of May 15; those for grants from the Thomas Smythe Hughes Medical Research Fund should be sent to the Academic Registrar not earlier than May 1 and not later than June 16.

Notice is given by the London (Royal Free Hospital) School of Medicine for Women that scholarships of the total value of 1100*l.* will be awarded in May and July next. Information and forms of application can be obtained from the Warden and Secretary of the School, 8 Hunter Street, W.C.1.

OXFORD.—At a meeting of Congregation held on March 11, an offer by the University Grants Committee of the Treasury to provide a sum not exceeding 35,000*l.*, under certain conditions, for the purpose of establishing a superannuation scheme for members of the regular teaching or administrative staffs of the University, was accepted without a division. At the same meeting a decree was proposed by the Rector of Exeter, allocating certain sums from the Government grant for 1923–24 to the payment of science professors by way of special allowance in respect of their duties as heads of Departments. The decree was supported by the Regius professor of medicine (Sir Archibald Garrod) and opposed by Mr. J. L. Stocks, St. John's College, who thought that the principle on which the allocation was made was faulty. On a division there appeared fifty-six votes for the decree and fifty-six against it. The decree was therefore not carried. An offer of the Forestry Commission and the Colonial Office to contribute a sum of 5000*l.* a year to the maintenance of an Imperial Forestry Institute at Oxford, on condition that the University contributes a sum not exceeding 300*l.* a year for five years in addition to its present contribution to the Forestry Department, was gratefully accepted.

THE Parkin prize of the Royal College of Physicians of Edinburgh, the value of which is 100*l.*, is open to competitors of all nations for the best essay on a certain subject connected with medicine. The subject chosen for the next award is "The effects of volcanic action in the production of epidemic diseases in the animal and in the vegetable creation, and in the production of hurricanes and abnormal atmospherical vicissitudes." Competing essays, written in English, must be received by the Secretary of the College not later than December 31 next. They must bear a motto, and be accompanied by a sealed envelope bearing the same motto outside, and the author's name inside. The successful candidate is required to publish his essay at his own expense and to present a copy to the College within three months after the adjudication of the prize.

SHORT courses of instruction for teachers in technical and evening schools are being arranged by the Board of Education to be held in the summer of this year. Teachers who desire to attend any of the courses must make application to the Board of Education on Form 106e. U. as soon as possible, and not later than March 31. Railway fare and a grant towards maintenance at the rate of 1*l.* per week will be made to selected teachers. Courses on engineering science and electrical engineering will commence on Monday, July 14, at the University of Birmingham, where members will reside at the University Hostel, Edgbaston, until the afternoon of Saturday, July 19, when they will proceed to Oriel College, Oxford, where they will reside until the termination of the courses on Wednesday, July 30. The standard of the work in each course will be that of the National Certificates in Mechanical Engineering and in Electrical Engineering. Courses for teachers of building subjects will be held in London during the period Monday, July 21–Saturday, August 2.

FROM the University of Leeds we have received a report for 1922–23 on University Extension lectures and Tutorial Classes. The classes were attended by 620 students, showing a decrease of 70 compared with the number in 1921–22. The receipts, 3144*l.*, consisted almost entirely of grants from the Board of Education, the University, and local authorities; students' fees amounted only to 68*l.*, or a little over two shillings per student attending the classes. These figures do not suggest that there is a large unsatisfied demand for university extension teaching in the Leeds district. If larger appropriations are to be made for university extension work, as demanded at the demonstration organised last November by the British Institute for Adult Education, it will be necessary to widen the scope of the work as has been done with such astonishing results in the United States, where "extension teaching has been the outstanding feature of educational effort in the past two years," and "university extension is the organised and systematic effort to . . . make the campus of the university as wide as the State itself" (Bureau of Education, Bulletin, 1923, No. 24). Statistics for 1921-22 of State Universities and State Colleges show that, out of a total working income of 122 million dollars, 15 million are appropriated for extension service.

