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Co-ordination of Food Research.[1]

THE appointment of the Imperial Economic Committee was a further step in the evolution of the Empire, and, should it be successful, an important one, for the aim is to promote "the greater prosperity of the Overseas Empire, the better distribution of the white population within the British Commonwealth, and the better employment of the population which remains at home." This the Committee hopes to accomplish by devising "methods of turning the trend of commerce into channels which will most effectively assist in the development of the Empire"; and it goes on to say that this "is a task at once complex, difficult and delicate, and [one which] cannot be hurried"—a conclusion with which few will disagree.

This first report before us confines itself to food, and the daily press has familiarised the public with the main feature of the proposals put forward, namely, the establishment of a permanent organisation, modelled broadly on the lines of the Development Commission, designed to secure regularity and continuity of supplies, and to conduct a publicity campaign "calculated to appeal particularly to the young, so that a habit [of consuming Imperial products] may be engendered in the coming generation." It is obvious that the effects of such a campaign could not be wholly commercial. If it were successful, it must increase the sense of empire, and of imperial responsibilities in the people. Its political import, therefore, would be great.

The special interest of the report to readers of NATURE lies in Part II., which is headed "The Importance of Research." "We are impressed," says the Committee, "by the paramount importance of research in solving the problems of the food supplies of the Empire," and to meet this need it proposes what is neither more nor less than the establishment of an imperial scientific service with headquarters and institutions in every geographical unit. A beginning has already been made towards such a state scientific service. At home there is the Department of Scientific and Industrial Research; in Canada and Australia there are parallel organisations; whilst at the Cape there is an active scientific division of the Department of Mines. Co-operation already exists, but it is almost exclusively of the kind which commonly takes place in the scientific world—interchange of papers and letters, and, much more rarely, of actual workers. The Committee aims at something more, namely, the co-ordination of these several and scattered organisations into a real imperial scientific service for the application of science to the food industries. This it hopes to

[1] Report of the Imperial Economic Committee on Marketing and Preparing for Market of Foodstuffs produced in the Overseas Parts of the Empire. Pp. 38. Cmd. 2493. (London: H.M. Stationery Office, 1925.) 9*d*. net.

attain by strengthening the scientific organisations in each country, and by establishing a system of studentships and grants which shall make it easy for scientific workers within the service to move from one part of the Empire to another.

Ultimately, the Committee hopes to see developed "an organised profession, trained at the Universities, specialised at the Research Stations, practised in research on a commercial scale, and utilised and rewarded in the trade at large," and "a professional institution which would play the same part in the food industry as that played by the Institution of Civil Engineers and the Institution of Mechanical Engineers in their industries."

That there is room for some such development as the Committee has outlined is not open to doubt. The application of science to the handling of food is patchy. On the engineering side it is good—cold storage engineering, for example, is as completely scientific as any other branch of engineering. But on the biological side, the industry, broadly speaking, is unscientific, and there is a great field for the application of botanical physiology, of biochemistry, and particularly of colloidal chemistry, to the problems of the storage of flesh, fruit, and vegetables. The food industry needs not only laboratory work on the biological side, but also infiltration by men with some training in the biological sciences—all this the Committee recognises. Before these aims can be attained, however, much persistent advocacy will be necessary. It is greatly to be hoped, therefore, that strong endeavours will be made to press forward the recommendation of the Committee as to research, until the scheme suggested is put into practice.

The Fundamentalist Controversy in the United States.

(1) *Both Sides of Evolution: a Debate.* By the Rev. Charles Spurgeon Knight. Pp. 233. (San Jose, Cal.: The Arthur H. Field Publishing House, 1925.) 1 dollar.

(2) *The Dogma of Evolution.* By Prof. Louis Trenchard More. (Louis Clark Vanuxem Foundation Lectures delivered at Princeton University, January 1925.) Pp. vi + 387. (Princeton: Princeton University Press; London: Oxford University Press, 1925.) 16*s.* net.

THE nature of the fundamentalist controversy in the United States, and the issues that are really at stake in it, are admirably illustrated by these two books, which we propose to review together. The first is an account of a public debate which is stated to have taken place in some small town disguised under the initial N—— in what Americans are prone to call "the wild and woolly west"; the other is a series of lectures admirably thought out and expressed, delivered before an academic audience in Princeton in the cultured east. In the first book, it would be difficult to assign the palm for crudity of thought and expression between the supporters and opponents of evolution; but the second book is a mine of valuable facts and of thoughtful criticism, though, like the first, it contains a polemic against the theory of evolution in its ordinary American presentation.

(1) If we turn to consider the first book more in detail, we find that it consists of an introductory address on the history of the theory of evolution by the president of the State University, followed by a defence of evolution by Prof. Allen, the local biologist. This is succeeded by an attack on evolution and a defence of the doctrine of special creation by Dr. Barkly, who is apparently an eminent Californian divine. A rejoinder by Prof. Allen then follows, and the book concludes with a second attack by Dr. Barkly. As the author of the book is the Rev. Dr. Knight, who describes himself as pastor and evangelist, it is not surprising that he considers the supporters of evolution to have been finally vanquished, and that he is careful to let the Church speak last. From the preface we might be disposed to infer that the president, Prof. Allen, and Dr. Barkly are imaginary characters, and that the whole of the arguments are the outcome of Dr. Knight's brain, and for the credit of our biological confrères in California we hope that this is indeed the case.

We note to begin with that the word "Evolution" is understood in its widest Spencerian sense: it is defined as including the nebular theory of Laplace and the supposititious development of living from non-living matter. It is evident from "Dr. Barkly's" rejoinders that what is chiefly attacked by the fundamentalists is this speculative extension of the theory of evolution, and we consider that the whole case for the validity of the theory of organic evolution is prejudiced by binding it up with such wild and baseless guesses as that for which the authority of Dr. Salesby (*sic*, ? Saleeby) is quoted to the effect that the ferments constitute the bridge between living and non-living substance, or that of Prof. Leonard Trolland, of Harvard, who states that life is an "autocatalytic reaction." If science be defined as the study of natural processes and the imaginary prolongation of them into the past and future, then no conclusion is more firmly based than that life only arises from pre-existing life, and that therefore in all sound theories of organic evolution the fundamental properties of living things must be taken for granted and are the postulate on which all our reasoning is founded. If we make guesses as to the spontaneous generation of life from dead material, we are stepping outside science, and invoking what may be called an extra-natural or supernatural agency; and there science, which deals with processes and not with origins, comes to an end.

The supporters of evolution lay stress on the wonders alleged to have been performed by Dr. Burbank in producing new varieties of plants by crossing. These wonders, which have been "featured" in many popular western accounts of evolution, have evaporated under detailed criticism, and it is due to Dr. Burbank himself to say that he has never countenanced the extravagant claims which some of his admirers have made on his behalf. For the rest, the well-known arguments from embryology (including the tailed stage in the development of man), from palæontology, from comparative anatomy, and from the peculiarities of island species are somewhat vividly presented. We may note in passing, as an example of intense provincialism, the astounding statement that Prof. A. Franklin Shull had "demonstrated the descent of the elephant from the Mœritherium of the upper Eocine" (*sic*). That this demonstration was effected by our own beloved and deeply regretted Dr. Andrews, of the British Museum (Natural History), is overlooked entirely.

The attackers of the theory of evolution are, of course, quick to seize the opening provided for them by the inclusion of superannuated theories of cosmogony and guesses as to the origin of life within the ambit of the evolution hypothesis. That theories of cosmogony are in the melting-pot, it is easy, in these days of Einstein and of radioactivity, to demonstrate. Indeed, if "Dr. Barkly's" attention had been directed to some recent utterances by the talented secretary of the Royal Society, he would no doubt have felt his position strengthened. In the columns of NATURE, Dr. Jeans has discussed the number and variety of atoms which were originally "created." Dr. Barkly stresses the point to which we have alluded above, namely, that life is never generated from dead matter, but he goes on to say: "It should be remembered that spontaneous generation is a necessary part of evolution as held by most evolutionists. If this fails part of the foundation on which they erect their theory is shattered beyond repair."

When he comes to the field of organic evolution, most of Dr. Barkly's arguments are incredibly crude; but there are one or two of them that are worthy of attention. His trump-card is Mendelism, and he quotes Dr. Batson (*sic*): "That particular and essential bit of the theory of evolution which is concerned with the origin of species remains utterly mysterious; we no longer feel as we used to do that the process of variation now contemporaneously occurring is the beginning of a work which needs only time for its completion, for even time cannot complete that which is not yet begun." There are many of us who fully agree with Dr. Bateson that the mutations with which Mendelians experiment have played no part in the evolutionary process; but so far from the genesis of species being mysterious, we hold that it is as clear as daylight to those who look in the right direction for a solution, and that nothing but the obstinacy of the Mendelians in persisting in searching in the wrong direction is the cause of the mystery which they find therein. When we discover that every wide-ranging species is split into local races, that a new local race establishes itself every time a new territory is colonised, that contiguous local races are fully fertile, *inter se*, but that distant races begin to show the mutual infertility which is characteristic of distinct species, we feel that the problem is in a fair way to its final solution.

Another argument of Dr. Barkly's is that domesticated animals and cultivated plants tend to revert to the wild type when neglected, and that therefore these breeds are not analogous to wild species. This, we think, is a valid argument. The diagnostic features of species are all reactions to their environment—in a word, adaptations to it—but the peculiarities of domestic animals, however useful to man, however "developed" from his point of view, are mere monstrosities from the point of view of the animals themselves, and owe their origin to disturbances of the developmental processes which result from the unhealthy conditions to which the germ is exposed at a critical period of its growth. As a consequence, we have "germ weakness" which is transmitted from generation to generation and produces similar results in each. But this germ weakness gradually disappears when normal conditions are restored; and so the domesticated pigs released in Jamaica in the seventeenth century have reverted to a form almost identical with the wild boar. It is, we hold, the one regrettable but natural mistake in the "Origin of Species" that Darwin considered these domesticated breeds as examples of the process which gave rise to new species.

It would be pointless and would weary readers of NATURE were we to recount Dr. Barkly's other arguments, such as: "If eyes were developed from pigment spots why are they not being developed now?" or "If this going backward from a hoofed animal down to a fish is not the opposite of all evolution, then the development of a horse out of a fish cannot be evolution at all, which, of course, overthrows the whole Darwinian theory at a blow."

Dr. Barkly's final reply is a pæan in praise of what religious teaching and religious belief have done in building up and upholding American civilisation. With much of what he says, all must agree, and it is the subconscious feeling that the American presentation of the theory of evolution threatens to undo the work of religion, which, as we have already pointed out in a previous communication to NATURE, is the driving force behind the fundamentalist movement. But though we have no desire to discuss religious questions in these columns, we cannot forbear to give one choice example of the crudity of Dr. Barkly's ideas: "Children always inherit through their parents—Jesus inherited through His mother for He was every whit a man, and He would have inherited through Joseph if Joseph had been His father, but in that case He could never have been more than a man. . . . The miraculous in His life is the manifestation of His Divine heredity." Comment is superfluous!

(2) It is a relief to turn from such outbursts of half-educated ignorance and prejudice to the calm scholarly and scientific atmosphere of Prof. More's book. In the series of lectures embodied in it he begins by emphasising the complete break between modern and medieval modes of thought which, according to him, began at the Renaissance. The first sign of the break began with the heliocentric system of Copernicus, but the Church did not realise the implications of this system until it was openly promulgated by Galileo, whose trial brought the conflict between the old and the new to a head; but, as Prof. More remarks, it is not true that opposition to science, whenever it has showed itself, is directed against the physical sciences themselves. Public opinion, according to him, is always indifferent to scientific theories, interest in which and eventual hostility to which are only aroused when they threaten to affect directly the social and ethical habits of society. It was because Galileo showed that the earth was only an inconsiderable member of the sidereal universe, and therefore could not be the main object of God's creation, that the outcry against him arose. Similarly, in the middle of the nineteenth century, it was not the change of one species of animal into another that outraged public feeling, but the theory that man was sprung from the lower animals, with the supposed bearings of this theory on such doctrines as the immortality of the soul.

Prof. More has some severe things to say about the "bluff" with which the propaganda in favour of evolution in the middle of the nineteenth century was conducted. The public were assured that natural selection was an all-sufficient explanation of the development of life, and that thought was nothing but molecular motion. Those who dared to raise such questions as to how a negative process like selection, which is only a pruning-knife, could originate anything new, or how thought and knowledge, if they were merely accidental concomitants of molecular disturbance, could tell us anything of the external world, were shouted down. Prof. More deprecates the hero-worship of Huxley; and Huxley would certainly have disclaimed it for himself. Huxley, as Prof. More shows, was intensely human; he promulgated inconsistent views at different times; at one time declaring that the geological record was so imperfect that it could prove nothing about evolution, and at another founding the whole of the case for evolution on palæontology. Sometimes he preached pure materialism, and at other times he acknowledged that matter was inconceivable without mind to picture it in—which is simply Berkeleyan idealism. Prof. More also objects to Huxley's constant iteration of the purity of his love for truth—as More says, this savoured of brag, because it implied that he alone sought the truth and that his opponents did not.

Prof. More then gives a searching and critical exposition of the history of biological thought in ancient times: he is rather severe on his fellow-countryman, Prof. Osborn, whom he convicts of a very superficial acquaintance with the classics. For he points out that neither the Greeks nor the early fathers of the Church, whom Osborn had claimed as forerunners of Darwin, had the remotest conception of evolution. According to Prof. More, the idea that various groups of animals originated from a common ancestor could only arise when it became clear that fossil species had existed, different from those now living, otherwise why should we not assume that all the inhabitants of the earth began their existence together?

Coming to more modern times, Prof. More discusses the theories of Lamarck and Darwin and confesses himself strongly attracted to the former. He criticises some of Lamarck's ideas, such as his distinction between the action of God and of natural law, but he thinks that if experimental research bore out Lamarck's assumptions (and we hold that it does), then there would be little to say against the theory. When he comes to Darwin he deprecates hero-worship in his case just as in Huxley's case. He points out that the idea of natural selection came into Darwin's mind as a sudden suggestion when he was a young man, and that he devoted the rest of his life to the attempt to prove it to be true, so that his scientific method was deductive and not inductive. He is severe on Darwin's assumption that the aberrations of domestic animals are of the same nature as the adaptations of species, and he points out that Darwin was devoid of any training in the philosophic criticism of his own ideas and did not realise that selection explained nothing and that his theory was really a theory of the constant occurrence of small inheritable variations in all directions (which the pure-line experiments have shown to be baseless).

In Great Britain the scientific bluff of the nineteenth century has been detected and discounted, with the result that the broad theory of evolution has been generally accepted by all the educated classes, and its acceptance is not regarded as involving a materialistic philosophy. But fashions in thought, as in clothes, often originate in Britain and are afterwards transferred to America, where they continue to flourish after they have become somewhat *démodé* here, and to judge from Prof. More's quotations, a crude mechanistic philosophy of life is still rampant in America. For in the last analysis we come down to the two alternatives: either what we call life, the external manifestations of which are concatenations of physical and chemical forces, is due to the arrangement of atoms in the living substance, or else it is due to the operations of an invisible entelechy or psychoid which uses and arranges these forces to gain a definite end.

Prof. More, who is a physicist himself, is mercilessly severe on the bad physics and worse chemistry with which the mechanistic biologists strive to cloak the inadequacy of their explanations. When the attempt of Verworn to show that the action of each living being was the result of its protoplasm containing a characteristic type of molecule (the mythical biogen) broke down and it became obvious that protoplasm is not a characteristic compound but a characteristic mixture of compounds, the difficulty of explaining how the typical proportions of this mixture were maintained became insuperable. The absurdity of some of the attempts to overcome this difficulty quoted by Prof. More, is almost incredible, as, for example, that of Prof. Ritter who maintains that every individual organism is a chemical compound! It is against the mechanistic view and not against evolution in general that Prof. More's whole polemic is directed, and he concludes with two chapters on "Evolution and Society" and "Evolution and Religion."

In the first of these chapters, Prof. More shows the impossibility of reducing sociology to the status of a definite science governed by fixed laws. He points out how all the prophecies of sociologists of the Spencerian type are being falsified by the trend of events, and that society in general does not "evolve" by the work of natural selection on the masses, but by the sporadic appearance of really great men and their incalculable influence on their fellow-humans. In the concluding chapter he develops this subject further: he says that in the spiritual realm we do not observe regular progress, but extraordinary and unaccountable breaks; that no theory of evolution will account for Jesus, St. Francis of Assisi, or Pascal (nor, we may add, for Mahomet or Buddha), and that the wider acceptance of the theory of evolution has not led to moral progress as Spencer predicted that it would do. We may conclude this review by a quotation from this chapter: "If it were a general law that homogeneity changes to heterogeneity then all primitive stocks should progress if sufficient time be given. The contrary is the rule. Only a few primitive stocks have shown the power to progress to a high civilisation. . . . Unless they (the remainder) fall under the constraint of a foreign dominating stock we see no signs that they would ever advance to a complex or heterogeneous social state."

Is not Prof. Elliot Smith right after all?

E. W. M.

Lodge on Radio Communication.

Talks about Wireless: with some Pioneering History and some Hints and Calculations for Wireless Amateurs. By Sir Oliver Lodge. Pp. xiii + 251. (London, New York, Toronto and Melbourne: Cassell and Co., Ltd., 1925.) 5*s*. net.

THE author in his preface describes this book as a friendly book. It is a message of greeting from one of the pioneers of the art of radio communication to the many who are following in his footsteps. He would be hard to please who did not find something acceptable and worthy of thought in these interesting chapters. The first part of the book describes radio in general. The second part gives hints that make for efficiency, and the final part gives methods of calculation which will be helpful to amateur constructors.

We have read the book with much pleasure. It is of great value to have on record views of the early history of radio communication by one who took a leading part in making that history. The book makes no pretence to be a complete history, but we think that the author has laid due stress on those discoveries and inventions which played a leading part in radio development.

No one has a more open mind than Sir Oliver Lodge. He is willing to investigate any phenomenon although it seems to contradict physical principles almost universally accepted. This attitude of mind is admirable. His statements, however, about the ether are perhaps too dogmatic. He believes firmly in the ether of space as a continuous reality which welds not only us but all the planets into a coherent system. "We are utilising it every day of our lives, and it would be ungrateful as well as benighted if we failed to render due homage to its omnipresent reality and highly efficient properties." We think that this is putting belief in the ether on too high a level. Like the planetary electron, it is still unfortunately in the region of metaphysics. The hypothesis has proved of the greatest value in the past. It greatly simplifies our physical explanations of light, electricity, and gravitation, and no physicist hesitates to use it. But we must still recognise that it is only a hypothesis and be ready to change our views if anything more useful and convincing is suggested. It is advisable to take up a humble attitude.

Sir Oliver is enthusiastic about the modern methods of rapid transport and the greatly increased facilities for communication between inhabitants of this planet. But he points out that much more than physical and material progress are wanted before the much-desired, but long-delayed, era of universal peace can come. An essential preliminary is that every one should have a whole-hearted desire for the co-operative advancement of all nations on terms of mutual amity and goodwill. "Now that we are able to travel farther and faster, we should travel to some good purpose. And now that we can speak across a continent, let us see to it that we have something worthy to say."

It is perhaps going too far to state that we have extended the range of human speech to distances undreamt of by our ancestors. It is interesting to remember that the ancient Greeks contemplated not only the possibility of speech being heard at places hundreds of miles apart, but also that some of them believed that one at least of their philosophers could "broadcast." It is recorded that Pythagoras could be heard lecturing by different audiences in different towns on the same day and at the same hour. Whether Pythagoras anticipated Sir Oliver as a broadcaster or not, it shows that some ancient Greeks had considered the possibility and the effects produced by broadcasting. Unfortunately, the story of Pythagoras, who flourished about 500 B.C., is shrouded in the dim magnificence of legends.

The author points out that Joseph Henry in 1842 had the genius to surmise that there was some similarity between the etherial disturbance caused by the discharge of a Leyden jar and that caused by ordinary light. In 1875, Edison observed that when an electric discharge took place, sparks ensued between neighbouring conductors, and Elihu Thomson investigated this phenomenon. A very important step forward was made in 1897 when Lodge showed how to obtain accurate tuning by the use of a coil of variable inductance. He also considered the possibility of transformer reception. Further great advances were made by Fleming and Lee de Forest. Those of us who can remember the difficulties of reception twenty years ago regard the present easy methods of getting excellent reception as almost miraculous.