MR. M. R. PARANJPE, in the *Educational Review*, of Bombay, maintains that science is not now so well taught as formerly. Twenty or thirty years ago, school science was very often taught wholly in the class-room; now there is a tendency to teach it wholly in the laboratory. The result of this is that some branches of science are not taught at all in schools, and the scope of those that are taught is limited by the practical work that can or cannot be done by the pupils themselves. Laboratory work may be, and often is, merely a kind of drill, worth while, it is said, for the training in neatness, accuracy, and method that it gives. It has been assumed that habits acquired in the laboratory assert themselves in the ordinary business of life. But according to modern educational psychology, there is probably as great a fallacy here as in the old dictum, "Learning by rote trains the memory." As Mr. Paranjpe says, "A careful analyst is not always a clean and tidy person. A trained geologist has no eye for the sign-boards in a street or the show-cases in a shop. A famous scientist is not necessarily a rational critic." Meanwhile, if school science is judged, not by the reflected glory it derives from the researches of Sir Ernest Rutherford and others, but by the average level of scientific knowledge among the people, it clearly stands condemned. This standard is very low indeed; according to Prof. Smithells, it does not correspond in grammar to knowing the difference between a noun and an adjective. Before the present state of things can be remedied, there must be some radical changes: the dominance of school science by university teachers must cease; the disunited branches of science must be brought together as one subject for school purposes; and finally, lecture-room and laboratory work must be co-equal.

Early Science at the Royal Society.

March 16, 1663. Sir Paul Neile presented a copy of some of Mr. Horrox's astronomical papers, which Dr. Wallis was desired to peruse, who accordingly took them with him to Oxford.—Dr. Charlton mentioning, that toads have a long bony substance in their heads, dividing the brain, best to be shewn when there are ants to eat the skulls of toads clean, he was desired to shew the observation at the proper season.

1680. The president [Sir J. Williamson] acquainted the Society, that Mr. Mercator had lately shewn the King a new way or projection of maps useful for seamen; but did not mention the particular method of it. Mr. Hooke said that Mr. Mercator had been with him to discover to him his projection; but that he was not willing to understand it from him, in order that when his own, which he had already discovered to the president, should come out, it might not be thought, that he had taken any part of Mr. Mercator's invention.

March 18, 1660.—A discourse being held concerning the water's ascending in tubes or syphons, Dr. Henshaw made several experiments in one tube with water, spirit of wine, rose-water, spirit of salt, and spirit of vitriol.

1662. Mr. Oldenburg acquainted the society with a letter sent from a Somersetshire gentleman; wherein was proposed a way of preventing famine by dispersing potatoes throughout all parts of England. A committee was appointed to consider of all the particulars, and to make a report, who were to meet at Mr. Howard's lodgings in Arundel-house.

March 19, 1661.—Mr. Evelyn brought in a paper containing an account of three pots with earth in them, wherein he had sowed several sorts of seeds for the farther trial of the increase and weight.

1673. Mr. Oldenburg read a letter from A. Mullerius at Berlin containing an offer of an anonymous person, of furnishing a key of the Chinese language, for a recompence. It was ordered that the writer be desired to send a specimen of his performance by means of this invention.

March 20, 1660.—The amanuensis was ordered to make the experiment of the calcination of antimony, whether it increaseth or not; and to weigh it before and after, in and out of the water.

1677. It was desired by the Society, that as many books, as could be procured of [by] Roger Bacon, should be perused; and it was wished, that they were all collected and printed, as being supposed to contain very many curious and useful matters. Dr. Gale affirmed that he had collected as many of the works of this author as he could. That the King had a book of Roger Bacon called the *Opus Majus*: and that his book of the prolongation of life which was supposed to be lost was affirmed by Dr. Plot to be in the Bodleian Library. Dr. Plot mentioned that there was one book of Roger Bacon in the library of University-College at Oxford, which he thought to be no where else in the world.

March 21, 1667. Mr. Hooke reported that the air had lately been so thick about London that he had not been able to see [certain] stars.

1671. Mr. Boyle communicated an account of nineteen observations made by himself on shining flesh, both veal and pullet, especially the former, in one piece of which he had reckoned above twenty several places, which all shone more or less, without finding by the smell the least degree of stink, whence to infer any putrefaction.

March 22, 1664. Mr. Pepys was desired to procure the journals of those masters of ships, who had been with Major Holmes in Guinea and differed from him in the relation concerning the pendulum watches.

March 23, 1663. It was ordered that Sir Robert Moray and Sir Paul Neile be desired to consult with the lord Ashley, whether it may be fit to desire the King to give a rule to the two secretaries of state, that all the proposals, that shall be made concerning mechanical inventions, be referred to the Council of the Royal Society, to be examined by them, as to their novelty, reality and usefulness.

1670. Mention being again made of Mr. Cock's readiness to make a great burning concave, it was suggested that the King might be moved to command it to be made.

1686. It was the opinion of the members present that the protrusion of mountains by subterraneous fire or otherwise may occasion some alteration of the poles of the earth as well as the accession of new matter.

March 24, 1685. A letter of Mr. St. George Ash, written by order of the Dublin Society was read, wherein they desired to continue their correspondence with the Royal Society, and promised to send an account of several curiosities then before them; and mentioned particularly a girl of eleven years of age, prodigiously skilful in most parts of mathematics, having been examined before the Dublin Society with severity enough in Algebra, Geometry, Trigonometry, Astronomy, Chronology, speculative Music and Mechanics, in all of which she answered with great readiness and judgment.

March 25, 1661. It was directed that inquiry should be made, whether there be such little dwarfish men in the vaults of the Canaries as was reported.

1675. Mr. Hooke remarked [in discussion] that all bodies dissolvable by the saliva are tastable, and consequently all bodies tastless, that cannot be dissolved by the saliva.

1679. Upon the mention of sheathing of ships with lead, Mr. Hunt gave an account, that he had tinned some iron nails; but that it would not wholly preserve them from rust.

March 26, 1662. The amanuensis was ordered to go to Radcliffe, and bespeak large receivers of glass as thick as possible, with an hole in the bottom capable of receiving a man's arm: And that he make cement for Mr. Rooke according to Monsieur Huygen's directions.

1668. It being mentioned again, that the Florentines had affirmed, that sounds move equally swift against and with the wind, it was suggested by the president, that the experiment might be conveniently enough made between Deal and Dover, and that he would desire the governor of Deal-castle to take care of it.

March 28, 1667. Dr. Wren produced drawings of the figures of hail which had fallen March 27, 1667, the upper part of which was a perfect cone, the under part the frustum of a cone.

1678. Mr. Moses Pitt, bookseller, having made a proposal to the Society of his design of printing an Atlas, it was referred to a committee to report their thoughts of it.

March 29, 1665. Dr. Charlton having been called to account for his taking home with him, the little box with Macassar poison; he alledged, that he had done so, fearing it might be left, it being found standing in the window when all the company was gone out. It was ordered that nothing belonging to the society should be taken away without their leave.

1666. It was ordered, that particular written summons be sent to the princes of the blood, and to as many lords of the society as were in town, for attendance at the annual election at the usual place in Gresham-college.

Societies and Academies.

LONDON.