Many hints are given in Part II. which will prove useful to the amateur. He should use only wire of the highest conductivity, thoroughly insulate all his appliances, and make all joints as perfectly conducting as possible. Excellent chapters are given on the various methods of aerial excitation and on the grid as a "traffic regulator."

In the final part of the book, calculations are given suitable for amateur constructors. Stress is laid on the fact that the maximum possible inductance that can be obtained from a wire of length l is $3nl$, where n is the number of turns of wire. If the inductance of the coil is not equal to $3nl$, then it has not been properly made. Maxwell pointed out that it has this value when the radius of the circular section of the coil is 3·22 times the radius of the cross section. But in this case the formula from which the maximum value was deduced is only a rough approximation. If we take the much more accurate formula given by Rayleigh, we find that the ordinary method gives a result which is about 3 per cent. too small. The methods given of calculating the capacity of the aerial are only rough approximations and merely show the order of the magnitude of this quantity. The reviewer finds it very difficult to understand what radio engineers mean by the capacity of an aerial, although he has investigated several empirical formulæ which give results agreeing closely with measurements. A. Russell.

Liquid Fuels from Coal.

The Conversion of Coal into Oils. By Dr. Franz Fischer. Authorised English translation, edited with a Foreword and Notes, by Dr. R. Lessing. Pp. 284. (London: Ernest Benn, Ltd., 1925.) 36*s*. net.

In view of the fact that there are no appreciable sources of natural petroleum in Great Britain, and that the country is therefore dependent on overseas supplies for all its rapidly growing requirements, the importance of studying methods whereby substitutes could be provided by treatment of raw material indigenous to Britain cannot be overstated. The technical problems involved are being studied both at home and abroad by many competent workers, more especially in those countries which do not produce natural liquid fuel. Inquiry is also stimulated, even in those more fortunately situated, by the rapidly increasing demands for oil for all purposes.

During the past few years progress has been made in our knowledge of the constitution of coal both in

Great Britain and America, whilst many valuable contributions to the subject have emanated from Prof. Franz Fischer and his co-workers in the Kaiser-Wilhelm Institut für Kohlenforschung at Mülheim-Ruhr in Germany, a research institution which was inaugurated in 1914, shortly before the outbreak of the War. It is especially helpful at the present time to those workers who are seriously studying the subject to have available a translation of Dr. Fischer's work on "Die Umwandlung der Kohle in Öle" from one so competent to handle the subject as Dr. Lessing, himself identified with much valuable work on the constitution of coal.

In the treatise, the whole problem of the conversion of coal into liquids is critically surveyed. Naturally the book is largely concerned with the author's carefully planned researches extending over some nine years, but, at the same time, due consideration has been given to the work of other investigators, and if in certain cases the review of work in Great Britain and in America is somewhat sketchy, the fault lies in the break in the scientific relations between the various countries due to the War.

The subject matter is divided into five main sections, of which Chaps. 1 and 2 deal with the extraction of coal by solvents and the production and working of primary tar respectively. Most of the work described in these chapters has been dealt with adequately by British investigators and appears in the English literature. In Chap. 3 the hydrogenation of coal is considered at some length, but a much more extended description of the results achieved by Dr. Bergius of Mannheim might have been included. Chapters 4 (Synthetic Processes) and 5 (Hydrocarbons from Carbides) form the most valuable portion of the book, since they summarise, for the first time, the recent developments in the synthetic processes which Dr. Fischer has studied so intimately.

It is the author's evident belief that a solution of the light liquid fuel problem will, if found, lie in syntheses from the simple molecules of carbon monoxide and hydrogen, the coal being first broken down by some process and utilising the water-gas reaction to yield these molecules. He points out that "dry distillation is essentially a destructive method based on the thermal decomposition of the ulmins, and particularly of the bituminous constituents of coal," and that products of low boiling range, for which, of course, there is an almost unlimited demand, are formed only to a small extent. "The large size of the molecules of the compounds forming coal itself explains its behaviour on distillation, that is, the fact that thermal decomposition of the bitumen and the other coal constituents yields predominantly products of high boiling points." He considers, and with reason, that synthetic methods, starting from very small molecules, are more likely to yield low boiling fuels than the method of destructive distillation.

Dr. Fischer therefore advocates first recovering the primary or low temperature tar by one of the destructive distillation processes, followed by complete gasification of the semi-coke. The gas so obtained forms the raw material for the preparation of a mixture of oxygenated synthetic oils produced from carbon monoxide by catalytic processes and which he has designated "Synthol." This product consists of a complex mixture of diverse aliphatic compounds from which acetone, methyl-alcohol and ethyl-alcohol can if necessary be recovered by fractional distillation for use as solvents, the remainder apparently forming an excellent motor fuel. A few road tests are quoted in which comparisons are made between benzol, synthol, and various mixtures of benzol-synthol and benzol-alcohol-synthol, in which both mileage and starting properties compared favourably.

Interesting and valuable as this is as showing the possibility of obtaining from coal large quantities of lighter oils, it must not be forgotten that the process has still to be worked out commercially, and little data exist as to whether such a process can produce liquid fuels on a really large scale at a price competitive with natural fuels. In Great Britain the fuel problem is twofold, namely, to produce a solid smokeless fuel which can be burnt in existing grates, and at the same time to produce supplies of fuel oil, both light and heavy, for commercial and marine purposes. Some 35 million tons of coal per annum are burnt in the domestic grate, and should a stage be reached in which the bulk of this raw coal was subjected to preliminary carbonisation, a useful supply both of heavy and light oils would be available, but the coke would be required for household purposes. If, however, these methods can be developed successfully so as to be capable of application on a scale commensurate with the needs of a nation, there will be ample room for both, and the degree to which low temperature distillation would be combined with further treatment of the coke to produce liquid fuels would be determined in various countries according to their resources, requirements, and national habits.

In the foreword, the editor points out that he has adhered as closely as possible to the original text so far as is compatible with English phrasing. In an appendix, however, he has considered one or two of the latest developments of low temperature carbonisation, treatment of primary tars, and hydrogenation of coal, so as to indicate to his readers developments with which, for reasons already mentioned, Dr. Fischer could not be expected to be familiar. A useful bibliography completes a work which should undoubtedly find a place in the library of the British chemists and engineers who are now working on the many-sided problem of rendering Great Britain to some extent independent of foreign sources for her supplies of liquid fuels. C. H. L.

Botanical Text-books.

(1) *A Class Book of Botany.* By Ernest Stenhouse. Pp. xi+514. (London: Macmillan and Co., Ltd., 1925.) 7*s.* 6*d.*

(2) *A Textbook of General Botany.* By Prof. William H. Brown. Pp. xi+484. (Boston, New York and London: Ginn and Co., 1925.) 13*s.* 6*d.* net.

THE large variety of text-books of botany which have been published during the last few years, in Great Britain and in America, render it difficult for any addition to their number to present novelty of either treatment or subject matter. Most such works tend towards one of two extremes according as they appear to aim, on one hand, at imparting the maximum number of facts in the minimum of space, which in the hands of the inexperienced writer may lead to the endeavour to include all aspects of the subject, even perhaps insecurely founded hypotheses; or, on the other hand, the author may emphasise the more philosophical aspects of the subject, sometimes even to the exclusion of essential data. The best text-books are those which most nearly attain the balanced combination of these two aspects, and whilst subordinating facts to the illustration of principles, nevertheless provide the student with such a foundation of knowledge as shall enable him to build securely the superstructure of his later studies. It is in the selection of the illustrative data and its manner of presentation as part of a co-ordinated concept of vegetable life that the student gains by the experience of the author, provided that the latter has not forgotten with the passage of time the rungs on which he slipped as he himself climbed the ladder of progress.

The two books under review illustrate the two tendencies indicated above. In the "Class Book of Botany," by Mr. Stenhouse, we are impressed by the large amount of information which it contains, especially since it is intended for the use of those preparing for matriculation and similar junior examinations. But the facts are somewhat insistent as such, their significance and co-ordination too little emphasised. A useful feature is that each of the numerous chapters is preceded by suggestions for practical work, including many of an experimental character. Also each chapter is followed by a number of questions from examination papers.

There is much that is admirable in Mr. Stenhouse's book, but we have an ever-present consciousness as we peruse its pages that we are preparing for an examination. That it may produce successful candidates is very probable, but whether it will create lovers of the subject for its own sake is less certain. There are numerous illustrations of which the line drawings are in many cases reproductions of well-known figures, whilst the half-tone blocks have mostly been prepared from Mr. Irving's excellent plant studies. The latter are indeed the chief redeeming feature of an otherwise uninspiring chapter on common British trees. It may be noted that, apart from the ground usually covered by text-books of an elementary character, the simpler microscopic structure of plants is described, and there is a short account of a few of the common types of plant community.

(2) Prof. Brown's "Textbook of General Botany" is likewise of an elementary character and covers much the same ground. The earlier chapters treat of the various regions of the plant considered from the structural and physiological points of view, whilst the later chapters are devoted to the subdivisions of the vegetable kingdom, heredity, geographical distribution, etc.

Here the treatment is much more general in character, and occasionally one feels that the author passes too lightly over the ground, but the spirit in which the book is written is well expressed by the author's statement in the introductory chapter that "all persons should have some knowledge of botany if only for the purpose of understanding better so important a part of their environment as the vegetable kingdom." The text is well illustrated with more than five hundred original figures, mostly taken from tropical or subtropical material, the utility of which, however, is somewhat discounted by the lack of annotation.

The text in both of these works is divided into headed paragraphs: a device which, if it has advantages, tempts towards a discontinuity of narrative that neither author has been able to resist. E. J. S.

Bird Islands of Peru.

Bird Islands of Peru: the Record of a Sojourn on the West Coast. By Robert Cushman Murphy. Pp. xx+362+32 plates. (New York and London: G. P. Putnam's Sons, Ltd., 1925.) 15*s.* net.

THE western coast of South America is washed throughout a large part of its extent by a great river of cold water, an arm of the Pacific Antarctic drift. This, the Humboldt Current, has effects upon climate, vegetation, fauna, and human affairs that are no less profound than those of the Atlantic Current in north-western Europe. It is not until within nearly three hundred miles of the equator that the cold northerly flow leaves the coast, to sweep outwards past the Galapagos and become lost in the expanses of ocean. Thus, along the Peruvian littoral we have temperatures which are very low in relation to latitude, and where tropical jungles might be expected to skirt the coastward base of the Andean range there is a strip of arid desert fringed with barren islands.

It is owing to the Humboldt Current, therefore, that this region of the tropics has a fauna with marked Antarctic affinities. In latitudes where turtles might be expected to pull out on the beaches to lay their eggs in warm sand, we find instead penguins burrowing on a barren coast. To the current also is due the great abundance of life. For a variety of reasons the waters of this ocean stream are peculiarly favourable for the multiplication of diatoms; thus for the existence of immense quantities of fishes; and thus, in turn, for vast numbers of piscivorous birds. One more fact completes the chain of circumstances. The great colonies of sea-fowl nest on the islands, and as these are barren and unwashed by rain, the excrement of the birds accumulates to form great deposits of guano. This, then, is the origin of "the greatest modern industry based upon the conservation of wild animals."

Dr. Robert Murphy, now of the American Museum of Natural History, has made these matters the theme of an entrancing book, based largely on his own experiences during an expedition which was made possible by a bequest to the Brooklyn Museum, of which he was then curator. The object of the expedition was to investigate the oceanic conditions responsible for the abundance of life in Peruvian water, and the interrelationships and distribution of this life; to make zoological studies and collections; and to observe the conditions of the reorganised guano industry. The results are attractively set forth in narrative form, with allusions to previous writers, and are of great interest from more than one point of view. There is much of oceanography and biology, and much particularly about the birds; while native customs, antiquities, history, industrial considerations, and the incidents of travel are all given their place.

The chief guano producers are four in number, all of them belonging to the natural order Steganopodes—a cormorant, two boobies or gannets, and a pelican. Of these the *guanay* or white-breasted cormorant (*Phalacrocorax bougainvillei*) is the most important. The reader of Dr. Murphy's book will not fail to gather an impression of the almost incredible abundance of this species, and of the extent and density of their colonies—where there may be three nests to the square yard. A single island was estimated to have a population of five and a half million birds, old and young, to maintain which it is computed that not less than a thousand tons of fish would be required every day! One of the boobies (*Sula variegata*), although not producing so much available guano, is even more numerous. The reader who has ever watched a gannet dive from the sky, to spear a fish seen in the sea beneath, will surely marvel to read of a flock of a thousand *piqueros* plunging simultaneously on passing over a shoal.

The best guano has a nitrogen content thirty-three times greater than farmyard manure, and is much more effective as a fertiliser than any synthetic compound that has been devised. Its agricultural uses were known to the Incas before the Spanish conquest, and irrigation schemes and guano together helped to make fertile the desert levels of the coast. The island deposits were in these olden days worked in a conservative manner, and the birds were strictly protected. The lesson had to be learnt again, however, for when the value of guano was realised in Europe in the middle of last century an era of reckless exploitation began: the accumulation of ages was rapidly used up, one island being lowered in level by a hundred feet, while at the same time the productive birds became greatly reduced in number, both through disturbance of their nesting places and direct destruction. The birds and the industry would both in time have been wiped out had not wiser counsels prevailed (including the advice given by a British naturalist, Dr. H. O. Forbes, and by Dr. R. E. Coker of the U.S. Bureau of Fisheries) and the industry been placed under Government control by the Peruvian authorities. Extraction is now limited in amount and regulated in accordance with a system of rotation which reduces disturbance to a minimum; the birds themselves, with careful protection against human and natural enemies, are rapidly repopulating their colonies; and the industry prospers while building up its future as it goes.

Atmospheric Electricity.

Électricité atmosphérique. Par B. Chauveau. Troisième fascicule: Généralités sur les ions, l'ionisation et la radioactivité. La conductibilité et l'ionisation de l'atmosphère. Pp. xi+240. 22 francs. Deuxième fascicule: Le champ électrique de l'atmosphère. Pp. x+264. 25 francs. (Paris: Gaston Doin, 1924 and 1925.)

IT is a remarkable fact, and one not easy to explain, that although some of the most important contributions to our knowledge of atmospheric electricity have been made by British workers, there is no book in the English language dealing with the subject. The need for such a treatise has been constantly felt, especially when students have expressed a desire to undertake research on some problem connected with atmospheric electricity. Until quite recently, the only books to which such students could be referred have been written in German, and this has proved a great obstacle. The position has been very much improved by the almost simultaneous publication of two works in French, which language has much less terror for the average English student. One of these, "Traité d'électricité atmosphérique et tellurique," by E. Mathias, was reviewed in NATURE so recently as August 1 last, and now M. Chauveau's book, the first part of which appeared three years ago, has been completed.

We must congratulate M. Chauveau on having written an extremely valuable account of the present state of our knowledge of the electrical phenomena of the atmosphere. He has divided his work into three parts, each published separately, but this has only been done for convenience; the work must be treated as a whole, for the parts are not complete in themselves. The first part, which is an historical introduction, has already been reviewed in NATURE (vol. 110, p. 406, September 23, 1922). The second part, which was the last to be published, deals with the electrical field of the atmosphere; and the third part with ions, ionisation, and radioactivity. It is not necessary to give a list of the subjects dealt with, for one can sum up the contents of the book by saying that every piece of work of permanent value has been considered, and references are given to practically every paper which has ever appeared on the subject.

One is grateful to M. Chauveau for the descriptions he has given of the apparatus used and of the methods employed by the various workers. His summary and co-ordination of the great mass of results obtained is masterly and could only have been accomplished by one who has himself made a life's study of the subject.

On reading this book, the outstanding impression which remains with the reader is the enormous number of problems which are still unsolved. One has the feeling that we have as yet done little more than discover a large mass of almost unrelated facts. The only thing which seems to be common to all is the factor of electricity. The surface of the earth has a negative charge which undergoes daily and annual changes, to say nothing of abnormal variations due to meteorological factors, but we do not know whence this charge comes, nor how it is maintained; we do not know the cause of the daily or the annual variation; we do not even know whether these periodic changes are of a terrestrial or cosmical origin.

Then again, the air is ionised, but we do not know why it is ionised. The presence of radioactive constituents in the atmosphere would appear to offer a solution to this particular difficulty, but when we examine the matter more closely we find that the problem is not solved. The amount of radioactive matter is nearly ten times as great over the land as over the sea, yet the ionisation is practically the same over the centres of the oceans as over the continents. No one has yet proved a numerical correlation between the amount of radioactivity in the air and the state of ionisation.

What part does ionisation play in the whole phenomena? The amount of ionisation obviously affects the rate of loss of electricity from the surface, but does it determine the magnitude of the remaining charge? If so, and there is some evidence that it does, is the daily and annual variation of the potential gradient simply due to the daily and annual variation of the ionisation? For this there is as yet no evidence. In this connexion M. Chauveau appears to ascribe a rather more important rôle to the large ions than is usually done by other writers.

If the maintenance of the earth's negative charge is the greatest problem, the mechanism of the thunderstorm, with which the origin of the electricity associated with atmospheric precipitation is intimately bound up, runs it very close. M. Chauveau's treatment of this branch of the subject is very complete, and his description of the observational work is excellent. He is, however, not satisfied that the true mechanism of the thunderstorm has yet been discovered.

These are only a few of the problems still unsolved; the book is full of others to which we have not space to refer. We can only recommend that every one interested in the subject, especially those undertaking further investigation, should study this book very carefully.

G. C. S.

Our Bookshelf.

(1) *Modern Diagnosis and Treatment of Syphilis, Chancroid and Gonorrhœa.* By Brevet-Col. L. W. Harrison. Pp. viii+167. 10*s*. 6*d*. net.
(2) *Modern Methods in the Diagnosis and Treatment of Pulmonary Tuberculosis.* By R. C. Wingfield. Pp. xi+134+11 plates. 10*s*. 6*d*. net.
(3) *Modern Views on the Toxæmias of Pregnancy.* By O. L. V. de Wesselow and J. M. Wyatt. Pp. vii+99. 7*s*. 6*d*. net.

Modern Medical Monographs. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.)

THE rapid advance of scientific, as opposed to empirical, medicine has stimulated Prof. H. MacLean to edit a number of monographs dealing with subjects in which the average medical man, who cannot remain in contact personally with the progress of all branches of his profession, must yet maintain his knowledge at a modern standard. In the first three monographs published, the editor and authors have succeeded admirably in presenting modern views with a brevity and clearness which will prove a great attraction to the medical practitioner.

(1) The first volume under notice carries the admitted authority of Colonel Harrison. It contains references to every clinical and pathological detail in the diagnosis of venereal disease, and clear guidance through the confusing list of drugs now used in its treatment. It is certainly the best book of its size on this subject.

(2) Dr. Wingfield's work is offered to the senior student and to the general practitioner; junior students are recommended to turn elsewhere for the basis of their knowledge of phthisis, and in view of the limited amount of clinical data given, this is sound advice. The greater part of the book is devoted to treatment, but as this is always considered in association with the patient's condition, clinical features are not neglected. Dr. Wingfield is an exponent of treatment by graduated exercise, and gives a good account of the successful methods adopted at the Brompton Sanatorium, Frimley. Fresh air is considered of value only from the point of view of improving the general health, and sunlight is only mentioned casually. A most valuable chapter for the practitioner is that on after-care, including rules for the estimation of progress. The book is well illustrated by X-ray photographs.

(3) The third work under notice is of necessity a much less dogmatic book. Here the authors can only sum up the progress made by research into an obscure though important subject; conclusions are more provisional, and practical help for those who have to treat the disease is scanty. This is consequent on the absence of any definite knowledge of the pathology of pregnancy toxæmias, and the authors have made the best of a difficult task. In the treatment of eclampsia, they are not in favour of terminating pregnancy except in very toxic cases, where Cæsarian section is recommended; in other cases they advise morphia, washing out the stomach, and an enema, but no other interference.

Animals in the Making: an Introduction to the Study of Development. By J. A. Dell. (Bell's Natural Science Series.) Pp. xii + 115 + 8 plates. (London: G. Bell and Sons, Ltd., 1925.) 2*s.* 6*d.*

The appearance of this little book is most opportune. The teaching of biology in schools, as an introduction to the proper understanding of the reproductive processes in man, is being urged insistently by biologists, and the time seems to be approaching rapidly when biology will take its proper place in the school curriculum. The author of this book, himself engaged in school work and therefore familiar with the practical difficulties of teaching the subject to children, has here drawn up a course of quite easy laboratory exercises, designed to allow pupils to see and handle for themselves embryological material to illustrate the fundamental principles of animal development. The exercises are very simply conceived and are such as can, with ease and very little expense, be carried out in any school with the minimum of apparatus. They include elementary observations and measurements on growth, and the principles and use of the simple lens and microscope.