Royal Society, March 13.—A. **Fowler**: The series spectrum of ionised carbon (C II). The production of previously unrecorded lines of carbon has led to the identification of the leading members of the series of ionised carbon (C II or C^+) in the ordinary region of observation. The main series, however, lie in the extreme ultra-violet, and were identified in the observations of Simeon and Millikan with the aid of the spectral terms thus determined. The series of C II form a doublet system, like the spectra of boron and other elements of Group III., as would be expected from the spectroscopic displacement law. The highest terms are the common limits of the sharp and diffuse series, 196612 and 196670; hence the second ionisation potential of carbon is 24·3 volts. In the normal state of the atoms two of the outermost electrons in ionised carbon appear to move in 2_1 orbits, while the electron which generates the spectrum traverses a 2_2 orbit, as suggested by Bohr for neutral boron.—E. S. **Bieler**: The large-angle scattering of α-particles by light nuclei.—W. L. **Bragg**: The refractive indices of calcite and aragonite. The crystals have been analysed by X-ray methods. The strong double refraction is ascribed to the peculiar form of the CO_3 group. This consists of three oxygen atoms grouped around a central carbon atom and lying in a plane. The oxygen atoms are more highly polarised by an electric field than the other atoms in the crystal. The three atoms in the same CO_3 group, when they become electrical doublets, exert a strong influence on each other, which results in their being more strongly polarised by an electric field parallel to the plane of the group than by a field perpendicular to the plane of the group. Hence the refractive index of the crystal is greater when the electric vector is perpendicular to the trigonal axis of calcite than when it is parallel to the axis. The same holds for the pseudo-hexagonal axis of aragonite. This accounts quantitatively for the difference in refractive indices, both for calcite and aragonite.—Kathleen **Yardley**: The crystalline structure of succinic acid, succinic anhydride, and succinimide. The monoclinic holohedral crystal of succinic acid possesses two molecules per unit cell, and is based on the Bravais lattice Γ_m. The orthorhombic crystal of succinic anhydride is based on the lattice Γ_0 and has four molecules per cell. The X-ray method fails to determine the *class* to which the crystal belongs. In the unit cell of the orthorhombic holohedral crystal of succinimide there are eight asymmetric molecules, the fundamental lattice being Γ_0.—L. F. **Bates** and J. S. **Rogers**: Particles of long range from polonium. Polonium has been examined by the scintillation method for the emission of long-range particles, and it has been found that for every 10^7 α-rays of range 3·93 cm. emitted, there are also present 98, 51, and 26 particles of ranges $6{\cdot}1 \pm 0{\cdot}1$, $10 \pm 0{\cdot}1$, and $13{\cdot}1 \pm 0{\cdot}2$ cm. respectively, together with about 7 particles of longer range, which are probably H-particles. It is considered from the relative brightness of the scintillations alone that these particles are α-rays. Also from the evidence available it is deduced that these particles are emitted by polonium itself.—A. **Muller**: On the determination of the crystal-axes in "single-crystal" aluminium bars by means of X-rays. The aluminium bars used by Taylor and Elam for examining the distortion of aluminium crystals during a tensile test were examined by X-rays. The lattice structure was found to be retained even when they were stretched to a considerable extent.

Physical Society, February 22.—Mr. F. E. Smith in the chair.—G. **Temple**: A generalisation of Whitehead's theory of relativity. The generalisation refers to the case of a space-time manifold of uniform and isotropic curvature. The general equations of the gravitational and electromagnetic fields are obtained, and these are applied to the discussion of the problems of planetary motion and of the deviation of light rays in the solar field.—H. **Pettersson**: The structure of the atomic nucleus and the mechanism of its disintegration. In interpreting the results of their experiments on the disintegration of certain light atoms by the impact of α-particles, Rutherford and Chadwick have supposed that the α-particle transfers its momentum by direct impact to a proton which is a satellite to the rest of the nucleus. An alternative hypothesis is that the α-particle exercises a trigger-action, precipitating an explosion of the nucleus, which is supposed to have only a limited stability in the case of each of the elements.—Winifred L. **Rolton** and R. S. **Troop**: The effect of a magnetic field on the surface tension of a liquid of high susceptibility. A method of measuring surface tension recently described by Dr. A. Ferguson has been applied to test solutions of ferric and manganese chlorides for this effect. The results are negative.

Geological Society, February 27.—A. C. **Seward**: The record of plant-life (presidential address).—Prof. W. W. Watts, vice-president, in the chair.—W. B. **Wright**: Age and origin of the Lough Neagh clays. In 1918 a deep bore penetrating the clays showed that the series has a thickness of over 1000 feet, and is subdivisible into (*a*) Upper clays and sands, (*b*) middle shales, and (*c*) lower clays and sands. The age is Older Tertiary, not Pliocene. This is established by the presence of *Sequoia couttsiae* Heer and three species of Dewalquea. The series has suffered about the same amount of folding and faulting as the basaltic lavas upon which it rests. A prolonged period of weathering separated the last outpouring of lava and the deposition of the clays, resulting in the production of about 70 feet of lithomarge, which supplied the kaolin for the formation of the clays. The presence of abundant quartz-sand shows that the river-basins extended beyond the basaltic area. The clays have been largely derived by the denudation of lithomarge, from which the iron was carried away in suspension, while the coarser kaolin was deposited.

Zoological Society, March 4.—Dr. A. Smith Woodward, vice-president, in the chair.—E. G. **Boulenger**: On a new giant salamander, living in the Society's Gardens.—W. E. **Le Gros Clark**: The myology of *Tupaia minor*.—C. W. **Andrews**: Note on an ichthyosaurian paddle showing traces of soft tissues.—R. **Gurney**: The larval development of some British prawns (Palæmonidæ).—I. *Palæmonetes varians*.

Linnean Society, March 6.—Dr. A. B. Rendle, president, in the chair.—Miss Helena **Bandulska**: On the cuticles of some recent and fossil Fagaceæ. Both Fagus and Nothofagus cuticles have isodiametric stomata which vary much in size—those of Nothofagus have strongly cuticularised poral rims, accompanied frequently by cuticular thickenings at the junctions of the guard cells, and by a horizontal strip of cutin at the poles of their long axes, so that a dagger-like appearance is presented. In Fagus, all the cutinisations are less obvious, and generally only the poral rim is well cutinised. *Dicotylophyllum Stopesii* shows agreement in external form with several species of Nothofagus, and should be called *Nothofagus Stopesii*. *Fagus bournensis* is probably a

distinct species.—H. **Sandon** and D. W. **Cutler**: Some Protozoa from the soils collected by the *Quest* (1921–1922) expedition.

PARIS.