With these aids to study, the development of the frog, fowl, and rabbit are followed through on living material, step by step, and the changes observed correlated with change in habits and mode of life. The full course is planned to occupy a year, and at the end of that time the pupil has gained a considerable insight into the processes of development, fertilisation, and growth, the nourishment of the young, and even into the cellular structure of animals. Such an insight cannot fail to be of the greatest value to the child as a preliminary to an understanding of the essential facts of human development. The author is to be congratulated on the production of an excellent little book which should be of real help to countless other teachers who are anxious to extend biological teaching in schools.

Ancient Warriors of the North Pacific: the Haidas, their Laws, Customs and Legends, with some Historical Account of the Queen Charlotte Islands. By Charles Harrison. Pp. 222 + 11 plates. (London: H. F. and G. Witherby, 1925.) 15*s.* net.

For a missionary who has spent forty years among the Haida, this must be regarded as a rather unsatisfactory book. There is no question as to the accuracy of what is stated, but it is slight and there is insufficient information concerning the social life and social organisation of the people. The title of the book would lead one to expect some account of their fighting and warlike expeditions, but the information on this aspect of their life is very meagre. The most satisfactory sections are those dealing with the shaman and his medical and other activities. The religious beliefs are dealt with. A brief account is given of the history, geography, natural history, and geology of the Queen Charlotte Islands, and also of their natural resources. In an appendix, measurements by Dr. Oetteking are given of a few crania.

The author claims that "these islands are a great reservoir of potential wealth and that as the demands of the civilised world increase their natural resources will be developed." Earlier in the book he says of the Haida: "They were once a powerful nation and the terror of all the surrounding tribes. One hundred years ago they were numbered by tens of thousands; now only about one thousand can be found. . . . Their history is only another example of the inability of the North American Indian race to survive in contact with European civilisation." Presumably Mr. Harrison considers that the Haida will have quite disappeared before the country is systematically exploited, but if he has any wish that "undoubtedly the finest and most intelligent race on the coast" shall continue to exist, his suggestion does not appear to be the best way to preserve them.

Grundzüge der Kolloidlehre. Von Prof. Dr. Herbert Freundlich. Pp. viii + 157. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924.) 6 gold marks.

This book is written as a strictly non-mathematical introduction to colloid chemistry. The author's classical work, "Kapillarchemie," is mathematical, extensive, and designed for the advanced student and investigator. By abbreviation and excision of mathematical deductions and numerical data, a very much smaller book has been prepared. It is easy to read, introduces the fundamental points, and can be heartily recommended as a sound, interesting, and adequate survey of elementary, theoretical colloid chemistry.

The subjects dealt with include the phenomena at interfaces (liquid/gas, liquid/liquid, solid/gas, solid/liquid), such as surface tension, adsorption, capillary-electric phenomena, and the properties of interfacial layers. The Brownian motion is discussed historically, and then are outlined the general properties of sols and gels, including the problem of the Liesegang rings. Brief accounts of clouds and smokes, and emulsions and foams, complete this useful introduction to the author's detailed book.

The reviewer takes exception to the statement (p. 165) relating to emulsions: "When one liquid is in considerable excess, it necessarily becomes the dispersion medium." The literature on colloidal chemistry records several examples of even 99 per cent. of one liquid being dispersed in 1 per cent. of another liquid. Also, both types of such concentrated emulsions are known, namely, oil-in-water and water-in-oil.

WILLIAM CLAYTON.

Die Kriegsschauplätze 1914–1918 geologisch dargestellt. Herausgegeben von Dr. J. Wilser. (In 13 Heften.) Heft 1: Elsass. Von Prof. Dr. E. Kraus und Dr. W. Wagner. Pp. viii + 154 + 3 Tafeln. (Berlin: Gebrüder Borntraeger, 1924.) 13*s.* 2*d.*

KRAUS and Wagner's "Elsass" is the first in number of a series of monographs on the geology of some chief fields of the War. It shows the extent to which the German military staff used geological help. The series includes contributions to the geology of several areas in Europe of special interest which had been inadequately studied. Elsass, however, was geologically well known, though the province is tectonically complex because the Alpine movements have been superimposed on the older Variscan structure. The authors deal with the province in three divisions. In the North Vosges, pre-Cambrian gneisses and Cambrian rocks have both been folded by the Caledonian movements and succeeded by deposits ranging from middle Devonian to the Trias. In the Middle and South Vosges the gneisses are directly covered by Lower Carboniferous rocks; they have been altered by granites intruded during the Variscan disturbances which were followed by the deposition of the Permian and the Trias. The third region is the rift-valley of the Rhine with Oligocene, Pliocene, and Pleistocene deposits. The monograph contributes much fresh information, as well as summarising the evidence on these three important geological divisions.

Outlines of the Occurrence and Geology of Petroleum: an Introductory Handbook. By I. A. Stigand. With an Appendix on Geophysical Methods as applied to Oil-finding, by Dr. M. Mühlberg. (Griffin's Mining Series.) Pp. x + 246. (London: C. Griffin and Co., Ltd., 1925.) 10*s.* 6*d.* net.

MR. STIGAND's handbook is one of the most generally satisfactory of the many smaller works now available regarding the geology of oil. In the discussion of the origin of petroleum he concludes that it comes from many different sources, but that the bulk of it is due to micro-organisms. The chapter on field structures is admirably clear and does not attach to anticlines the exaggerated importance often assigned to them. The author is optimistic as to the quantity of oil available; he gives a long list, stratigraphically arranged, of oil-bearing localities, and if most of them were to become important producers the future supply of mineral oil would be assured; but many of the places in the list will probably not yield oil in quantities of commercial importance. The author lays on the mineralogists the responsibility for the denial that coal is a mineral, whereas reference to the text-books by Miers, the two by Dana, and the handbooks of the Mineralogical Department of the British Museum would show that the mineralogists are not the authors of the definition which leads to that ludicrous conclusion. The most important part of the work is an appendix on oil-field survey by the torsion balance, by magnetic and electric methods, by the use of seismic and acoustic observations, and of radioactivity. There is a useful bibliography on this branch of oil prospecting.

Physical Chemistry: its Bearing on Biology and Medicine. By Prof. James C. Philip. Third edition. Pp. vii + 367. (London: E. Arnold and Co., 1925.) 8*s.* 6*d.* net.

THE principal new feature of the third edition of Prof. Philip's book is the increased attention which has been paid to problems relating to hydrogen-ion concentration —a purely physical conception which has proved of such value in biological problems that its development has been very largely due to the intensive study of the phenomenon by physiologists. References to recent work have also been given, however, in other directions, and additional matter in reference to the properties of membranes has been inserted.

Distillation in Practice. By C. Elliott. (Chemical Engineering Library: Second Series.) Pp. 188. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

MR. ELLIOTT's monograph forms a useful supplement to his "Distillation Principles," recently noticed in NATURE. The first five chapters consider the operation of the fractionating column with mixtures of two components. Accounts are then given of distillation apparatus, and the cases of ethyl alcohol, petroleum, and coal tar are specially considered. References to recent literature are given.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Edited by Oliver Kamm, Roger Adams, H. T. Clarke, J. B. Conant, C. S. Marvel, F. C. Whitmore. Vol. 4. Pp. vii + 89. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 7*s.* 6*d.* net.

THE fifth volume of this excellent series includes twenty-eight preparations, among which are cupferron, ketene, pyruvic acid, and triphenylmethane. It is indispensable to all who have to carry out preparative work in organic chemistry.

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 Losses in Trout Fry after Distribution.

MAY I ask the co-operation of readers of NATURE—fish culturists and anglers—in testing the reliability of some experiments which were designed to ascertain the numbers of trout fry which survived out of a given number distributed in depleted trout streams? The importance of the experiments can scarcely be overestimated, because if corroboration of the Board's results is obtained in different parts of Canada and in the United States, then, if economic results are aimed at, fry will have to be rigidly excluded from all waters excepting those which are known to be suitable.

Three public bodies in Canada co-operated in carrying out the experiments during the summers of 1923 and 1924: (1) The Ontario Department of Fisheries, which furnished the fry and fingerlings and in most cases distributed them; (2) the Department of Fisheries, Ottawa, which appointed an experienced hatchery officer to check the determination of losses; and (3) the Biological Board of Canada, which appointed Mr. H. C. White to carry out the operations in the field.

In 7 streams and 2 ponds a total of 95,700 fry or fingerlings were planted, some in June of 1923, and some again in June of 1924. In 6 of the streams the losses were apparently total at the end of three months. In streams and ponds combined, apparently only 1375 survived, being less than $1\frac{1}{2}$ per cent. of the total fry planted.

The method of determining the losses was that of seining the streams or ponds and counting the survivors. A net fine enough to catch the smallest fry, and long enough to stretch across a brook, is used. A stout brail or stick, about 3 or 4 feet long, is attached to each end of the net. Heavy leads are fixed to the lower side of the net, so that fry may not escape at the bottom. The upper side is held above the water by the two men who operate the net, one on each side of the stream.

The seining should be done over and over again—a dozen or more times if necessary; in fact, often enough to ensure that almost every survivor is caught. Towards the end of the seining it may be necessary to have a third man rile the water thoroughly by stirring up the bottom of the stream in advance of the two seiners. This was done in order to prevent the fry from seeing and avoiding the net. Some practice is necessary in seining, otherwise the results will be untrustworthy.

In one of the brooks seined by the Board it was found that the fry ascended the stream about 40 rods above and 90 rods below the point of distribution. If it is desired to shorten the distance to be seined, and catch all ascending and descending fry, then two fine wire screens should be placed across the stream, one, say, 20 to 50 rods above, and the other 20 to 50 rods below the point of distribution. In each of these screens there should be inserted a cylindrical wire fish-trap, funnel-shaped at one end and joined by a smaller cylindrical wire tube or sleeve to an opening in the central part of the screen, so that the trap can be removed and cleaned at pleasure. The screen and the trap should be carefully constructed so as to catch all ascending or descending fry, and thus discover how many fry migrate up or down stream.

The outstanding causes for the high mortality which was found in south-west Ontario seemed (1) warm, stagnant, or peaty water; (2) enemy fish eating the fry, as shown by finding fry or fingerlings in their stomachs; and (3) lack of sufficient natural food.

The results of the Board's experiments thus far are a severe condemnation, not of fish culture as a whole, but of the prevailing method of distributing fry in streams, namely, dumping them at any point most convenient to a highway or travelled road. They should be distributed with fair uniformity along the upper stretches of streams or along the margin of ponds where trout naturally lay their eggs, if they can find suitable spawning beds.

The experiments demonstrate, or at least indicate: (1) a loss of 98 per cent. of the fry (for the method of planting used and the streams investigated) during the first three months after distribution; (2) consequently a greatly increased cost of production per fry; (3) the necessity of a thorough examination as to the suitability of every stream or pond in which it is proposed to plant fry.

At present we are planting fry in the dark, and in some cases we are feeding them to coarse or useless fish.

A. P. KNIGHT
(Chairman, Biological Board of Canada).

Kingston, Ontario,
September 8.

"Bordered" Squares of Fifth Order and their Magic Derivatives.

FIG. 1 is an ordinary "Bordered" square consisting of a "Heart" (in the associated position, the three rows, three columns and two diagonals of which sum to 39) and a "Border" formed of complementary numbers (25·1, 24·2, 23·3, etc.). There are 26 such "Hearts" and 605 "Borders," and, including inversions of the "Borders" and reversions of the "Hearts," there are 174,240 squares of this type with one inversion that has a similar number. These "Hearts" can be in 21 positions in a square of fifth order, and altogether with these "Hearts" in all their positions, I have calculated that there are more than 649,000 squares of fifth order of this type of "Heart."

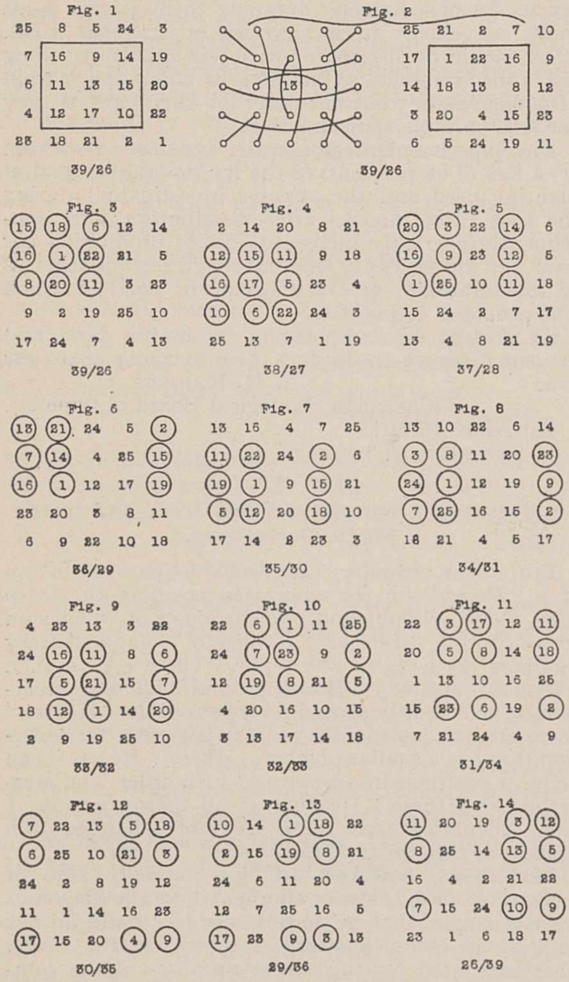
The above, however, are not the only kind of "Hearts." Fig. 2 shows another where the diagonals are not magic, that is, do not sum to 39 and do not have their complementary numbers in the heart. These are used for the corner numbers of the completed square. There are 135 such "Hearts" and 306 "Borders," giving a total of 88,128 squares with one inversion giving an equal amount. How many there are in the remaining 19 positions is quite unknown.

Fig. 3 shows still another kind of "Heart," where the diagonals are irregular and the number 13 is not in the "Heart." Thus the type of square of Figs. 1 and 2 is not feasible, but other positions of the "Heart" are practicable (see Fig. 3). There are only 12 such "Hearts" including the complementary "Heart," and the number of squares in all the different positions of the heart quite unknown.

So far in a square of fifth order, in a row or column the sum of the numbers of the "Heart" to the rest of the row or column has been as 39 : 26. But these are not the only proportions, and with certain exceptions all the proportions from 38 : 27 down to 26 : 39 can be made. The exceptions are 28 : 37 and 27 : 38, for which I have been unable to make "Hearts" under the conditions required. If in these squares each number be subtracted from 26, then the proportions

40 : 25 up to 52 : 13 can be obtained with the exceptions of 50 : 15 and 51 : 14 corresponding to 28 : 37 and 27 : 38. But none of these squares can be of the types of Figs. 1 and 2. The remaining figures give a square of these different proportions, and I have tried to illustrate some of the different possible positions of a heart in a square of fifth order.

Thus the number of "Bordered Squares and their



Derivatives" is very great, and if other known squares are included, such as pandiagonal squares, associated squares and their variations, rectangle squares, etc., the grand total of magic squares of fifth order, the 5 rows and 5 columns and 2 diagonals of which are magic, easily exceeds 1,000,000. I have accounted for more than a million myself, and that is without the many squares indicated above as unknown, the enumeration of which would be very laborious and intricate.

J. C. Burnett.

Barkston,
near Grantham, Lincs.

On the Spark Spectrum of Lithium.

In a letter to the editor of this journal (Nature, Feb. 7, 1925, p. 191) an account was given of a method for excitation of spark spectra, by which a vapour jet of the substance under examination is exposed to bombardment by electrons from an incandescent wire. During the development of the apparatus certain modifications were introduced with the result that a very intense source of light has been obtained. Under ordinary conditions the current through the discharge chamber is of the order of 1 amp. and can be maintained during several hours. It has furthermore been possible to work with this discharge apparatus in connexion with a vacuum spectrograph manufactured by Adam Hilger, Ltd., in such a way that no fluorite windows are introduced in the path of light.

With this apparatus the investigation of the spark spectrum of lithium described in the former note has been continued, and it has especially been possible to extend the classification of the spectrum denoted by Schüler as the doublet system of the Li II spectrum by inclusion of a number of further lines. Table I. gives a survey of the hitherto observed lines belonging to this system. The lines marked with an asterisk were not given in my former letter. An estimate of the intensities of the lines, as they appear on the plates, is added in brackets.

Table I.

5484·7 (8)	2s-2p	*2657·3 ($1\tfrac{1}{2}$)	3p-6s
4881·3 ($2\tfrac{1}{2}$)	3p-4s	*2605·1 ($1\tfrac{1}{2}$)	3p-6d
4671·8 ($3\tfrac{1}{2}$)	3d-4f	*2507·0 ($1\tfrac{1}{2}$)	3d-7f
4325·7 (3)	3p-4d	*2430·0 (1)	3p-7s
3684·1 (2)	3s-4p	*2402·3 (1)	3p-7d
3195·8 (3)	3d-5f	*2381·6 ($\tfrac{1}{2}$)	3d-8f
3155·4 (2)	3p-5s	*2330·0 ($\tfrac{1}{3}$)	3s-6p
3029·1 ($2\tfrac{1}{2}$)	3p-5d	*1653·3 (6)	2p-3s
2728·4 (2)	3d-6f	*1493·1 (4)	2p-3d
*2674·4 (2)	3s-5p	*1198·0 (5)	2s-3p

Table II.

2s = 134,033 (n^* = 1·810)	3d = 48,834 (n^* = 2·998)
3s = 55,318 (n^* = 2·817)	4d = 27,467 (n^* = 3·997)
4s = 30,097 (n^* = 3·819)	5d = 17,574 (n^* = 4·997)
5s = 18,895 (n^* = 4·820)	6d = 12,203 (n^* = 5·997)
6s = 12,957 (n^* = 5·820)	7d = 8,964 (n^* = 6·997)
7s = 9,438 (n^* = 6·819)	
2p = 115,806 (n^* = 1·947)	4f = 27,435 (n^* = 4·000)
3p = 50,578 (n^* = 2·946)	5f = 17,552 (n^* = 5·000)
4p = 28,182 (n^* = 3·946)	6f = 12,193 (n^* = 6·000)
5p = 17,938 (n^* = 4·946)	7f = 8,958 (n^* = 7·000)
6p = 12,413 (n^* = 5·946)	8f = 6,858 (n^* = 8·00)

In Table II. the scheme of terms corresponding to this spectrum has been given, together with the effective quantum numbers (n^*).

It will be seen that the conclusions drawn in the former letter regarding the doublet spectrum are at all points confirmed. As regards the singlet system of Li II a few further lines in the far ultraviolet have been observed, and at the same time it has been found that several of the lines marked with an interrogation sign in Table I. of my former letter are due to impurities. It is hoped in the near future to bring a more complete term scheme of this spectrum.

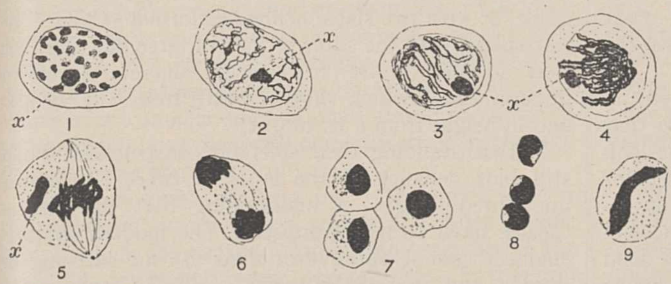
Sven Werner.

Universitetets Institut for teoretisk Fysik,
Copenhagen, September 10.

Spermatogenesis in a Spider (*Amaurobius sp.*).

At the suggestion of Prof. J. Brontë Gatenby, I recently made some preparations of spider's testis, in order, if possible, to test the accuracy of the observations described by Prof. Ernest Warren in a letter to Nature of September 12. In my preparations I have found many of the appearances figured by Prof. Warren. Fig. 1, probably corresponding to Prof. Warren's Fig. 3, is an early prophase of the first spermatocyte division; the clumps of chromatin are the first appearance of the chromosomes, and one clump (x), which is larger than the others, is presumably the sex chromosome. Fig. 2 shows a leptotene stage, Fig. 3 syndesis, and Fig. 4 a contraction figure in the diplotene stage. In all these, the sex chromosome can be easily distinguished, and in Fig. 5, which shows the chromosomes arranged on a normal spindle, the sex chromosome is seen lying apart in the cytoplasm. Fig. 6 shows the telophase of this division. The second spermatocyte division also appears to be normal.