Academy of Sciences, February 25.—M. Guillaume Bigourdan in the chair.—Paul **Marchal**: Contribution to the study of the migrations in Eriosoma. *Eriosoma ulmosedens* represents a particularly interesting type from the point of view of the history of the cyclic migrations of the Aphidians between different plants. It corresponds to a stage of evolution for which the separation of the species into distinct lines, specialised for the different plant hosts, is still incompletely realised.—Pierre **Weiss**: An argument in favour of the electrostatic nature of the molecular field.—M. Maurice de Broglie was elected a free Academician, in the place of the late M. de Freycinet.—Nilos **Sakellariou**: Oblique Casoratian areal curvature.—Thomas **Greenwood**: The straight line and the parallels of Euclid.—E. **Cartan**: The projective connexion of surfaces.—L. **Escande** and M. **Ricaud**: On similitude.—Louis **Breguet**: The mean aerodynamical resultant of a glider with flattened M wings submitted laterally to horizontal aerial pulsations.—Umberto **Crudeli**: Distribution of the electromagnetic field in a medium in repose.—H. **Eyraud**: The principle of action and the laws of the dynamics of the ether.—Ernest **Esclangon**: Experiments relating to the propagation of sound on the occasion of the explosions to be made shortly at Courtine. The detonation produced by an explosion produces a manometric percussion, which affects the ear, followed by a series of oscillations (infra-sounds) which are not audible. Two simple pieces of apparatus are described for detecting the latter.—Léon **Bloch**, Eugène **Bloch**, and Georges **Déjardin**: The higher order spectra of argon, krypton, and xenon. The gases were sealed up in quartz tubes furnished with windows of the same substance, and special care was taken during the preliminary evacuation to prevent the presence of mercury vapour or moisture. The spectra were produced by J. J. Thomson's method, without electrodes. With each gas three spark spectra of successive orders can be produced.—Henry **Lutigneaux**: A new mode of representation of objects in space of three dimensions: stereography.—C. **Bulow**: A new theory relating to the molecular constitution of chemical compounds. Referring to the recent theories put forward by H. E. Armstrong and by Kling and Lassieur, the author directs attention to a publication by him of similar views in 1919.—Mme. J. Samuel **Lattès** and Antoine **Lacassagne**: The estimation in the different organs of polonium injected into the organism. Detailed account of experiments on rabbits, with systematic analyses of six organs—spleen, kidney, lungs, liver, myocardium, and brain.—P. **Lasareef**: A physical theory of chemical reactions.—L. J. **Simon**: The argento-sulphochromic oxidation of coal. The experimental results are best explained by the assumption that coal consists of two intimately associated constituents, one of which can be oxidised to gases at a relatively low temperature: the other constituent requires a higher temperature, and the oxidation is always incomplete.—M. **Bourguel**: The action of sodium amide on the true acetylene hydrocarbons.—H. **Colin** and Mlle. A. **Chaudun**: The glucose of the α- and β-glucosides.—Léon **Piaux**: The action of catalysts on the oxidation of uric acid. The hydrates of iron and manganese.—Ch. **Mauguin**: The crystalline structure of corundum and of oligist.—M. **Allemand-Martin**: The general structure and stratigraphy of the peninsula of Cap-Bon.—Léon **Moret**: The existence of a lacustral level containing *Limnea longiscata* in the Nummulitic series of the Haut-Giffre massif (Haute-Savoie) and its signification.—A. **Lebediantzeff**: The dessication of agricultural soils in the open air.—Paul **Becquerel**: Is there a bioradioactivity? A summary of the negative results obtained by the author and others, all opposed to the views of Tommasina (1904) and Nodon (1924).—L. G. **Seurat**: The horizons of the intercotidal zone in Syrte (Tunis).—E. and H. **Biancani**: The action of some chemical and physical agents on the mobility of the ciliated infusoria. Ultra-violet light, if feeble in intensity, slows down the movements; if strong, the mobility is destroyed. Hypertonic saline solutions decrease the mobility, with increasing rapidity as the salt strength increases.—Jules **Amar**: Coagulation and the structure of the egg.—F. **Maignon**: Researches on the nature, constitution, and mode of action of the tissue diastases of animal origin. The interpretation of the results of chemical and electrical analysis.—B. **Szilard**: A direct-reading actinometer, designed to measure solar ultra-violet light.—R. **Fosse**, A. **Hieulle**, and Lawrence W. **Bass**: The action of hydrazine on uracyl and thymine.—Paul **Fleury**: A method of measuring the activity of a laccase.—H. **Bierry** and Mlle. L. **Moquet**: The estimation of the ketonic bodies and of β-oxybutyric acid in the urine of diabetic patients.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 1, Jan.).—C. **Barus**: Vibration in spark-blown closed quill tubes; electric oscillation. The air filament in quill tubes closed at both ends is maintained in vibration by a spark of controllable frequency, and the acoustic pressures generated are measured by the interferometer U-tube.—S. **Smith**: Note on electrically exploded wires in high vacuum. Two types of tube were used. In the first, an H-tube, the wire was stretched between aluminium electrodes, exploded, and a discharge passed through the capillary part of the tube was examined spectroscopically. In the second, a globe similar to that used by Wendt and Irion was used. All electrodes were of tungsten. Tungsten wires were exploded in both types of tube, and lead and aluminium in the H-type. If the pre-explosion vacuum was good, none of the wires produced enough gas to pass a discharge: no helium lines were detected in the few tubes through which the discharge would pass.—J. W. **Alexander**: (1) On the subdivision of 3-space by a polyhedron. (2) An example of a simply connected surface bounding a region which is not simply connected. (3) Remarks on a point set constructed by Antoine.—W. H. **Taliaferro**: A study of the interaction of host and parasite: a reaction product in infections with *Trypanosoma lewisi* which inhibits the reproduction of the trypanosomes. The normal life cycle of *T. lewisi* in the rat is as follows: trypanosomes appear in the blood four days after infection, increase in number at a decreasing rate until the tenth day, after which they decrease suddenly and remain constant until the thirty-sixth day, when they disappear altogether. Three resistance mechanisms developed by the rat appear to operate during these three stages. The increasing inhibition of reproduction during the first stage seems to be due to a specific reaction product developed in the serum.—L. O. **Howard**: Retarded establishment of introduced parasites of injurious insects. Delay may be due to lack of a sequence of parasites, the time taken to catch up in numbers with the host insects, lack of secondary hosts, interbreeding with native species, climatic conditions, etc. One species of Tachnid parasite alone of the many introduced has been very successful in America; a Carabid beetle (*Calosoma sycophanta*) has been very effective against the gipsy moth and native cater-

pillars. Other parasites have been reported after disappearance for periods varying up to twenty-five years.—W. E. **Castle**: Does the inheritance of differences in general size depend upon general or special size factors? A reply to the criticism by Sumner in the November issue of the Proceedings. The genetic factors affecting *total* size in mammals are general in action.—H. F. **Osborn**: Discoveries during the season of 1923 by the third Asiatic Expedition in Mongolia. The principal discovery was in eastern Mongolia, where rich deinosaur beds, probably of Cretaceous age and Æolian origin, were found. The dominant animal, found in all stages of development, was Protoceratops. From the close of Tertiary time, Mongolia must have been a fertile, richly inhabited country, possibly an evolution centre of land reptiles during the Age of Reptiles.—C. C. **Trowbridge**: Spectra of meteor trails. It is considered that the lines of the spectra of meteor trails are in at least as good agreement with those of the afterglow of nitrogen as with those of certain other elements which have been suggested as forming part of the trail, and other characteristics of meteor trails are thought to confirm this suggestion.—G. L. **Clark** and W. **Duane**: (1) On tertiary X-radiation, etc. Experiments described in the December issue of the Proceedings were continued, using molybdenum and silver as secondary radiators. The results confirm the previous findings: there is no evidence of the shift of 0·024 Å.U. in the scattered radiation required by Compton's theory. (2) Further experiments upon the reflection by a crystal of its characteristic X-radiation. Precision measurements of the characteristic spectrum of iodine reflected through 5 orders by the 100 planes of potassium iodide. The relatively great intensity of the fifth order peaks appears to be connected with the fact that within this angular range the anomalous reflection of iodine rays coincides with the regular reflection from the 100 planes. The grating space is 3·532 Å.U.—G. E. **Hale**: The law of sun-spot polarity (see NATURE, January 19, p. 105).

Official Publications Received.

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 12, Part 1: A Contribution to our Knowledge of the Flora of Northern Saghalien. By Yushun Kudo. Pp. 68+12 plates. (Sapporo.)

The British Cast Iron Research Association. Second Annual Report of the Council for the Year ending June 30th, 1923. Pp. 19. (Birmingham: Central House, New Street.)

Reprint and Circular Series of the National Research Council. No. 50: Second Report of the Committee on Contact Catalysis. Pp. 141. (Washington, D.C.: National Academy of Sciences.) 50 cents.

Bulletin of the National Research Council. Vol. 7, Part 4, No. 40: Honors Courses in American Colleges and Universities. By Frank Aydelotte. Pp. 57. (Washington, D.C.: National Academy of Sciences.) 75 cents.

The Physical Society of London: Proceedings. Vol. 36, Part 2, February 15. Pp. 67-151. (London: Fleetway Press, Ltd.) 6s. net.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands: Report on Experiments with Varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis and Montserrat in the Season 1921–22. Pp. iii+56. (Barbados.) 1s.

The Ninetieth Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 5, Part 1, 1923. Pp. xii+78+14. (Camborne.) 5s.

The War Office: Report of the Air Survey Committee. No. 1, 1923. Pp. 131. (London: H.M. Stationery Office.) 4s. 6d. net.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1923. Pp. iv+416+48. (London: H.M. Stationery Office.) 10s. net.

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1923; with Reports and Notes of the Director, Rev. A. L. Cortie. Pp. xx+43. (Blackburn.)

Diary of Societies.

SATURDAY, MARCH 22.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Properties of Gases in High and Low Vacua (3).

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.—W. E. Armstrong: The Psychological Method in Anthropology.—H. E. O. James: The Motor Aspect of Rhythm.

MONDAY, MARCH 24.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—W. E. Leslie: Telepathy.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—Informal Discussion on Failure in Metals.