There are, however, two kinds of spermatids; the larger, shown in Fig. 7, arises from the ordinary divisions described above, and gives rise to a normal spermatozoon; early phases of spermateleosis are shown in Figs. 7 and 9. The smaller type of spermatid has a very small amount of cytoplasm; these



apparently abnormal spermatids supposedly arise either by an extra division of the ordinary spermatids, or by degeneration of the normal forms. It is thus plain that in the spider examined by me the whole course of spermatogenesis corresponds with that known in the great majority of animals; there is no evidence of amitosis either in the spermatogonial or spermatocyte divisions. Abnormal spermatids are known to occur in many insects and molluscs, and occasionally occur also in mammals. In such cases, however, the testis is found to contain normal spermatozoa, which presumably are the agents in fertilisation.

S. D. KING.

Zoological Department,
Trinity College,
University of Dublin.

Birth-Control among the New Zealand Maori.

MAY I, as a New Zealander, make a few comments on Prof. J. S. Huxley's very valuable review of "The Ethics of Birth-Control" (NATURE, September 26, p. 455). Europeans have found it almost impossible to elicit definite information from the New Zealand Maori regarding methods of control, although we have known quite well that control of fertility was exercised, and abortion is prohibited by the Maori Sacred Legends. Very few Maori women have more than four children; many fewer than four. In ancient times there was a betrothal for about eight or ten years, during which time no children were born. This betrothal was really a trial marriage. At the age of from twenty-five to twenty-eight, formal marriage took place between the betrothed lovers or otherwise, and the married woman had as many children as she desired, and by whatever father she desired.

Race improvement was taught in the Sacred Legends, and it was regarded as the duty of every mother to have as fine a father as possible for her child. If she wanted to live with her husband but preferred some other man to become the father of her child, she might allege that this lover's spirit visited her. This was a recognised polite fiction. The husband might feel sorry his wife considered some other man a better potential father, but still he regarded himself as fortunate if his wife continued to love him and want him as her husband.

No man and no woman were allowed to reproduce unless passed as fit for reproduction by the Maori authorities; and before betrothal occurred there was medical examination of both parties by the parents of the young couple and by the doctors. Children were named by the community in accordance with their birth and form, and the girl-baby of a mother having difficult or abnormal childbirth was named in such a way as to indicate her unfitness for reproduction. Only the physically perfect men were permitted to become fathers, and no Maori woman would allow herself to bear children by other men than these. The Maori considered the father of more importance than the mother in the matter of race improvement. Even crippled women might be allowed to become mothers, but crippled fathers—never. Scarcely any really "unfit" babies were born, but should such an accident occur, the new-born unfit baby was given "The Peaceful Death." Marriages were generally for life, and polygamy was rare. There were usually more men than women in Maori communities. Sexual hygiene and control were exercised. Some of these practices I have detailed in "Safe Marriage" and "Sex and Exercise" (Heinemann's Medical Books); others will be detailed in "New Zealand Maori Sacred Legends," to be published shortly by Routledge and Kegan Paul.

ETTIE A. ROUT.

Choice of the Striking Point in the Pianoforte.

THE experiments dealing with the amplitudes of the partials from a struck string are many, and the conclusions are varied. For example, the experiments of W. H. George (*Phil. Mag.*, vol. 50, August 1925) show maxima at various points, and he arrives at the conclusion that the amplitude of the fundamental attains a maximum at a small distance from the bridge, while S. K. Dutta found that it attained a maximum at a distance of $l/9l$, where l = length of string. Again, Berry's conclusion is that forced vibration is a maximum at $l/9l$. Experiments made by me on the pianoforte have shown that the elasticity of the hammer must also be considered when calculating the duration of contact, which is of fundamental importance in the tone of the struck strings.

Recent experiments show that the amplitude of the fundamental and the octave, and the 2nd harmonic, are maximum when $T/\phi = 2$; T = period of vibration of the string, and ϕ = the duration of contact. Now ϕ depends upon the product of the striking distance and the mass of the hammer and its elasticity. The striking distance should not be very small, for then the resulting amplitude will be very small on account of the presence of the factor $\sin s\pi a/l$, where a = striking distance, and s is an integer. Secondly, it cannot be very large, for the reflection of the wave in presence of the load (hammer) would render the partials nonharmonic. Thus the striking distance must lie somewhere between $l/9l$ and $l/7l$. When a is fixed, the mass of the hammer and its elasticity are determinate. The best position of a is, however, obtained from the consideration of the note from the musical point of view.

R. N. GHOSH.

Physics Department,
Allahabad University,
Allahabad, India.

Practical Engineering in Ancient Rome.[1]

By THOMAS ASHBY, D.Litt.

THE Palatine, the nucleus of the City of Rome upon the Seven Hills, had great natural advantages of position; it was an almost flat-topped hill, with two distinct summits and a slight depression between them, protected by lofty cliffs, far more formidable than they seem at present, and almost entirely surrounded by two marshy valleys traversed by winding streams. Its neighbourhood to the Tiber enabled it to command the crossing, which, no doubt, existed in some form long before the foundation of Rome, probably just below the island, where the Pons Sublicius stood later. This crossing was of great importance, for it was the only permanent one over the whole lower course of the river.

Even in the palmiest days of Rome there were no bridges over the Tiber below the city, and those that there are now are all quite modern; while if we look upstream we find that above the city the only bridge for forty miles was that by which the Via Flaminia recrossed the river into Umbria just below Otricoli—and of that the last traces were obliterated by a flood some twenty years ago, which led to a complete change of course of the river. The traffic between the two banks was probably carried on by ferries, as at present.

Tradition ascribes the building of the Cloaca Maxima to a powerful race of foreign kings, the Tarquins, from the city of Tarquinii in southern Etruria. Little or nothing remains that belongs to the original structure; and indeed in the time of Plautus it was called *canalis*, and may have still been open at any rate for part of its course; for the whole this seems an almost impossibly insanitary supposition. We have, too, a number of branch drains which must have eventually led into it from the slopes of the Capitol—though conditions have been so altered that some of them now give into the open. I think they may be claimed as dating from the sixth or fifth century B.C., and as being thus by more than a century the earliest Roman arches in existence.

In this connexion I would recall that here we are dealing with a soft volcanic stone—the kind of tufa known as cappellaccio. When Appius Claudius built the Via Appia in 312 B.C., and his engineers had to build an embankment wall to carry the road along a hillside, we may see that, where they had to deal with the hard local limestone, they did not waste labour either in making a curved arch for the culvert, contenting themselves with inclining the sides gradually and then putting a lintel over, or in making the courses of the embankment wall horizontal.

The course of the Cloaca Maxima, as shown on the map, resembles, as Lanciani remarks, rather that of an Alpine torrent than of a carefully constructed drain; and its origin, from the canalisation of a stream meandering at the bottom of a flat valley, as the Tiber does at present, is sufficiently clear. The mouth of the Cloaca, with its three concentric arches of volcanic tufa, which may be assigned to 100 B.C. or a little before, was much more picturesque before the construction of the modern embankment. It is now a mere dummy, as the Cloaca itself, which still performs its functions, has been conducted into the new main sewer (the Collettore, as it is called) which runs just inside the embankment.

The Cloaca Maxima is a drain of considerable size, having an average measurement of 14 ft. high by 11 ft. wide, while the other two principal sewers of ancient Rome are rather smaller. Both these drains were built, like the Cloaca Maxima, of large rectangular blocks of stone, with a vaulted roof of the same material; and some of the minor drains were built in the same way, while others were covered with a flat block of stone, or with two slabs inclined to form a gable. This last shape, with the gable formed of large flat tiles, was that adopted in the brick-faced concrete sewers of imperial times, which vary in width from 2 ft. to 4 ft. and in height from 6 ft. to 9 ft.

Notwithstanding their splendid construction, which still bids defiance to the lapse of time, Lanciani is undoubtedly right in maintaining that the Roman Cloacæ have been overpraised. The modern sanitary engineer cannot approve of their use for carrying off sewage and rain-water together. Such contrivances as traps and syphons being unknown, the openings for the reception of the latter served to let out the effluvia from the former. Still more dangerous was the direct admission of sewage into the Tiber, which must have been odoriferous in the extreme when the water was low; while in times of flood the drains were dammed back, as was the case even in 1902.

In the time of the Republic the drainage system was under the general control of the censors, who let out contracts for the necessary constructions or repairs in this as in other classes of public works. They also had charge of the river banks and channel, and in 54 B.C. they erected a series of boundary stones (*cippi*) along both banks to prevent encroachment by private persons. Under Augustus in 8 B.C. the consuls of the year erected another series of terminal stones, and Augustus himself a third in 7-6 B.C.

Besides the erection of boundary stones, a good deal was done in the way of actual regulation of the river bank. There was no continuous embankment wall, as at present, but walls seem to have been built at the points where they were most needed. The Romans, at one point at any rate, at the Pons Aelius built by the Emperor Hadrian (the modern Ponte S. Angelo), were wise enough to provide three different widths of channel for different seasons of the year, in correspondence with which the bridge was provided with extra flood arches. The bridge was brought to light in its entirety in 1892, and it was found that, as originally constructed, it had three arches for low water, corresponding with a channel $66\frac{1}{2}$ metres wide. Two more slightly smaller arches were available when the river was moderately full, with a channel $97\frac{1}{2}$ metres wide. For great floods three smaller arches came into use, giving a total width of 135 metres to the stream. It was these three smaller arches and the bridge-heads characteristically sloping up on each side that were brought to light in 1892; and it is much to be regretted that it was impossible to preserve this remarkably perfect specimen of a Roman bridge.

[1] From the presidential address delivered at Southampton on August 28 before Section H (Anthropology) of the British Association.

From the consideration of the bridges of the city of Rome we naturally pass to that of the roads. The Via Appia, the queen of roads, as Statius calls it, was built as far as Capua in 312 B.C., and later on prolonged to Venusia (291 B.C.), Tarentum, and Brundusium (244 B.C.). It runs in a practically straight line from Rome to the Alban Hills. There it finds its first serious obstacle in the small extinct volcanic crater below Aricia, where Horace spent the night *hospitio modico,* not in the high-lying town, but at the post station below; and on the steep ascent from this post station it has, on the lower side of it, a massive embankment wall, about 200 yards in length. This, there is little doubt, is the *Pons Aricinus,* of which Juvenal speaks as being infested by beggars—like many another steep hill. The road soon reaches its summit level at Genzano, and descends once more in a straight line along the south-eastern slopes of the Alban Hills, passing at one point of its course over a smaller embankment, almost unknown to archæologists, and then, still perfectly straight, through the Pomptine Marshes.

Thence we arrive at Terracina. Above the town is the mountain, crowned by a temple of Jupiter Anxur, behind which the old road ran, keeping high above the sea, and descending again several miles farther on. Trajan is in all probability the author of the cutting at the foot of the isolated dolomitic mass of rock at the lowest extremity of the promontory, by which the road was enabled to pass round on the level. The height of the cutting is marked in splendid Roman numerals in swallow-tail tablets at frequent intervals.

After the two roads have rejoined, there is a flat stretch for some miles, with a number of ancient culverts and bridges, still used by the modern road; and then beyond Fondi the road enters the picturesque gorge of S. Andrea, where it is supported by massive embankment walls, well seen from the modern road, which has here abandoned the ancient line.

On the descent, in the modern village of Itri, we see the " Cyclopean " wall to which I have already directed attention, and shortly afterwards reach the Bay of Gaeta and Formiae, where Cicero had his villa. From this point onwards the road proceeded on the level. Just before the fine bridge over the Volturnus, it joined up with the Via Latina - Labicana, and crossed to Casilinum, the modern Capua. Shortly after the ancient Capua the road enters the mountains once more, and after passing through the famous defile of the Caudine Forks, we find three finely preserved ancient bridges, of which the modern road still makes use. They are probably assignable to the period of Trajan.

We soon reach Beneventum, beyond which the course of the ancient Via Appia is so doubtful that there is no question of there being any remains of great interest. We shall, therefore, do well to follow instead the Via Traiana, which Trajan built as an alternative route to Brindisi, following an older mule-track of which Strabo speaks.

The road passes through some difficult country with frequent ups and downs, and there are a number of bridges in concrete faced with fine brickwork, stonework being used sparingly, and then only at the base of the piers. These bridges are all 24 Roman feet wide, which is more than the usual standard width (14 feet) of the Via Appia and other Roman highroads—though even they widened out somewhat at the bridges. From the summit, about 3000 feet above sea-level, there is a long winding descent, the Buccola di Troia, to the city of Troia, the ancient Aecae, with its fine cathedral. Here we enter the *regna arida Dauni* and the plain of Apulia. The road crossed two rivers, the Cervaro and the Carapelle, both of which have changed their course, and so left their bridges high and dry in the fields. They are, from the great width of the valleys and the character of the streams, which are wide and shallow—in fact, almost dry except in times of flood, when they carry a great quantity of water—structures of great length. The first is about 280 metres in length, about half of which is accounted for by the bridge proper, a structure with at least fourteen arches, the principal one having a span of about fifteen metres. The second is much longer, beginning with a causeway 200 or 300 metres long; then follows the bridge proper, some 200 metres long, with about ten arches; and then follows a causeway about 250 metres long, with supporting buttresses on each side.

We may turn now to the Via Flaminia, the " great north road " of ancient Rome, built by Gaius Flaminius during his censorship in 220 B.C. The Via Flaminia, unlike the Via Appia and the Via Latina, is not able to maintain its straightness of line for very long after leaving the Tiber valley. It comes into some heavy country among the hills on the right bank, but the first really serious obstacle by which it is confronted is the valley of the river Treia, which is subject to violent floods, one of which, only four years ago, carried away the modern bridge just below Civita Castellana. The valley is about 1300 yards wide, and the drop in level to the bottom is about 250 feet on the south, while the ascent on the north is some 150 feet. The difficulties were considerable, but have been very well dealt with; and the causeways and bridge by which the Roman engineers took the road across the valley form a splendid monument of their skill.

After crossing the plateau to the north, the Via Flaminia descends to the valley of the Tiber, which is followed by the railway to Florence; and here we may see its parapets still preserved beside a modern road which has recently been constructed along its line. A few miles farther on, below Otricoli, it crossed the Tiber and entered Umbria, traversing a hilly district as far as Narni, perched on a lofty cliff above the river. Ascending through the town, it reached the famous Bridge of Augustus, one of the wonders of Italy even in the sixth century after Christ, as Procopius tells us. Of the four arches by which it crossed the stream, only one is now preserved. Many other ancient bridges are preserved along the course of the road. The only other important work of which I shall speak is the tunnel by which the passage of the road through the Furlo Pass is facilitated; the inscription recording its construction by Vespasian may still be seen above the entrance.

The aqueducts of ancient Rome are among its most celebrated monuments; but, conspicuous as are their remains within the city and in its immediate neighbourhood, less is known of them at a greater distance than might have been expected. I have myself been engaged in the study of them for more than twenty-five years, and hope shortly to be able to complete the work with which I have been occupied for so long.

For the present purpose, I shall confine my attention almost entirely to the four aqueducts which drew their supplies from the upper valley of the Anio, the Anio Vetus (272–269 B.C.), Marcia (144–140 B.C.), Claudia, and Anio Novus (both built by Caligula and Claudius, A.D. 38–52)—two of them, as their name implies, taking their water from the river itself; while the other two made use of excellent and very abundant springs which are for the most part conveyed to Rome by the modern Acqua Marcia, though a few of them still gush forth freely in pools which have a beautiful bluish tint (one of the springs was, indeed, known to the Romans as Caeruleus). These springs, indeed, as has been ascertained by the engineers of the modern aqueduct, come from holes in the roof of the original Roman headings. They rise under the rocks at the edge of the floor of the Anio valley, only a little way above the river-level, and come probably from huge reservoirs in the interior of the massif of Monte Autore, being supplied by percolation from a great basin about 1500 metres above sea-level, which is snow-clad for the greater part of the year. As the Roman headings lie some seven or eight metres below the present level of the valley, which has been much raised by floods, it seems useless to try to identify, as previous authors have done, the individual springs of which the Romans made use.

It will be convenient to follow the course of all the four aqueducts together, observing their principal remains as they occur. The Anio Novus originally drew its water from the river four miles above the springs of the Aqua Claudia, at the forty-second mile of the Via Sublacensis; but as the water was apt to become turbid, Trajan carried out a project of Nerva, according to which the three lakes used by Nero for the adornment of his villa above Subiaco were used as filtering tanks. This increased its length considerably, the new intake being some six or seven miles farther up. Considerable remains of the dam still exist on the way up to the far-famed monasteries; but the centre of it collapsed in a flood in 1305—as the story goes, partly owing to the malice or imprudence of some of the monks who began to tamper with it. Otherwise there are no remains of any particular interest until we reach the gorge of S. Cosimato, some fifteen miles farther down. It lies a couple of miles above Vicovaro, where the road from the valley of the Digentia and Horace's Sabine farm joins the main road down the Anio valley, the ancient Via Valeria.

From Vicovaro onwards, all the four aqueducts remain on the left bank of the Anio. The deep valleys of some of its tributary streams create considerable difficulties for the aqueducts, and great bridges were required to cross them.

Farther down, the Aqua Claudia and the Anio Novus leave the river valley, and reappear in a small valley leading southward to the Valle d' Empiglione, which is traversed by the road from Tivoli to Ciciliano and Genazzano. In this valley we find only one channel (where we should expect to find two), of rough concrete, belonging to the original construction, and measuring 1·20 metre wide and 2·60 or 2·70 metres in height—characteristic dimensions of the channel of the Anio Novus when running alone. It runs along the side of the valley, so that only one external wall is exposed, and this has later facing. The same difficulty presents itself when we reach the main Valle d' Empiglione, for whereas previous observers have supposed that the two aqueducts which are here visible can be assigned respectively to the Aqua Claudia and the Anio Novus, the line going south belonging to the construction of the tunnel under the Mons Aeflanus by Paquedius Festus in A.D. 88, mentioned in an inscription, careful investigation shows that they branch off from one another at the north edge of the valley, and that the south branch falls slightly more rapidly than the other.

The south branch is undoubtedly still attributable to Paquedius Festus, and the western to the main aqueduct; but the problem of the existence of one specus only (which confronts us again at Ponte degli Arci, though not after we have passed Tivoli) remains at present insoluble.

The level of the bottom of the specus, at the beginning of the existing arches going southward (the northern extremity of the aqueduct near the road has disappeared), is 248·57, and at the end of the bridge it has fallen to 248·17, or 40 cm. in 349 m., which represents a fall of 1 in 872·5, or 1·15 per 1000. On the western branch the levels are 249·91 at the beginning of the bridge, and 249·83 at the end, or 8 cm. in 156 m., *i.e.* 1 in 1950, or 0·51 per 1000. Both of these falls are below the average fall in the long stretch of arches between Capannelle (where the aqueducts emerge from their long underground course) and Rome, which varies from 3·22 to 0·96 per 1000. The general average is 2 per 1000, but there is much variation.

In the next valley to the south is the only instance known to me of the existence of an alternative channel on an aqueduct bridge, which perhaps was provided in order to allow of cleaning before the beginning of the long tunnel, in which it would naturally have been exceptionally difficult. The tunnel must be about 2¼ kilometres long, and the fall is 5·90 m. to the tank where the branch rejoins the main aqueduct, or 1 in 381, or 2·62 per 1000.

We must now return to the main line, which has a fine bridge, the so-called Ponte degli Arci, over a tributary of the Anio. The original bridge was a massive structure in *opus quadratum*, most of which has disappeared, though the impressions of the blocks are visible on the pier of the great brick arch on the south-west bank, and some of the masonry itself in the base of the last pier on the north-east bank. The brickwork with which the concrete of the greater part of the bridge is faced is, once more, Severan in character. When the aqueducts emerge on the hillside above Tivoli we find the four specus distinct from one another once more.

There is a very interesting point where from a reservoir of the Anio Novus a branch channel runs off, falling sharply (about 1 in 10), and supplying when required, by means of vertical shafts, the channels of the three lower aqueducts.

After passing the point of junction of the tunnel built by Paquedius Festus, the next feature of interest is the fine bridge known as the Ponte S. Antonio, which served to carry the Anio Novus across a deep and narrow valley. We may note here a right-angled turn, which often occurs, to break the speed of the water immediately before reaching the bridge. The channel is surprisingly narrow, being only 80 centimetres wide and about 3·12 metres high. The bridge was originally a massive structure in ashlar masonry of volcanic tufa, and the fine central arch, 32·30 metres in height and 10·40 in span, is still visible on the west side. The width was originally only 2·60 metres and the total length is about 120 metres.