ROYAL SOCIETY OF ARTS, at 8.—Dr. T. Slater Price: Certain Fundamental Problems in Photography (Cobb Lectures) (1).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—E. Fish: A Compound Composite Odontome.—G. Northcroft: The Clinical Aspect of the Care of Children's Teeth.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. L. Koch: Northward of Greenland.

TUESDAY, MARCH 25.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. L. G. Parsons: Some Wasting Disorders of Early Infancy (Goulstonian Lectures) (1).

INSTITUTION OF AUTOMOBILE ENGINEERS (Annual General Meeting) (at Royal Society of Arts), at 6.30.—H. S. Rowell: Balancing of Automobile Engines.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—J. Ward: Some Notes on the Theory of Lubrication, with particular application to the Michell Thrust and Journal Bearings.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. D. Johnston: Developments of Pictorial Photography in England and America.

WEDNESDAY, MARCH 26.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at 6 Queen Square, W.C.1), at 5.30.—Dr. T. M. Legge: Specimens of 15th Century Stained Glass.—F. S. Eden: Ancient Stained Glass in London.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—A. A. Campbell Swinton: The Possibility of Electrical Television, both with and without Wires (Lecture).

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.—J. E. Barnard: Lecture Demonstration.—G. O. Searle: Methods of Mass Production in Sectioning Flax Stems.—H. Wrighton: Microscopical Metallurgy.

ROYAL SOCIETY OF ARTS, at 8.—N. Green: The Fishing Industry and its By-Products.

THURSDAY, MARCH 27.

CHEMICAL SOCIETY (Annual General Meeting), at 4.—Prof. W. P. Wynne: Presidential Address.

ROYAL SOCIETY, at 4.30.—Prof. W. A. Bone, A. R. Pearson, and R. Quarendon: Researches on the Chemistry of Coal. Part III. The Extraction of Coals by Benzene under Pressure.—R. V. Southwell and Sylvia W. Skan: The Stability under Shearing Forces of a Flat Elastic Strip.—J. E. P. Wagstaff: Experiments on the Duration of Impacts, mainly of Bars with Rounded Ends, in elucidation of the Elastic Theory.—*To be read in title only*:—N. Ahmad: Absorption of Hard γ-Rays by Elements.—E. V. Evans and H. Stanier: Sulphur Studies in Coal Gas. I. The Removal of Carbon Bisulphide by a Nickel Catalyst.

ROYAL AERONAUTICAL SOCIETY, at 5.—Annual General Meeting.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. L. G. Parsons: Some Wasting Disorders of Early Infancy (Goulstonian Lectures) (2).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. D. S. M. Watson: Evolution To-day (2)

INSTITUTION OF ELECTRICAL ENGINEERS at 6.—Lt.-Col. H. E. O'Brien: The Future of Main Line Electrification on British Railways.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—C. Morson: Treatment of Carcinoma of the Prostate.

FRIDAY, MARCH 28.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Specimens illustrating the various Maldevelopments of the Palate. (Demonstration.)

INSTITUTION OF MECHANICAL ENGINEERS (jointly with the Institution of Civil Engineers), at 6.—Discussion on the Report of the Joint Committee on Standard Tests for Hydraulic Power Plants.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. A. G. Buckham: The Way of the Lovely Sky.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. J. Simpson: Wood-wool; its Manufacture and Application.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. H. Maclean: Insulin.

SATURDAY, MARCH 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Properties of Gases in High and Low Vacua (4).

PUBLIC LECTURES.

SATURDAY, MARCH 22.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Natural History of Subterranean Animals.

WEDNESDAY, MARCH 26.

UNIVERSITY COLLEGE, at 6.—Prof. Karl Pearson: The Contributions of Sir Francis Galton to Psychology.

FRIDAY, MARCH 28.

COUNCIL CHAMBER, OLD COUNTY HALL, SPRING GARDENS, at 8.—J. T. Quinton: The Sanitary Inspector in the Machinery of the Public Health Service (Chadwick Lecture).

SATURDAY, MARCH 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—S. H. Warren: Prehistoric Man and the "Land of Lyonesse."