In the next valley, that of the Mola di S. Gregorio, there is a long bridge of the Anio Vetus, which, however, is a construction of the time of Hadrian, itself restored later—the change of period occurs in the arch over the stream. The original channel ran underground up the north bank of the valley until it could pass under the stream, and then returned on the south bank, where its channel may still be seen. It is, after all, unlikely that in 270 B.C. the Romans would have constructed an aqueduct above-ground which could so easily have been cut by an enemy, and Augustus followed the older line in his reconstruction. The bridge has a rapid descent of 2·92 in 25·30 metres, or 1 in 8·66, or 116·5 per 1000, at the end (the only case known to me at the end of a bridge) into the newer channel, which is some six metres higher than the older channel, with which it seems to have no communication. It continues to run for some way along the valley before it turns at right angles to tunnel through the ridge separating it from the next one, that of Ponte Lupo. The bridge had a total length of about 165 metres (with a fall of 1·06 in the main portion of 136 metres, or 1 in 129, or 7·75 per 1000), and a maximum height of 24·50 ; it has two tiers of arches for the most part, though the last seven on the left bank originally had only one.

We now arrive at the valle of the Acqua Nera, which is crossed by the Ponte Lupo, the best-known and the largest of the aqueduct bridges in this district.

It has hitherto been believed—and Mr. Newton and I still held that view when the drawings were made—that it carried all the four aqueducts. Accurate levelling has shown that this is not the case, and that the Anio Novus and Claudia both pass under the floor of the valley considerably higher up. This, indeed, gives them a much better line than the devious course which they would have taken supposing they had passed over Ponte Lupo.

The upper channel is, therefore, that of the Aqua Marcia ; the fall from Ponte S. Pietro is 186·79-182·27, or 4·52 metres in about a kilometre, or perhaps more ; for the specus, as usual, runs along the side of both valleys for some way both before and after the tunnel through the ridge. But there is a problem in regard to the Anio Vetus. At the last shaft of the earlier channel in the Valle della Mola di S. Gregorio the intrados is 168·86 metres above sea-level, while at the last shaft of the newer channel, after the bridge which Hadrian built, the intrados is about 172 metres above sea-level ; the floor of the specus would be about 2·80 metres lower in each case. The level of the water of the Fosso dell' Acqua Nera is 155·19, and the bottom of the specus at the Ponte Taulella is 155·61. The distance between the last two points in a straight line would be not much over two kilometres ; but along the line of the aqueduct it should be 21,120 Roman feet, or more than 7 kilometres according to the *cippi*.

It is thus quite impossible that the Anio Vetus should not have been above-ground at the Acqua Nera, unless it was carried under it by a syphon. There is, about 17 metres below Ponte Lupo, on the right bank of the stream, a massive concrete buttress, faced with *opus reticulatum*, probably belonging to the time of Augustus, and containing a shaft, which, though blocked up, certainly seems as if it went down at least as far as the level of the stream, and might very well reach down to a channel passing under it.

The question why syphons were not made use of to take the aqueducts in a straight line (like the modern Acqua Marcia) across the Campagna from Tivoli to Rome (in which they would have come to intermediate levels considerably lower than that which they reach at Porta Maggiore), in order to avoid the long detour which we are now following, has been well answered by M. Germain de Montauzan in his book on the four Roman aqueducts of Lyon, in which no less than ten syphons have been observed. The Romans did not trust their concrete and cement for making syphons, though they might have done so. They were unable to make a large metal pipe that would stand pressure ; and at Lyon the contents of a channel 0·58 by 1·75 metre are transferred to nine or ten lead pipes with a bore of 0·20 when the syphon is reached. We have only to calculate the enormous quantities of lead that would have been required to take the water from four channels, the largest of which measured nearly 1·20 metre wide and 3 metres high, and to remember that small-bore pipes would have been choked almost at once by the heavy calcareous deposit, to realise how impossible it would have been to adopt this method here. On the other hand, all the building material required was quite easy to obtain on the spot or not far off. But there is no objection to its use in a rock-cut channel for a short distance ; and if we do not accept this view, we have to find a place for the specus of the Anio Vetus in the lower part of Ponte Lupo ; and a careful study of its construction and of the dating assigned to its various parts by Miss van Deman has shown me that this is by no means easy, though from the levels it is admissible.

Raffaelle Fabretti, one of the pioneers of the investigation of the aqueducts, whose work " De Aquis et Aquaeductibus Urbis Romae " was first published in 1680, marks the so-called Ponti Diruti as the last remains of the aqueducts visible towards Rome ; and, indeed, it was believed until a few years ago that they ran underground from this point to the well-known line of arches which begin at Capannelle. Even Prof. Lanciani had written of all the four that there were no traces from Cavamonte to Roma Vecchia and Capannelle respectively. But the casual discovery of a part of the channel of the Aqua Claudia on the farm road leading to the Casale della Pallavicina directed his attention to the possibility of discovering the course of the aqueducts in this district ; and he further suggested that the large amounts of calcareous deposits thrown out at the shafts (*putei*) which occur at frequent intervals in the subterranean course of the aqueducts were bound to reveal their course still further towards Rome, where they traverse the lower slopes of the Alban Hills. This proved to be the case ; and it has thus been possible to follow them from point to point in their gradual descent towards the plain, until they emerge between the Via Latina and the Via Appia.

In all this stretch, however, there were no complicated problems of engineering to be solved ; and we may therefore turn to the consideration of the remains of the aqueducts after their emergence. The arches of the Claudia and Anio Novus gradually increase in height from Capannelle to Roma Vecchia, until beyond it they reach their greatest elevation in this section, estimated by Lanciani at 27·41 metres. In this stretch they are extremely well preserved and have not required restoration to any considerable extent. The lower stone channel of the Claudia is surmounted by the concrete specus of the Anio Novus, faced with brick and *opus reticulatum*—an obvious afterthought, the detrimental effects of which we have already seen.

Further on, as we come nearer to the city, considerable reinforcements have become necessary. In many places the original stonework of the piers has been removed for building material, and Lanciani quotes the records of the sale of, *e.g.*, two or four peperino pillars by the Hospital of Sancta Sanctorum at the Lateran, to whom the ground belonged. But, as he also points out, sometimes the brickwork was removed and the stonework left; or, again, the brick facing is sometimes hammered away from the concrete.

The question as to the amount of water carried by the aqueducts depends upon the value given to the *quinaria*, the official unit of measure, explained by Frontinus, who, as *curator aquarum* under Trajan, wrote a treatise upon the aqueducts. The most probable value has recently been determined as 0·48 litre per second or 41·5 cubic metres in twenty-four hours; and we thus get the following table:

	Quinariae (Frontinus).	Litres per second.	Cubic metres per diem.
Anio Novus	4738	2274	196,627
Claudia	4607	2211	191,190
Marcia	4690	2251	194,365
Anio Vetus	4398	2111	182,517

There were no large clearing or settling tanks within the city, only comparatively small reservoirs (*castella*) from which distribution was made by lead pipes; and this is the case with the modern aqueducts also, so abundant is the supply.

The Romans, as we have seen, having at their disposal comparatively little theoretical knowledge of mechanics, they yet succeeded in achieving marvellous results, largely from their practical ability. They must have solved such problems as the transportation of an obelisk by the multiplicity of simple elements of traction employed and by the ingenuity displayed in their arrangement. When it is a question of sea transport, we cannot but admire the courage of those who succeeded in bringing such huge masses of stone through the Mediterranean from Egypt to Italy without the aid of steam — an even greater enterprise than dragging them along the land without the appliances that we now have at command. The study of practical engineering among the Romans shows us that in this, as in other spheres, they added very considerably to the sum of human achievement, and thus contributed in no small measure to make the condition of the human race what it is.

The Science Museum, South Kensington.

WORK has just been commenced on the eastern portion of the new Science Museum buildings in South Kensington, and by the spring of 1927 a handsome façade (Fig. 2) should have replaced the plastered brickwork which has stood on the west side of Exhibition Road since the War.

Behind this east face, however, much has already been done, and a series of galleries on each of the four floors have been completed during the past three years to replace the Western Galleries on the north side of Imperial Institute Road, which were transferred to the Imperial War Museum in 1922. With the completion of the eastern front, which includes four galleries facing Exhibition Road, the first portion of the new Science Museum buildings will have been provided, following the recommendations of Sir Hugh Bell's Committee of 1911.

This Committee recommended [1] that the existing buildings, which had been originally erected for the refreshment rooms of the Exhibition of 1862, should be replaced by three main blocks with connecting galleries, to be erected on the existing site and to extend ultimately from Exhibition Road to Queen's Gate between the Natural History Museum and the Imperial College of Science. The eastern block, which is now nearing completion, will provide 100,000 sq. ft. of exhibition space, and so much of the connecting galleries as are in use, though not completely finished,

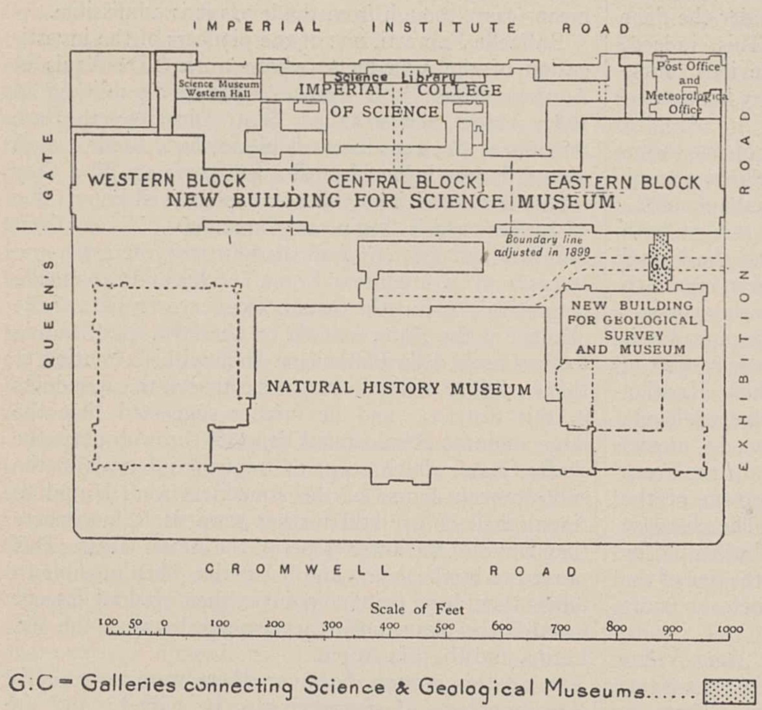


FIG. 1.—Plan of museum buildings, South Kensington.

[1] H.M. Stationery Office, Cd. 5625 and 6221, 1911, 1912.

brings the total up to 135,000 sq. ft., or about one-third more than was available in 1912; but since then it has been necessary to allot more than 20,000 sq. ft. to the aeronautical collection and to that which illustrates wireless telegraphy and telephony. Up to the present, therefore, the exhibition space which will shortly be available is only about half of what the Committee of 1911 considered to be immediately necessary, so that the construction of another block, to provide about 110,000 sq. ft., is already an urgent need, and this would bring the available accommodation about up to the Committee's recommendation; the old buildings which it would replace are constructed with wooden floors, staircases, etc., so that the risk of fire in them is great, and should a conflagration occur, practically nothing of the important naval and shipping collections which they now contain could be saved.

The provision of the third block, which will face Queen's Gate, would, in the opinion of the Committee, be needed later for the development of the collections or in consequence of an extension of the scope of the Museum, but not for several years.

For the present, the galleries in the eastern block which have been completed are being utilised to accommodate the collections which were exhibited in the galleries now occupied by the Imperial War Museum, that is, those illustrating physical science, mining and metallurgy, and some which have been long in store for lack of exhibition space; others have been moved there to allow more space for the aeronautical collection which is being developed rapidly. But in every case only a selection from each collection can be exhibited, since the space which is or shortly will be available is insufficient to do more than this.

The scope of the Science Museum as formulated by the Committee of 1911 is "to afford illustration and exposition of the various branches of Science within its field, and of their applications in the arts and industries," which is a very wide definition, as it includes the illustration of current practice as well as the preservation of objects of historical interest; so wide indeed is it that to develop the Museum on the lines of a storehouse of all that relates to advance in science and technical industry, would require accommodation far in excess of that which is likely to be available. The policy, therefore,[2] which has been adopted is to show for each group such a critically selected series of objects as will illustrate all important stages in the development of a group, and to exhibit also a number of examples to represent the current practice of to-day. But even this is difficult with the existing accommodation, and several groups are still inadequately represented.

In the series which illustrate historical development, examples of early mechanical and scientific apparatus which have been designed, constructed, or used by pioneers in various branches of science and technology are not only of great historical interest, but are also most stimulating to those who visit the Museum and study its collections. Among the more recent acquisitions several are of this kind, for example, the contents of James Watt's workshop, Henry Maudslay's screw-cutting lathe of 1810, Hughes' microphones of 1878, Prof. Fleming's thermionic valves (1889–1904), and early wireless apparatus lent by the Marconi Co. These and many others furnish starting-points of special interest from which history of the groups to which they belong can be studied.

FIG. 2.—The Science Museum, South Kensington, when completed.

In various parts of Great Britain there must be many other objects of a similar character which might be with advantage presented or lent to the Museum for exhibition, if only to guard against the risk of them passing into the hands of those who may be ignorant of their historical importance and may therefore dispose of them, when they are usually lost sight of. The historical value of what has already been lost to the history of science in this way is incalculable.

The present arrangement of the collections is only temporary, being determined by existing conditions, and by the need for exhibiting the science collections which have been for the most part stored during the past three years. When another block of the new

[2] Report on the Science Museum for the year 1923 H.M. Stationery Office, 1924.

buildings becomes available, more satisfactory arrangements can be made, and collections which can now only be shown in part will be more adequately represented.

The ground floor contains the more important objects illustrating prime movers, and locomotive engineering. Six early pumping and rotative engines of great historical interest are placed on either side of the main hall, the atmospheric engine from Pentrich Colliery (1791), the Old Bess pumping engine by Boulton and Watt (1777), and Heslop's beam engine (1795) on the left, with Boulton and Watt's rotative engines of 1788 and 1797, together with a rotative beam engine of about 1820 on the right. Models of the principal types of stationary engines occupy the wall cases, while others of windmills, water power installations, etc., are in the south gallery. Such internal combustion engines as are not shown in connexion with aeronautics or motor transport are also exhibited here. On the north side of the floor, the four early locomotives, the *Puffing Billy*, the *Agenoria*, the *Rocket*, and the *Sans Pareil*, are arranged down the centre of the north hall, with models of many other types of locomotives on either side (see Fig. 3). This gallery was originally designed for special exhibitions in which various groups would be shown more fully than could be done in the normal collections, but this use of it has to be postponed until the locomotives can be accommodated elsewhere. At the end of this hall is the reproduction of James Watt's attic workshop at Heathfield, Birmingham, showing all his machines, tools, etc., as they were at his death in 1819; its position within sight of three of the engines designed by him and built at Birmingham towards the end of the eighteenth century is especially appropriate.

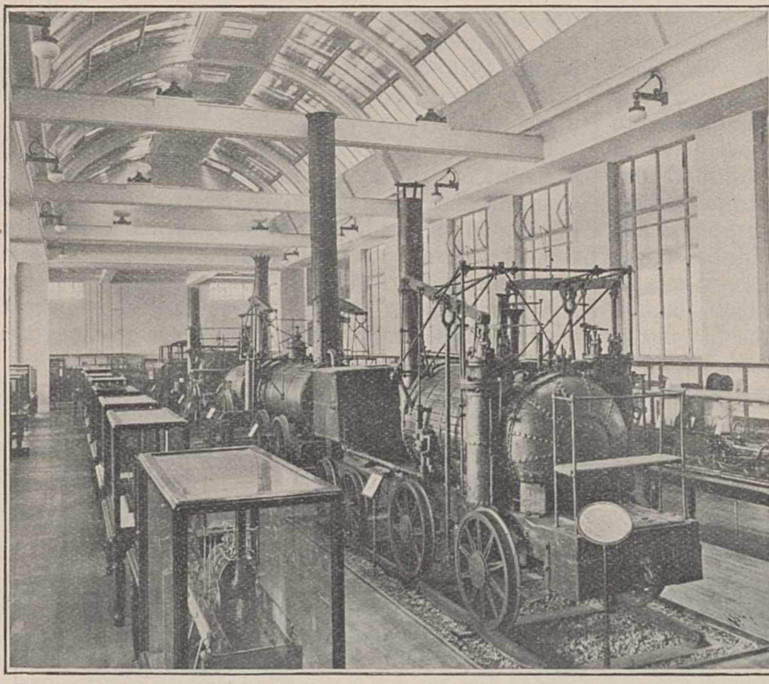


FIG. 3.—North hall, ground floor, Science Museum, South Kensington. Locomotive Collection.

The rest of the ground floor, the west gallery which is to connect the eastern with the centre block, contains part of the collection illustrating aeronautics. Here are models of the early machines of Henson and Stringfellow, Wright's aeroplane of 1908—the gliders of Lilienthal, Chanute, and Weiss, Maxim's flying machine and other objects illustrating the pioneer period of aviation. A collection of some fifty aeroplane models shows the strikingly rapid development of the heavier-than-air machine during the War, culminating in the Vickers-Vimy Rolls-Royce plane which was flown across the Atlantic by Sir John Alcock and Sir Arthur Brown in 1919. A large collection of aero-engines, many of them sectioned, is also shown here. The aeronautical collection has now extended into two adjoining rooms of the old buildings, where the structure of aircraft is illustrated; Roe's interesting triplane of 1907 is also here. Aeronautical instruments of all kinds are shown in the wall cases. The aeronautical collection includes that of the Imperial War Museum, which has been lent by the trustees of that institution, and the combined collections form an exhibit of air transport which is more complete and important than any other in existence; the full-size planes and some other of the larger exhibits have for the time being to be placed in the basement, where they are available to visitors, but it is hoped that later on the collection may be shown as a whole.

FIG. 4.—Centre gallery, first floor, Science Museum, South Kensington.

The first-floor galleries will before long be connected by a bridge with the new Geological Museum which is about to be built alongside the Science Museum to receive the collections which are now in Jermyn Street, and the Office of the Geological Survey. In these galleries, therefore, so much of the collections illustrating mining, ore-dressing, and metallurgy are being arranged as can be shown there (Fig. 4). The north gallery on this floor will contain the valuable collection of textile machinery which has been in store for several years. Tools and machine tools are shown in the western cross gallery, where the development of certain selected tools, such as the axe, drill, hammer, etc., from the times of the earliest civilisations to the present day, form interesting and instructive exhibits. In the gallery which connects this floor with the old buildings, the collections of electrical engineering and of telegraphy, telephony, and radio communication are being arranged.

The upper floors of the eastern block are being utilised for the exhibition of the collections of scientific apparatus, which were formerly in the galleries on the north side of Imperial Institute Road. Of these the following are being arranged on the second floor: mathematical, electrical, thermal, and acoustical instruments, while the north gallery will contain the geophysical collections of meteorology, seismology, gravity instruments, and terrestrial magnetism. In the western gallery, which will later on connect this floor with the centre block, will be the collection of pumps, and also that which illustrates engineering construction, and certain aspects of municipal engineering which are now being developed. On the third floor the collections of astronomical and optical instruments will be shown, as well as those illustrating geodesy, surveying, cartography, geography, and oceanography, so far as the space allows. The western gallery of this floor has been allotted to chemistry and industrial chemistry, and these collections are being actively developed.

The naval and marine collections will still remain in the old buildings (the southern galleries). Many additions have recently been made to these, especially in the section of boats and small craft. Mechanical road transport will shortly be arranged in the western hall near to the Imperial Institute Road entrance.

The great superiority of the new galleries in their arrangements, the lighting, and generally in the facilities for exhibiting the collections to the best advantage, will be apparent to every visitor. The wall cases do not extend to floor level but stop at a height of 2 ft. 6 in. from it and are carried up to a height of 7 ft. By this means the whole of the contents are comfortably within the visitor's view, and the ineffective display of objects at ground level is avoided (Fig. 4). Channels in the floors carry electricity, compressed air, and gas to all the galleries for use in the demonstration models, and the number of these which are shown in motion or which can be operated by the visitor is being largely increased. Seating accommodation for visitors has not been overlooked, and the need of students in this respect who may wish to examine objects in detail, and to make notes, has been met by placing portable stools in each gallery.

Obituary.

Sir Francis Darwin, F.R.S.

A SON who follows a famous father is apt generally to find himself in somewhat of the position of a sequel to a very popular romance, and that Francis Darwin stands prominently forth in the light of his own achievements is enough to show that in him we possessed a man of great distinction. Whilst he will probably remain best known as the author of his father's Life, much of his work in other lines has borne fruit. But to those who had the privilege of his friendship, he will always be a living memory on account of his very human personality, his great kindness of heart and ready sympathy, and his extraordinary personal modesty. The writer well remembers his astonishment, when first attending Darwin's lectures, at his frequent confessions of ignorance (shared, of course, even if not admitted, by all other physiologists) upon this or that point that was under consideration. This, though to-day a more common frame of mind, was less customary at that time, when the teacher usually strove to make a more or less completely rounded presentation of his subject, avoiding the unknown or the little understood so far as was conveniently possible.

Educated at Clapham Grammar School and at Trinity College, Cambridge, where he obtained a first class in the Natural Sciences Tripos, Darwin afterwards went to Würzburg to study under Sachs, as did so many of our most capable men at that time. He afterwards graduated in medicine, but never practised.

Francis Darwin's earliest published paper appeared in 1872, during the time of his medical study at St. George's Hospital. It was a conjoint paper with the prosector at the Zoological Society's Garden, describing the anatomy of an ostrich which died of copper poisoning through the ingestion of "two pennies and fifteen halfpence." Then followed in 1876 the publication of his M.B. thesis on the causation of vascular dilatation in acute inflammation, which records experiments carried out under Dr. E. Klein at the Brown Institute in London.

During the next few years Darwin worked at Down, where for eight years he acted as his father's secretary, and assisted him in much of his work. More especially was this the case in Charles Darwin's researches into the movements of plants, the well-known book upon this subject appearing in 1880 under the joint names of Charles and Francis Darwin. Two years later the latter was elected a fellow of the Royal Society, and when his father died in the following year he removed to Cambridge, where, except for occasional absences in London and elsewhere during recent years, he resided during the remainder of his life, at first in one of the houses of the well-known "Darwinery" on the Huntingdon Road, and afterwards at 10 Madingley Road.

University lecturer in botany from 1884 until 1888, and reader from 1888 until 1904, Francis Darwin had much to do with the complete reorganisation of the Botany School that then went on, especially when from 1892 until 1895 he was deputy for Prof. Babington. He devoted the stipend to the improvement of the teaching in various departments of the subject, while he himself gave his time to teaching and research in vegetable physiology. The results of his experience in this direction appear in the well-known manual of "Practical Physiology of Plants" by himself and the late E. H. Acton, published in 1904; and he also brought out a stimulating work upon the "Elements of Botany," designed for the medical course in elementary biology. Though not what would be called an eloquent lecturer, Darwin always aroused great interest in the subjects that he taught, and by his great kindness of heart, by his clear understanding of the difficulties of a student, and by the minute and painstaking care that he devoted to their explanation, he won the affectionate esteem of many generations of undergraduates.

During this period Darwin published his first paper on the transpiration of plants, and so entered the field which was to include his major experimental work. In this paper, with R. D. Phillips (1885), he introduced his own particular form of the potometer for measuring the rate of uptake of water by a cut shoot so expeditiously that several readings might be taken within a minute. In 1893 there followed an attractive piece of work upon the growth of large gourd fruits, recorded by a weighing mechanism designed by his brother Horace Darwin. This demonstrated the extent to which the fruit, on the plant, might actually lose weight when the leaves associated with it were transpiring water actively. In 1897 he described a quite new instrument—the horn hygroscope—for investigating the rate of transpiration from living leaves. This ingenious device made use of the strong curvature of a shaving of horn when one side is exposed to more humid air than the other. It can be applied to leaves on the plant with the minimum of disturbance; and Darwin's big paper of 1898, entitled "Observations on Stomata," contains an extensive study of the effect of external conditions on the rate of transpiration made with this hygroscope.

In 1911, in association with Miss D. F. M. Pertz, Darwin described yet another simple instrument for studying transpiration. His porometer measures, not the water vapour given off from the leaf, but the openness of the stomata, since it determines the rate at which air can be drawn through the pores of the stomata under a standard suction. It can be attached to leaves upon the plant; and it has been widely used by subsequent investigators.

The other field of physiology in which Darwin specialised may be considered as an extension of his early studies at Down on the movements of plants. He published a certain amount of experimental work in support of the localisation of sensitiveness to the factors producing curvature of growing organs, and he was a staunch exponent of the statolith theory of "geo-perception."

Darwin's greatest service to science, perhaps, was the "Life and Letters of Charles Darwin," a biography which may rank with the best that have ever been written. It gives the clearest possible picture of Charles Darwin as a man and as an enthusiastic student of science, tracing in a masterly way the gradual development of his views upon evolution and upon other subjects, while at the same time keeping the actual author of the work in the background, and leaving his character to be traced only from the general style, and the occasional references in letters. A continuation, or expansion, of this work was later published as "More Letters of Charles Darwin" by Francis Darwin and A. C. Seward.

President of the British Association at Dublin in 1908, Darwin devoted his address to the subjects of his own researches, especially bringing forward his since little accepted hypothesis of unconscious memory or habit in the development of plants and their movements. He received honorary degrees from his own University and also from St. Andrews, Dublin, Liverpool, Sheffield, Brussels, Upsala, and Prag. He served twice upon the Council of the Royal Society, and was its foreign secretary from 1903 until 1907, and vice-president 1907–8. He was knighted in 1913. A keen musician, and a kindly host with a strong sense of humour, Darwin was regarded with affectionate respect by great numbers of people.

Mr. F. J. Brodie.

Mr. F. J. Brodie, who entered the Meteorological Office in April 1869 and retired in December 1919, after fully fifty years' service, died on August 29 in his seventy-third year. He was principal forecaster for many years, and was essentially a forecaster of the old type, basing his predictions strictly on past experience, with a thorough grip of weather changes and their controlling features, whereas the present-day forecasters work on a somewhat more strictly scientific basis.

Mr. Brodie was for many years an active fellow of the Royal Meteorological Society, and he contributed numerous papers to the Quarterly Journal of the Society, dealing chiefly with fogs and gales; "Prevalence of Fog in London, 1871–1890," and "Prevalence of Gales over the British Isles, 1871–1900," being of especial importance. He was a prolific worker and writer, communicating regularly to *Symons's Meteorological Magazine*, now the *Meteorological Magazine* issued by the Air Ministry. He was the principal forecaster throughout the War, the period involving much responsibility, and the especial duties required were at times ill supplied with necessary meteorological data, and under such conditions Mr. Brodie's long training and experience were of the utmost value. He continued his official position until two years after the age limit. Mr. Brodie's health failed considerably during the last two or three years of his life. He was greatly respected by his colleagues, and many who were associated with him in the early days of the Meteorological Office, as well as those working with him in more recent years, can testify to his amiability of character and his willingness at all times to help forward the development and better understanding of meteorology.

We regret to announce the following deaths:

Prof. A. A. Friedmann, Director of the Central Geophysical Observatory of Russia, on September 16, aged thirty-seven years.

Prof. Andrew Gray, F.R.S., emeritus professor of natural philosophy in the University of Glasgow, on October 10, aged seventy-eight years.

Dr. C. F. Sonntag, prosector to the Zoological Society of London, on October 10, aged thirty-seven years.

Current Topics and Events.

THE City of Gloucester proposes to commemorate the achievements of Sir Charles Wheatstone, the practical founder of telegraphy, by placing a bronze memorial tablet on one of its public buildings. This will be unveiled by Sir Charles Sherrington, president of the Royal Society, on October 19, which is the fiftieth anniversary of Wheatstone's death. To electricians, Wheatstone will long be remembered as the perfecter of the "Wheatstone bridge" which they use in their everyday work. In 1867 he described the self-exciting, shunt wound dynamo. They remember him also as the pioneer of the electric telegraph. So far back as 1837, in conjunction with Sir William Cooke, he made the electrical transmission of messages an assured success. In 1844 he conducted some of the earliest experiments in submarine telegraphy. To physicists Wheatstone is well known by the use he made of a rotating mirror to detect whether an electric discharge was oscillatory or not. He made valuable researches in sound, particularly in connexion with Chladni's figures and for his experiments on the prismatic decomposition of the electric light. In 1837 he made the important discovery that sparks between metals gave distinctive spectra. Wheatstone had a marvellous gift for interpreting documents printed in cipher. He deciphered with apparently little difficulty an important document sent him by the Trustees of the British Museum. He invented the Wheatstone's cryptograph, which is one of the most successful devices for rapidly coding and decoding secret messages. The ordinary English concertina was invented and patented by him in 1829. He was a professor at King's College, London, for many years and bequeathed to it all his scientific library and apparatus. This bequest was added to by his family and also by the Physical Society of London. An article on his connexion with the growth of telegraphy was published in NATURE, vol. 11, p. 510 *et seq*. It is interesting to remember that Oliver Heaviside, whose death we had recently to deplore, was his nephew.

DR. ALEŠ HRDLIČKA in the course of his lecture on "Early Man" before the Royal Anthropological Institute (see NATURE, October 10, p. 557) expressed a fear that the important work on the fossil apes of the Siwalik Hills might not be continued. In a statement published in the *Times* of October 7, Dr. Pilgrim, director of the Geological Survey of India, stated that although the Geological Survey in a country like India must be subservient to economic requirements rather than to those of pure science, there is at present an exceptional opportunity for combining the two, owing to the discovery of oil in the fossiliferous deposits of the Punjab. This statement will reassure those in Great Britain who are interested in the advancement of science, as they have regarded recent developments in India with some apprehension, lest changing conditions may lead to a neglect of those branches of research in which immediate advantage is not always apparent. The danger of the neglect of opportunity which Dr. Hrdlička feared in India is also very real elsewhere. He referred to the material, possibly of priceless value to science, which is being lost beyond recovery in Java on the site of the discovery of *Pithecanthropus erectus*. According to information which has been received from Australia, the situation there also has some disquieting elements. It is stated that under recent regulations all skeletal remains of aborigines which may be discovered there have to be deposited in local museums. It is therefore impossible for specimens to be sent out of Australia for study by anthropologists elsewhere. This, though serious enough, might be regarded as a not entirely unreasonable requirement on the part of the Australian authorities if there were some assurance that these remains would be carefully preserved and stored, their provenance recorded, and that after careful study the data to be obtained from them were published and made accessible to other workers. Apparently, however, this is not the case. It is surely incumbent upon scientific workers in Australia to see that provision is made for this to be done. It should certainly be taken into account when an appointment is made to the recently founded chair of anthropology.

SOME interesting particulars have reached us of an exhibit which has been arranged in the new house at the Royal Botanic Gardens, Kew, for the display of plants of special interest. One portion of the exhibit shows various examples of phyllodes and phylloclades illustrated by different species of Acacias, which, instead of the normal leaves, have the leaf petiole flattened and leaf-like. The leaves proper are usually only seen in seedling plants, the green leaf-like organs of the mature plants being entirely flattened petioles. This condition of affairs is also exhibited by *Oxalis bupleurifolia*, and in this case the three normal leaflets may be seen at the tips of the phyllodes. In some other plants the leaf-like organs are flattened shoots, and these are illustrated by the common Butcher's Broom, *Ruscus aculeatus*, and by *Semele androgyna*. These phylloclades or flattened branches are also shown by species of Asparagus, Carmichælia and Phyllocladus. Other plants displayed in this house show examples of "parallel development" in plants belonging to unrelated natural families. Those which have assumed an Ericoid habit with leaves of a heath-like character are shown by a heath, by Fabiana, one of the Solanaceæ, by Gamolepis, one of the Compositæ, and by Calythrix, a member of the Myrtaceæ. Near these are placed some specimens with a cypress-like character of foliage illustrated by a Crassula and a New Zealand Veronica. The various Cactoid types of growth are shown by species of Pelargonium, Vitis, and Rhipsalis, one of the true Cactaceæ, while larger specimens are illustrated by one of the South African Euphorbias and one of the candelabra-like Cacti from Central America. The Cactoid habit is also shown by a Senecio, one of the Compositæ, and by an Asclepiad, *Stapelia hirsuta*. The spherical type of plant structure is exhibited by a South African

Euphorbia, *Euphorbia obesa*, and by representatives of South American Cacti.

In his address to the French Association for the Advancement of Science at Grenoble in July, the president, M. Emile Borel, dealt with the problem of the organisation of scientific research in France. Every one now recognises that the social progress of a nation depends on its use of the laws which facilitate the production of the means of living. A smaller band sees that the greatest material advances have been founded on discoveries made by research workers in fields which at the time seemed of little or no practical interest, and the problem of how to keep alive this type of research when democracy can only appreciate results which are immediate and material is a serious one. M. Borel considers it cannot be solved by allowing the academies and other institutions to determine the researches which are to be encouraged by the nation, or by providing national support for all research workers, but by placing in the hands of the academies, universities, institutions like the Association for the Advancement of Science, and of distinguished men of science, funds for the encouragement of young men who are willing to engage in research and are worthy of support. Some of these men would prove worthless, but M. Borel would apply to them the old axiom of law that " it is better to acquit ten guilty than to condemn one innocent." The address is reproduced in the issue of the *Revue Scientifique* for August 22.

In accordance with resolutions passed at a preliminary representative meeting, held at the suggestion of the Optical Society on July 21, arrangements to hold an Optical Convention in 1926 are now being made by the executive committee appointed for that purpose. Mr. F. Twyman has been elected chairman of the committee. The Convention, which will be entirely British in character, will be held in London about the middle of April next. Its activities will be directed towards providing a coherent presentation of the very notable advances which have been made in British optics during and since the War. Lectures, discussions, demonstrations and exhibits will be arranged, and it is intended that these shall be of such a nature as to appeal to professional men, to those engaged in industries, and to the general public. A record of the proceedings of the Convention will be published, in which will be included an account of the papers read and the discussions held, together with a description of the instruments exhibited. Although no general appeal for financial support has yet been issued, promises have already been made, by several members of the optical industry and by the Optical Society, to contribute to the Guarantee Fund sums which amount, in all, to more than 1000*l*. This may be taken as an indication of the interest that is being taken in the proposal, and suggests that adequate financial support for the Convention will be forthcoming.

An interesting feature of the September issue of the *Aeronautical Journal* is a paper by R. A. Frazer submitted for the R. 38 Memorial Prize Competition and awarded the prize. It is entitled " The Rigid Airship in Relation to Full-Scale Experiment " and deals not merely with the experimental methods that have been evolved specifically to cope with scientific experimentation on such a large scale, but also with many interesting historical details relating to early struggles to arouse interest in this form of investigation. The driving force, it would appear, behind much of this work in its initial stages was J. R. Pannell, one of the members of the staff of the National Physical Laboratory at Teddington, who lost his life in the R. 38 disaster over the River Humber. Among the equipment salved from the wreck were three note-books comprising all the entries made by the N.P.L. representatives, and a film registering the pressures over the upper rudder practically up to the moment of the disaster. From the material which came to hand in this way it was found possible to reconstruct the principal stages and episodes of this dramatic flight. The experimental observations proved sufficiently complete to admit of reduction, and these data, which cost so many valuable lives, are now on permanent record in a paper published by R. A. Frazer and H. M. Bateman, one of the survivors of the disaster.

It is a question how far the public in general is aware of the excellent work which is being done by the London County Council in stimulating the interest of its teachers in those scientific and artistic subjects which fall outside the scope of the ordinary curriculum, but are of incalculable value as a broadening influence on their intellectual outlook. Among the courses of lectures which have been arranged from time to time, the anthropological and biological courses given at the Horniman Museum, Forest Hill, which is maintained by the Council, have been particularly useful. This museum has been arranged especially with a view to the instructional value of its exhibits, and an excellent series of handbooks has been compiled by the curator, Dr. H. S. Harrison. These are written on thoroughly sound and scientific lines, but at the same time are not too technical to be of assistance to those whose scientific knowledge has not reached a very advanced stage. The latest issue in this series deals with the cases in the museum illustrating simple means of travel and transport by land and water (Horniman Museum, Forest Hill, S.E., No. 14, 1925, price 6*d*.). As the museum is liberally supplied with models, Dr. Harrison has been able to cover the subject adequately from the simple application of man or woman power by means of the headband or pack to the various types of wheeled transport, and from the skin canoe to the sailing ship.

Capt. Eckersley recently broadcast the main results arrived at by the International Radio Conference which has just been held at Geneva. The results of the tests made in September proved conclusively that Europe has too many broadcasting stations. This is mainly due to the narrow limits of the wave band (300 to 500 metres) that has been allotted by the European governments for broadcasting purposes. As government, maritime and commercial radio services must be considered, it is unlikely that longer wave-lengths will ever be permitted. The majority of the experts therefore were in favour of reducing the number of broadcasting stations. To accomplish this, every nation must be prepared to sacrifice some of its stations. A few well-designed high-power stations will probably give better results than many low-opwer stations. If this were done the crystal set users would get a better service. It can be so arranged that these high-power stations cannot interfere with one another. An objection might be raised that certain towns would lose their broadcasting status and that the programmes they receive would have little local colour. This difficulty might be overcome by retaining the local studios in those towns and allowing them to give regular programmes by means of land lines to whatever station had charge of their district. The new scheme, which begins on November 1, will only come into operation gradually. It was absolutely necessary to attempt to mitigate the troubles caused by interference which would have caused a chaotic state of affairs during the coming winter. Details of the scheme will be announced as they are finally arranged by the permanent staff at Geneva. New stations outside the scheme will be given wave-lengths below 200. The new Dublin station, which will begin operations this year, was fortunate to be allotted a wave-length in the regular broadcasting wave-band.

A CIRCULAR issued by the Bureau of Standards, Washington (No. 276), contains a useful survey of progress in the design of motor headlights. Tests conducted by various committees have led to the conclusion that for modern driving it must be possible to see any substantial object on the road 200 feet away. This involves a powerful beam and inevitably some degree of dazzle to approaching persons. The most hopeful solution lies in the scientific control of the beam, and various optical devices for limiting it below a horizontal plane 30 to 40 inches above the roadway are described. In addition it is desirable to spread the beam laterally so as to show up the limits of the roadway. Various dimming devices, involving diminution of the light, have not proved very satisfactory. Methods of controlling the beam are more hopeful, *e.g.* devices for tilting the headlight or reflector so as to direct the beam downwards when approaching another car. The same result is obtained in some modern headlights by the use of either of two filaments within the same bulb, one out of focus. In the final portion of the circular, requirements for headlights are summarised, and the method of testing in the Bureau of Standards laboratory is described. These tests are based mainly on specifying candle-power in various directions with the view of ensuring a sufficient beam for driving, and at the same time limiting emission of light in undesirable directions.

A SUMMARY of the past season's work at Knossos is given by Sir Arthur Evans in the *Times* of October 9. In the course of completing the reconstitution of the west wing of the Palace, a series of discoveries of exceptional interest throw a new light on the entrance system from the west and at the same time link up its processional scheme of decoration with the religious functions of the Palace Sanctuary. According to the earliest planning, belonging to the great building preceding and partly incorporated in the Palace we know, the entrance had run in directly from the west instead of from the south as in the later building. This West Porch was itself preceded by an earlier structure giving into a corridor, of which the side walls have been traced. In a void where the old foundations had been grubbed up were found stucco fragments which had been torn from the wall. These fragments showed a decoration of painted groups of seated female figures engaged at their toilet. It has been suggested that the decoration of the later corridor, which replaced this earlier passage after the greater part of the Middle Palace had been destroyed by earthquake, represented not only processional votaries bringing in gifts to the goddess, but also acolytes carrying out relics from the inner sanctuary for public exhibition in the presence of the "Priest-King." This has received unexpected support from a discovery in the South Propylæum which has brought to light a subterranean depository choked with debris and pottery of the last Middle Minoan period. Abundant remains of painted stucco show that its interior had been decorated in a deep Venetian red ground with ochre bands grained with ruddy brown to imitate woodwork. This Sacristy within the Propylæum may have been the sanctuary from which the sacred vessels were taken out to be borne in procession. Remains of brilliantly polished stone plaques with marble-like surface indicate the splendour of the Early Palace entrance which it was attempted to reproduce in the Later Palace in stucco.

IN 1875 the Bradford Naturalists' Society, now the Bradford Natural History and Microscopical Association, and also the Bradford Scientific Association were formed in Bradford. With varying fortunes both societies have continued active in the cause of natural history and of science, and on September 25 and 26 they joined in the celebration of their jubilee. The Lord Mayor honoured the two societies by a civic reception at the Cartwright Hall on September 25, and on September 26 a most successful exhibit and demonstration of the scientific work of the members was held at the Technical College in Bradford. Under the title of "Fifty Years of Local Science" an interesting account of the work of the two societies has been published under the joint editorship of H. J. M. Maltby and W. P. Winter, which includes brief notes of many stalwart Yorkshire workers in the cause of natural history, notably the late William West, whose influence upon natural history, radiating from his classes at the Technical College at Bradford, will long remain a living force in the development of clubs of Yorkshire field naturalists.

WE much regret to learn that Prof. H. Maxwell-Lefroy, professor of entomology, Imperial College of Science and Technology, South Kensington, was rendered unconscious by fumes while experimenting with insecticides in his laboratory on October 10 and was taken to hospital in a serious condition. In answer to an inquiry at the moment of going to press, it was stated that he was still unconscious and his condition remained grave.

MEMBERS of the staff of Rothamsted Experimental Station, Harpenden, Herts., are available for lectures during the winter to farmers' unions, chambers of agriculture, agricultural societies and similar bodies. No charges are made, but associations are expected to defray the lecturer's expenses. The subjects for lectures are included under such general titles as manuring, soil micro-organisms, weeds, chemistry of manuring and crop production, soil physics, insecticides and fungicides, insect pests, bees, and plant diseases. Communications regarding the lectures should be addressed to the secretary of the Station.

THE annual exhibition of electrical, optical, and other physical apparatus arranged by the Physical Society of London and the Optical Society is to be held on January 5-7, at the Imperial College of Science and Technology, South Kensington. In addition to the usual display by instrument makers, the exhibition this year will include new features in the shape of illustrations of recent physical research and of improvements in laboratory practice, examples of effective lecture experiments and repetitions of historical experiments in physics. These exhibits will be kept distinct from the trade exhibits, and a section of the catalogue will be devoted to them. Offers of such exhibits should be sent to the secretary of the Physical Society at the Imperial College of Science not later than November 16. The new development will afford an opportunity for the interchange of ideas between research workers and teachers, and will also be of service in bringing the latter into touch with recent advances in physical science. The repetition of historical experiments will be of interest not only to teachers but also to the general public, who will be admitted to the exhibition on January 7. This is another novel feature, admission to the exhibition in previous years having been confined almost entirely to scientific workers.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An assistant lecturer in agriculture at the Farm Institute, Sparsholt, near Winchester—The Director of Education, The Castle, Winchester (October 26). A demonstrator in inorganic chemistry in the University of Leeds—The Registrar (October 26). A lecturer in the department of chemistry of the University of Cape Town—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (October 27). A professor of botany in the Rhodes University College, Grahamstown — The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (November 4). Assistant-Secretary to the Royal Society of Arts—The Secretary, John Street, Adelphi, W.C.2 (November 7). An editorial assistant under the British Non-Ferrous Metals Research Association, for abstracting and reviewing British and foreign scientific and technical publications and for editing and interpreting research reports—The Secretary, B.N.F.M.R.A., 71 Temple Row, Birmingham. Two male junior assistants in the research department, Woolwich, for computing work in connexion with ballistic observations—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

ANOTHER FAINT NOVA IN AQUILA?—Prof. Max Wolf recently detected a star of magnitude 8·7 in Aquila, which was absent both from the Bonn Durchmusterung and from numerous photographs taken in recent years at Königstuhl, which show stars down to magnitude 12 or 13. It has been in the neighbourhood of mag. 8·7 for about three weeks, and was observed on Oct. 3 by Mr. B. M. Peek at Bournemouth and on Oct. 5 by Mr. G. Merton at Blackheath. Its place for 1925·0 is R.A. $19^h\ 27^m\ 24{\cdot}7^s$, S. Decl. $6°\ 35'\ 10''$. It is either a Nova or a remarkable variable, and in either case deserves careful observation. The object souths at about 6 P.M., so it will be possible to follow it for at least two months before it gets too near the sun for observation.

BRIGHT METEORS.—Mr. W. F. Denning writes that, on the evening of October 6, meteors were rather abundant though fog prevailed and the gibbous moon was up during the latter part of the observation. Meteors are often plentiful in the first week of October, several minor showers of moderate richness being of annual recurrence at this period. A few bright meteors were among those recorded on October 6 at Bristol, namely, one at $19^h\ 39^m$ G.M.T., equal to Jupiter, passing upwards just under Cassiopeia from a radiant at $14° + 31°$ or $12° + 7°$; another at $21^h\ 0^m$ G.M.T. falling in the S.E. sky rather slowly from $18° + 14°$ to $33° - 10°$. This was brighter than Venus and probably directed from a radiant in Cygnus, Cepheus, or Draco. A third at $21^h\ 56^m$, about equal to Jupiter, shooting from near β Ursæ Minoris to between α and β Ursæ Majoris. If one or more of these objects were noticed at other places, it would be interesting to hear of any details of their apparent paths which would enable their actual courses to be computed.

ORBIT COMPUTING.—There is at present a dearth of readily accessible books in English that give full details of the rather difficult but fascinating problem of orbit computing. Students of celestial dynamics will therefore welcome the paper on this subject by Mr. G. Merton (Monthly Notices of Royal Astronomical Society, June 1925). The method described is based on that of Gauss, but full use is made of various improvements introduced since his time, including some by Mr. Merton himself. Special attention is given to rapid convergence, a point in which many of the older methods are defective, and to the avoiding of all unnecessary repetition after the first approximation to the geocentric distance is obtained. In particular, the parallax is eliminated in a less clumsy manner than that of Gauss's *locus fictus*. There are two fully worked out numerical examples, elliptical orbits being illustrated by the case of Baade's planet 1924 TD (lately named Ganymede) and parabolic ones by Orkisz's comet 1925 II. Some tables are appended to the paper, which avoid the necessity of consulting any other work, except a table of logarithms and the Nautical Almanac for the sun's co-ordinates.

Research Items.

CARVED STONES IN ASSAM.—In vol. 20, New Series, No. 5 of the Journal and Proceedings of the Asiatic Society of Bengal, Dr. J. H. Hutton gives some further notes on two groups of carved menhirs in Assam, one at Dimapur in the Dhansiri Valley and another, which is scarcely known, at Kasomari-pathar near Jamuguri in the Dayang Valley. Adjacent to the latter are remains, previously undescribed, consisting of a couple of carved stones and a broad upright slab surrounded by the remains of a brick wall. One of the stones is carved into a hollow like a basin. Outside its rim is a trough ending in a spout. The second, an oblong stone, is carved into a wedge-shaped trough. The upright slab, at the foot of which a hollow has been excavated, is broken at the top at a point originally pierced by two round holes. As the basin must have been connected with a libation ceremony, it is possible that an offering was poured through the two holes as is done by the Angami to-day in the *lisü* ceremony at which wooden phallic symbols, corresponding to the monoliths at Dimapur, are erected. The Kasomari monoliths presumably are also phallic, or connected with fertility, as is shown by two pairs of domes on one stone which undoubtedly represent breasts.

ABORIGINAL ROCK PAINTINGS AND CARVINGS IN AUSTRALIA.—In the course of an account of the aborigines of the Northern Flinders Ranges, Southern Australia, in Vol. 3, No. 1 of the Records of the South Australian Museum, Messrs. Herbert M. Hale and Norman B. Tindale describe some interesting rock paintings in a former native camping ground at Malkaia, six miles south-east from Mount Serle, and a series of rock carvings at Owicandana on a number of outcrops of sedimentary rock. The former, of which the designs sometimes recall those of the carvings, are on a cliff overhanging a shelf and forming a shelter, of which the walls are blackened with smoke from the occupants' fires. The paintings are in pipeclay, charcoal, and red and yellow ochre. The designs consist of perpendicular bars with branches, or crossing bars, a bird track, a meandering pattern possibly representing a snake, a figure which Basedow elsewhere identified as a pubic tassel, a boomerang, etc. The rock carvings are similar to those which have been described by Basedow in other localities in South Australia. They are covered with a hard dark rust-coloured patina and some have been smoothed by age. The present natives are unacquainted with their purpose or meaning. In the main they consist of "corroboree circles," incomplete circles, a few emu and other tracks, and some unidentified designs. Some, the circles for example, are formed by a number of closely connected indentations, possibly made with a stone chisel; others of inferior technique and possibly made with a cold chisel, look like comparatively recent, sporadic attempts to copy ancestral work.

FUNDAMENTAL WORK UPON THE COTTON HAIR.—It is very striking to note that the development of fundamental research in the newly formed Research Association dealing with commercial fibres, be they wool, flax, or cotton, leads the investigators back to study their problems in terms of their fundamental biologic unit. This is again exemplified in the study of the mercerisation of the cotton hair without tension by Mary Alexandra Calvert and Frederick Summers, which has recently been published from the British Cotton Industry Research Association (Journal of the Textile Institute, vol. 16, pp. T233 to T268, August 1925). These investigators have shown how regular is the change of width of the single hair during swelling upon mercerisation, in a number of typical cottons, and how fully this change can be accounted for in terms of the change from collapsed dry hair to a hair with swollen elliptical section, contracted in length and with lumen nearly filled by the swollen wall. Further, they show that no additional change in width can be produced by increasing the concentration of sodium hydroxide beyond about 16 per cent., and that the maximum width then obtained is identical with the width of the original hair as it existed in the fruit boll, contraction occurring as the boll opens and the hair dries. They show in addition that the reason for this limit to increase in girth must be sought in the cuticle, which fails to extend beyond its original dimensions in spite of the pressure of the swelling cellulose within. When the width of this mercerised hair afterwards shrinks, without change in the shape of the cross-section, as the hair is washed in water and then dried, this inextensible cuticle smoothly follows the contraction, and the authors have some very interesting suggestions as to the minute structure of the cuticle in the light of its behaviour. These suggestions are accompanied by some very good microphotographs. In fact, this study in a field of applied science is a botanical contribution of absorbing interest.

AN AUTHENTIC BUD VARIATION IN POTATO.—So recently as 1918 so experienced a plant breeder as Mr. A. Sutton expressed the view that "there is no ground for believing nature ever has given rise to any new and distinct variety of potato by bud-variation." The point at issue is of first-rate importance, both scientifically and from the practical point of view, and it is therefore very interesting to have Mr. R. N. Salaman's confirmation, as the result of extensive breeding experiments, of Mr. McKelvie's original view that he had found an authentic bud sport turning up in the case of the Arran Victory potato. Thus sponsored, this bud sport, or somatic mutation, deserves the most serious consideration. Actually a series of such sports has been under observation, the obvious point attracting attention to them being the suppression of patches of the purple coloration in the skin, leading ultimately to a form with white tubers with occasional patches of colour, or, in the extreme form, tubers with a pure white skin. Most of the forms thus arising produce plants with vegetative form and foliage indistinguishable from Arran Victory; but one remarkable mutant has definitely a different growth form and different shaped leaflets, a point noticed by McKelvie and completely confirmed by Salaman. This same mutant also shows the tuber form altering in a large majority of its produce from the typical round tuber of Arran Victory towards a typical "kidney." Mr. Salaman has carried out crossing experiments with these bud mutations, with the result that the loss of pigment in the tuber appears to be accompanied *pari passu* with a reduction in the number of ovules capable of giving rise to coloured tubers. Thus it appears that a change arising in a vegetative shoot and propagated in the first place vegetatively, a change presumably in the genes controlling colour formation in the tuber but, in one mutant form at least, associated with other far-reaching changes in the constitution of the plant, has been associated with changes in the genetic constitution of the germ cells. Mr. R. N. Salaman describes his breeding experiments in the *Journal of Genetics* (vol. 15, No. 3, July 1925), his final conclusion being that "A somatic mutation which is characterised by the loss of a specific character such as pigmentation of the tuber skin, may evince this loss in other directions both in its own body and, through its germ cells, in its offspring."

MOVEMENT OF SAND CAYS.—A short report on the movement of sand cays on the Great Barrier Reef under the influence of atmospheric conditions is contributed to the *Queensland Geographical Journal*, vol. 39, by Lieut. T. Taylor, and forms one of the Great Barrier Reef committee's reports. Beaver Cay, on a small coral reef about 20 miles from Dunk Island, was used as a triangulation station in 1921. In 1922 the position was found to have moved. The position of the new mark was fixed, and after an interval of two months, during which high winds prevailed, was redetermined. Again it was found that the cay had moved. In short, there seems to be no doubt that this cay, as well as another three miles distant, moved approximately 100 yards in less than two years. The paper is accompanied by a chart of the reef and cays.

THE COMPTON EFFECT.—When γ-radiation falls on matter it is "scattered," that is, sent off in directions which make angles θ with its direction on incidence, and the scattered radiation is "softer," that is, more readily absorbed, than the incident. Two years ago Compton came to the conclusion that the scattering was accompanied by an increase of wave-length of the radiation which for a range from 0·7 to 0·025 Ångström units was equal to $0{\cdot}048 \sin^2(\theta/2)$. He also gave an expression for the intensity of the scattered radiation in the direction θ which involved the term $1 + \cos^2\theta$, basing his work on the quantum theory. In the issue of the *Physikalische Zeitschrift* for July 21, Dr. G. Wentzel discusses the experimental results obtained up to the present time and the alternative theories which have been proposed to explain them, and comes to the conclusion that the Compton theory is most in harmony with the facts.

CONTACT ELECTRIFICATION OF SNOW.—A series of experiments on this subject and some measurements are described by Dr. A. Stäger in the *Annalen der Physik* for August. When hoar frost is blown away from an ice surface by dust-free air, it is negatively charged, one gram carrying on the average −180 electrostatic units, and in exceptional cases −1000 units. An experiment at the Hahnenmoos Pass in the Bernese Oberland, with icicles about 20 cm. long and 1 cm. thick suspended by silk threads attached to the two ends, showed that when they were hung in the drifting snow near the ground, and then brought into contact with a Lutz electrometer, deflexions of more than 56 volts were generally obtained, the charge being negative; when they were hung in the finer drifting snow one or two metres above the ground, the charge was generally positive and smaller than before. It was found that an iron wire, 9 metres long and 0·3 mm. thick, could be raised to a potential of several thousand volts by driving snow, and could give a continuous current for several seconds with about 3 watts power. The method used by the author in measuring the space charge during snowfalls is described, together with experiments with solid carbon dioxide and with different powders, in some of which luminous effects are obtained similar to those which have been observed in clouds of street dust. The experiments are used to explain winter thunderstorms, and the connexion of sleet and hail with ordinary thunderstorms where the ice effect, in addition to that due to liquid water, contributes to the production of electric charges.

RESISTANCE TO CORROSION OF ELECTROPLATED CHROMIUM.—Mr. F. A. Ollard read a paper on this subject before Section B (Chemistry) of the British Association, at the recent meeting at Southampton. Two series of tests were described, one made in the laboratory and the other in service. The laboratory tests were made on test pieces cut from a strip of mild steel, which were then plated with cadmium, nickel, copper and chromium and combinations of these metals in various orders. The test pieces were then subjected to an exposure test, boiler test, salt spray test, and heat test, and the results noted. The most satisfactory results were shown by the test pieces which had been plated first with nickel and then with a thin layer of chromium. Test pieces plated first with cadmium and then with chromium showed a tendency for the chromium to flake off, and all test pieces containing cadmium failed badly under the influence of heat. The nickel-plated specimens usually showed a certain amount of surface corrosion, while the specimens in which the chromium was plated directly on to the steel usually failed owing to the coating being somewhat porous. Contrary to expectations, the chromium stood fairly well in the salt spray. The second series of tests were made by placing chromium-plated articles in service. Spoons, forks, and knives were treated by this process and used in various places under very heavy conditions, and these remained bright and untarnished without any cleaning. Also, some small parts on motor-cars, etc., had been plated and are standing very well, although sufficient time has not yet elapsed to give any definite results. A pin in a die-casting mould has also been treated and appears to withstand the action of the molten metal very satisfactorily. It is hoped to do a considerable amount of further work on this subject, and among the experiments to be tried are the effects of sea water and the variation of reflective power with ageing.

TUNGSTEN IN CONSTRUCTIONAL STEELS.—R.D. Report, No. 65, from the Research Department, Woolwich, gives an account of an investigation carried out by Mr. J. A. Jones on "The Influence of Tungsten on the Properties of Medium Carbon Steels containing Nickel and Chromium." The carbon varied from 0·3 to 0·4 per cent., nickel from 2·5 to 5·9 per cent., chromium from 0·6 to 1·1 per cent., and tungsten from 0·7 to 2·4 per cent. The thermal critical ranges, microstructure, and mechanical properties of a number of these alloys have been examined. The principal results are that in steels of otherwise identical composition increasing tungsten raises very slightly the temperature of Ac_1. The rise amounts to about 8° C. for the addition of 1 per cent. of tungsten. This element behaves like other alloying elements in increasing the efficiency on hardening at the slower rates of cooling such as are involved in the heat treatment of large masses. Its effect in this direction is most pronounced when added to nickel steels containing about 6 per cent. of nickel. Addition of tungsten also reduces the fall of hardening produced by tempering. The carbon-tungsten steels containing up to 1·7 per cent. of tungsten, and the 3·5 per cent. nickel-tungsten steels containing less than 1·5 per cent. of tungsten, with a carbon content of 0·3 per cent., did not give sufficiently good mechanical properties to be considered as high tensile constructional steels. Remarkably good properties are, however, given by the 6 per cent. nickel steel containing 0·3 per cent. of carbon and 0·6 per cent. of tungsten. The steel giving the most promise of useful application was a steel with 6 per cent. of nickel and from 0·6 to 1·0 per cent. of tungsten. The author's final conclusion is that while tungsten, in common with other alloying elements, beneficially affects the properties of constructional steels, there is nothing so distinctive in its influence as to warrant any special recommendations in its favour.

The Evolution and Colonisation of Tidal Lands.

THE joint discussion on "The Evolution and Colonisation of Tidal Lands" between the Sections of Botany and Geography during the British Association meeting at Southampton was opened by Prof. F. W. Oliver, who spoke of the raw materials that go to the making of tidal lands, namely, shingle, sand, and fine silt, and of the transport of these by tide, currents, and wind. Plants can only become established on tidal lands during periods of quiescence. Vegetation thereon arises almost entirely from sea-borne seeds, the sea also bringing drift which in time enriches the ground with humus. Plants as they become established collect and hold silt and blown sand, and are, therefore, in effect creative. In the case of sand dunes, the conditions were traced which lead to permanence. The parts played by *Agropyrum junceum* and *Psamma arenaria* in the building of dunes were discussed, it being pointed out that the latter was liable to be killed when invaded by abnormally high tides for some hours. Gales of 60-70 miles an hour stimulated the formation of dunes owing to the consolidation of the sand by wind force. Salt marshes differ markedly in type according to the nature of the ground, being either sandy or slushy or consisting of firm mud. Their proper development requires the concurrence of a number of plants at each successive phase. Reference was made to the almost unique capacity of *Spartina Townsendii* to occupy the softest muds and to spread rapidly on them. Its efficiency in such ground is comparable to that of marram grass in sand and *Suæda fruticosa* in shingle.

The possibilities of artificial control of the shore line by appropriate planting and conservation of plants were alluded to, and the possibility of consequent injury to navigation pointed out. Extensive mud flats are the natural "hinterland" of a system of tidal creeks or channels, and if the level of these muds be unduly raised by the silting action of halophytes, by so much is the volume of tidal water that can enter a harbour reduced. In the absence of sufficient water to scour out the channels at later stages in the ebb, they are always liable to become shallow and ultimately choked.

Prof. J. W. Gregory laid stress on the fact that although deposition by rivers and currents in the formation of tidal lands was of vast importance, coast erosion was also accompanied largely by the deposition of the matter thus set free. This deposition took place rapidly in sheltered positions. Sedimentation was much more rapid and complete in salt water than in fresh. Thus the transport of the products of erosion was restricted, and sedimentation in protected places along the coast was easy. Three processes are involved in the deposition of such tidal lands; first, the formation of a sand bar; second, the formation of a spit of longshore drift; and third, the deposition of plains in quieter waters behind the bar or spit. The development of these features on the British coasts was illustrated by reference to the records, from Roman times onwards, of the mouth of the Humber and other rivers. Mention was also made of the occurrence of similar phenomena on the coasts of Australia and Burma. In conclusion it was pointed out that the conditions controlling tidal-land formation at the present time were probably similar to those under which the great coal fields of the world had originated.

Prof. R. H. Yapp dealt particularly with the colonisation of the mud flats in the Dovey estuary in Wales. The vegetation succession Salicornia → Glyceria → Armeria → Festuca was described. In the early stages vertical accretion of silt is rapid, but the rate decreases as age advances. Stress was laid on the efficiency of the dominant plants as silt-binders. Sun-cracks, even during prolonged drought, rarely appear on such surfaces covered with vegetation, except in the earlier phases of colonisation when roots are few and binding less complete. Erosion resulting in the undercutting of the margins of the marsh and of the numerous drainage "pans" was described step by step. The rate of retrogression due to such erosion is slow compared with the rate of the various constructive forces leading to the increase of tidal lands.

Dr. Vaughan Cornish pointed out that little attention had been given to the importance of the ebb and flow tides in the formation of tidal lands. This was mainly due to the difficulty of observation. He described the interplay of ebb and flow tides in the passage of detritus, and held that the beach is stroked intermittently in one direction only, that of the flood tide. In this connexion it is important for local authorities and coastal engineers to examine carefully the movements of detritus at the turn of the tides.

Lord Montagu of Beaulieu spoke of his contact with the work of Prof. Oliver, and of his firm belief that only by the co-operation of local authorities with trained botanists could the problems of coast protection be dealt with adequately. His own experiments on reclamation were referred to with the object of dispelling the belief that easy and quick returns from grass crops could be secured by enclosing and draining salt marshes. He stated that Spartina sometimes acted indirectly as a denuding force, owing to the current being concentrated into narrower channels through the growth of the grass. This led to the falling in of the banks in consequence of undermining.

Dr. E. J. Salisbury described chiefly the ecological changes occurring in sand dunes with increasing age. There is a gradual diminution of calcium carbonate as the dune gets older, owing to the accumulation of carbon dioxide through the action of micro-organisms leading to a rise in the hydrogen-ion concentration. This is correlated with changes in the types of plants found on the dunes at different ages. Whereas the pioneer plants of the dunes are "lime-loving," several chalk down plants being commonly found, the character of the vegetation gradually changes until the old dunes are covered with plants characteristic of acid soils, such as heather.

Natural Mental Tests.

NATURAL mental tests are defined, in a pamphlet recently received, by Mr. Arthur MacDonald, of Washington, as "studies of man which have for their object an estimate of him with reference to his reputation, education, and culture, and also with regard to the things he has done, the results he has accomplished . . ., in short, his mental products." Thus a study of the occurrence in a group or community of men of genius or talent, those who are noted for literary, scientific, or any other educational achievement, forms a test of the mentality of that group. Such a series of natural tests is of considerable anthropological significance. By means of them we compare the effects of various conditions and environments upon the mental status of the average man, who is the representative of the community. Mr. MacDonald has brought together the data from a number of studies of man's mentality which, though not designed for that purpose, form such a series.

Mental ability has been found to resemble the physical properties of man in range and distribution; it conforms to the normal curve of distribution. Thus among a representative group, the proportion of successful men is about the same as that of morons and individuals of low-grade intelligence; and the proportion of men of great talent and genius the same as that of idiots and imbeciles. The range of intelligence above the normal ordinary man is as great as the range below.

In general, men of outstanding ability obtain a great reputation among their contemporaries; so that we are enabled to compare the varying occurrences of men of genius and of talent by means of their reputations. The number of such occurrences varies chronologically, with nationality and geographical situation, with social origin and parentage, and with degree of education. Finally, there are various types of genius and talent which occur in fairly constant proportions among different communities.

Not much reliance can perhaps be placed upon data dealing with the number of eminent men who have lived in the various centuries and decades of our history; for the spread of publicity and the improved means of communication are likely to give an advantage to more recent periods of time. It is interesting to note, however, that while men of talent increase in number up to recent years in Great Britain and in the United States of America, the largest number in France lived in the seventeenth century.

When we turn to a comparison of the number of great men of science in various countries, however, we do not find any advantage resting with the English-speaking races. Ever since 1750 Switzerland has had the largest number of associates of foreign Royal Societies; Holland has sunk from second place to tenth, Germany has risen from low down to third, and France is high throughout. England is about sixth, and the United States about tenth throughout. In Great Britain itself, the Nordic races have a great advantage as regards men of genius. England and Scotland much out-top Ireland and Wales—a fact which is fairly generally recognised.

Coming to the influence of social origin and environment, we find that it is the great middle class, the commercial and professional group, the "neither poor nor wealthy," which produces the bulk of talent and genius both literary and scientific. In France and in the United States also, it is the urban rather than the rural districts which have the advantage in this respect. This is probably connected with the superiority of educational opportunity in the former, for naturally we find more talent among educated than uneducated persons; 80 per cent. of a group of distinguished American men of letters had received at least a high-school education, while 98 per cent. of a group of talented French men of letters were well educated.

Dividing men of genius into men of letters, sciences, arts, and action, we find that in all countries the greatest number of men of genius are men of letters, especially in France and Germany. Men of action come next in all countries except Germany, where there are more men of arts and sciences with genius. In most countries the arts have the advantage of the sciences.

These conclusions probably need the support of more statistical evidence to become firmly established, and to show clearly their bearing upon one another. They nevertheless form the introduction to a number of interesting problems connected with variation of mentality in man.

M. D. VERNON.

Bergens Museum.

ON April 25 Bergens Museum celebrated its centenary by a festival to which representatives of Norwegian, Danish, Finnish, Icelandic, and Swedish institutions were invited, and by the publication of a handsome volume, which permits the friends of the museum in other countries to share the interest and to offer congratulations to their colleagues of Bergen. In 1900 a complete history down to that date was published by Dr. J. Brunchorst. The present work records the remarkable expansion during the succeeding quarter of a century, and the fruition of ideas that germinated in the bygone decades.

Bergens Museum has never been content to remain a mere storehouse and exhibition. It has been a centre of scientific research and of the publication of the results to all classes. The museum itself has so grown that it has occupied three successive buildings. To the last of these, two wings were added about 1900, and an entirely new building for the history of culture now approaches completion. The museum also has a separate laboratory and a modern biological station, and is about to erect a building for its geophysical institute. It possesses a seismological station, a bio-chemical laboratory, and a botanical laboratory.

The two serial publications of the museum—the yearbook for researches and *Naturen* for popularisation—are widely known. Among many separate publications, "An Account of the Crustacea of Norway" by Dr. G. O. Sars stands pre-eminent. To the printed word is added the spoken. Not only are there popular lectures, but there have also arisen regular schools in zoology, botany, and geology, with the right of examining their students for public posts.

Thus we arrive at the goal of the museum's activities, its incorporation—which cannot much longer be delayed—as the University of Bergen. Already its staff of 25 men of science includes 8 recognised professors. The ideas that had been gaining ground since 1892 were set on a broader basis in 1915. Plans were prepared and funds solicited. The intention was first to establish faculties of natural science and of medicine based on the museum and such medical institutions as exist in Bergen. Unfortunately the hard times have rendered it impossible to have these two faculties at work in the centenary year; but the course of future development is marked out and will undoubtedly be followed so soon as the economic situation permits. Many a university has founded a museum of high rank; but we do not remember a museum that, beginning as a private institution in a single school-room, has so determinedly used its energies for the highest and widest ends of learning as to blossom into a university for which a prosperous future is assured.

In its earlier years men of the highest scientific distinction were connected with Bergens Museum, such as D. C. Danielssen, Herman Friele, Fridtjof Nansen, G. Gustafson, A. Appellof, and Jørgen Brunchorst. A welcome feature of the present volume are the portraits and brief biographies of those who have served the institution during the present century. Into the hands of the present staff the future of Bergens Museum and Bergens University may be entrusted with confidence.

F. A. B.

The Tensile Properties of Single Iron Crystals.

AT the autumn meeting of the Iron and Steel Institute held in Birmingham on September 9–11, Prof. C. A. Edwards and Mr. L. B. Pfeil presented a continuation of their work on the subject of the tensile properties of single iron crystals. Eighteen months ago, they succeeded in preparing some large iron crystals by the method of straining and heating introduced by Carpenter and Elam. The

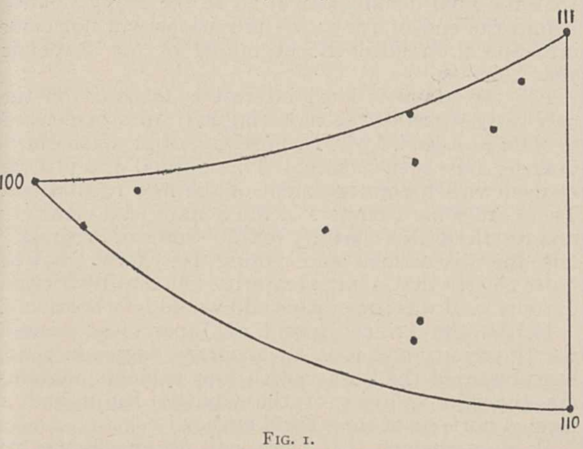


FIG. 1.

large crystals described in the present paper were prepared by this method, although some small modifications have been introduced which allow them to be made with greater certainty. This method consists, briefly, in so treating the original mild steel sheets as to obtain a grain size of 120 per square mm. Suitable strips were decarburised at 875° C. for 48 hours, heated to 1000° C. for 12 hours, and finally slowly cooled. In this way a number of strips 8 in. × $1\frac{1}{2}$ in. × $\frac{1}{8}$ in. were obtained, each strip consisting of one large crystal in the central part. In all cases it was necessary to remove the surface film of fine crystals by carefully filing before the existence of the large crystals could be detected by light etching. Test-pieces were cut from these with the aid of a manganese templet. This ensured that they were all of the same size and minimised the risk of bending of the metal, which is very soft. The test-pieces were 2·5 in. × 0·75 in. × 0·110 in.

The stress elongation curves obtained show that up to about two tons per square inch the strain was proportional to the stress, and further that there was no well-defined yield point. In this respect, therefore, single crystals of iron behaved quite differently from the ordinary microcrystalline metal, which has a well-defined yield point and approximated much more nearly to a non-ferrous metal such as copper. Later on in the paper the authors give a diagram showing the gradual development of a yield point in this iron as the size of the crystals is diminished and crystal boundaries come more and more into play. It may, therefore, be concluded that this very characteristic property of microcrystalline iron is due in some way to the influence of the crystal boundaries. The limits of proportionality of ten crystals were determined and were found to vary from 1·72 to 2·52 tons per square inch, with a mean figure of 2·19. It is possible, however, that these values are too high, since the filing of the specimens will in all probability have caused some work hardening of the metal. The limit of proportionality of microcrystalline iron is about eight tons per square inch, so that the values for single crystals are little more than a quarter of this and may possibly be even less.

Tensile strength determinations were carried out on 25 crystals. Eighteen of these give figures in the neighbourhood of 10 tons per square inch. The corresponding figure for microcrystalline iron is about 20 tons, so that the tenacity of the single crystal in more than two-thirds of the test-pieces is only about half that of the metal in the ordinary form. In the remaining 7 single crystal test-pieces, however, the values varied from 11 to, in one case, 15·38. In this case, therefore, the tenacity of the single crystal was fully three-quarters that of the microcrystalline metal. This figure, however, is well below the highest figure for single crystals of aluminium obtained by Carpenter and Elam, namely, 90 per cent. of the tenacity of the microcrystalline metal. It is interesting to notice that, on the whole, the single crystals possessing the highest tenacity were also the most ductile. Figures varying from 30 to 53 per cent. were obtained. Corresponding to these differences of tenacity and ductility, the crystals distorted in different ways during the tests. The majority of test-pieces broke similarly to type II. of the aluminium crystals described by Carpenter and Elam; that is, the crystals retained their width but diminished in thickness. At the fracture they drew down to a knife edge and parted in a straight line nearly at right angles to the axis of the test-piece. Crystals which gave a higher tenacity and ductility both narrowed and thinned and showed a marked tendency for the cross section to change from a rectangle to a parallelogram (Carpenter and Elam, type IV.). At the point of fracture they necked and broke without drawing to a knife edge. Just before parting a large slip occurred on a plane making an angle of 45° with the length of the strip and with a "dip" of 45°. The crystal which broke at 15·38 tons per square inch gave a fracture different from the two types mentioned. It narrowed, thinned, and also necked.

Prof. Edwards and Mr. Pfeil have not as yet been able to determine the orientation of these crystals.

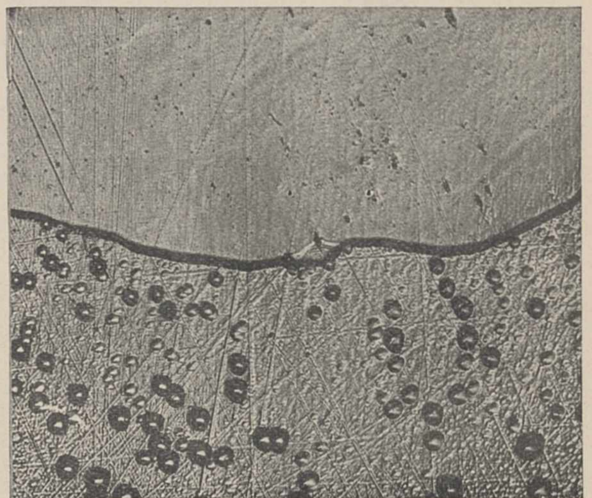


FIG. 2.

It is tolerably certain that the differences in tenacity, ductility, and method of distortion correspond to differences of original orientation of the crystals and of the method of distortion. The authors state definitely that the orientations of twelve crystals examined by them were not identical, basing this opinion on an examination under oblique illumination, and they speculate as to how it is that equal tensile strength values can be associated with variations in orientation. It is important to point out, however, that they do not yet know whether an iron crystal during a tension test slips upon a dodecahedral plane or cube plane, or indeed upon either of these. This work has still to be done.

A beginning, however, has been made by Miss Elam, who contributed a note at the same meeting entitled "The Orientation of Crystals Produced by Heating Strained Iron." In their previous paper, Prof. Edwards and Mr. Pfeil had stated that square etching pits were frequently obtained with a diagonal in the direction of straining, and concluded from this and other observations that the crystals were similarly oriented. Miss Elam has examined several of their single crystals by X-ray methods, and the crystal axes relative to the axis of the strip of ten crystals have been determined. Some of them have been done by her and the remainder by Mr. R. W. Aston at the Cavendish Laboratory, Cambridge. The accompanying diagram (Fig. 1) represents part of the stereographic projection of the crystal axes with the positions of all the axes of the test-pieces, and hence the direction of straining, marked by a point. The relation of each point to the three principal crystal axes, *i.e.* the apices of the spherical triangle marked (100), (110), and (111), indicates the orientation of the crystal. This diagram shows that the points are scattered throughout the triangle and that the orientation of the crystals is consequently very varied.

Only two crystals showed cubic etching pits, and in both of these the surface of the strip was parallel to a cubic (100) plane in the crystal. These pits were quickly developed by etching in dilute nitric acid, whereas the other crystals appeared unattacked. When first formed the pits were rather indefinite-shaped pyramids, but on prolonged etching they became square. Crystals of other orientations showed pitting only on prolonged etching, and although the form varied from crystal to crystal, the pits had no regular shapes. Fig. 2 shows two crystals. The lower one is deeply pitted and has a cube face nearly in the plane of section. The upper one is not pitted and is attacked to a less extent although more uniformly. X-ray examination showed that the plane of the section was approximately a (112) plane. Miss Elam's experiments show, therefore, that the single crystals produced by Messrs. Edwards and Pfeil have not necessarily the same orientation, and that it should be possible to pick out those in which a (100) plane lies in or near the plane of section.

H. C. H. C.

University and Educational Intelligence.

ABERDEEN.—Kilgour research scholarships have been awarded to Miss E. H. M. Geddes (botany), and to Miss I. Dean and Mr. A. H. H. Fraser (zoology).

The University Court has appointed the following assistants: botany, Mr. N. J. G. Smith and Dr. R. Crookall; materia medica, Mr. T. J. C. Macdonald; pathology, Mr. J. Gray; zoology, Nita I. Rennet.

BIRMINGHAM.—At a meeting of the Council of the University on October 7, the following appointments were made: Dr. W. C. Osman Hill to be demonstrator of anatomy; Miss H. I. Pfister to be lecturer in physiology; and Mr. J. F. D. Shrewsbury to be lecturer in bacteriology.

The foundations of the new buildings for the biological departments having been completed, work has been begun on the superstructure. The new building for the oil-mining departments is nearing completion.

CAMBRIDGE.—Dr. A. C. Seward, master of Downing College and professor of botany, has entered on his second year of office as vice-chancellor.

The Cambridge University Commissioners are considering their draft of the new statutes; it is expected that it will be published before the term divides and that the final document will go to the Privy Council before the end of 1925; its provisions will not come into operation until the beginning of the academic year 1926–27.

For the moment local interest is focussed on the new restrictions of the motoring activities of persons *in statu pupillari*. Mr. D. Portway, of St. Catherine's College, has been nominated as special pro-proctor to deal with the enforcement of the new regulations. There are some members of the Senate who view any new restrictions as contrary to the "Spirit of Progress," but the discussions and voting last term showed quite clearly that a large majority felt that restriction of some kind was imperative and would be wholesome.

H.I.H. the Prince Regent of Japan, who visited the University and took an honorary degree in 1921, has presented the library with four cabinets containing the 666 volumes of the Gunsho Ruiju and a framed portrait of their blind author.

It is announced that there will be an election to an Isaac Newton Studentship (for research in astronomy or physical optics) early in the present term.

THE third annual report of the Imperial College of Tropical Agriculture, for the year ended December 31, 1924, has just been issued, and is a very satisfactory and interesting document. At the close of the year there were eighteen diploma students and fourteen post-graduates working at the College. As there were only six post-graduates on the register at the beginning of the year, the increase of this type of student is very satisfactory. The College is still hampered by lack of adequate funds for the completion and equipment of its new buildings and laboratories, and for the building of a hostel, which is so desirable an addition to the College for the proper accommodation of the students. As a result of the appeal for 100,000*l*. made by the late Lord Milner, 21,083*l*. were contributed during the past year, and this sum has been slightly augmented since the report was published. The report records the laying of the foundation stone of the new building of the College on January 14, 1924, at which several members of the Governing Body were present, including Sir Arthur Shipley, the chairman. Reference is also made to the death of Mr. Claude Tinné Berthon, honorary consulting engineer to the College, who not only designed and superintended the erection of the Instructional Sugar Factory, but was also largely responsible for securing gifts of machinery and plant from the British Sugar Machinery Manufacturers and allied firms to the value of upwards of 20,000*l*. towards its equipment. The year under review was also marked by the retirement of Sir Francis Watts, the first principal of the College, who had been Imperial Commissioner of Agriculture for the West Indies for twenty-four years. Sir Francis, in recognition of his services, was appointed, on his retirement, to the honorary position of Principal Emeritus of the College. The report also records the appointment of Dr. Hugh Martin Leake, formerly principal of the Agricultural College, Cawnpore, to be principal of the College in succession to Sir Francis Watts.

Societies and Academies.

CAMBRIDGE.

Philosophical Society, July 20.—Sir J. J. **Thomson**: The structure of light.—A. S. **Eddington**: Internal constitution of the stars.—H. **Nagaoka**: The transmutation of mercury into gold.—W. **Burnside**: On groups of linear substitutions which contain irreducible meta-cyclical subgroups.—S. **Pollard**: On Hausdorff's proof of the extended Riesz-Fischer theorem.—M. H. A. **Newman**: On the theorem of Pappus.—C. G. **Darwin**: Notes on optical constants.—R. de L. **Kronig**: The theory of the influence of magnetic fields on the stopping power of gases for α-particles.—J. T. **Saunders**: The trichocysts of paramecium.—V. **Nath**: Spermatogenesis of *Lithobius forficatus*.—H. Munro **Fox**: The effect of light on the vertical movement of aquatic organisms.—E. C. **Francis**: (1) On differentiation with respect to a function. (2) The Lebesgue-Stieltjes integral.—D. H. **Black**: The β-ray spectrum of the natural L-radiation from radium B.

PARIS.

Academy of Sciences, August 24.—C. **Sauvageau**: The presence of free iodine in *Polysiphonia Doubletii*. A definite proof is given that iodine in the free state is present in this plant.—L. **Escande**: Similitude extended to high velocities. Supplementary researches on the similitude of viscous fluids.—R. de **Mallemann**: The calculation of the rotatory power of a tetrahedral molecule. It is concluded that the existence of rotatory power, in an asymmetric molecule, is not incompatible with optical isotropy of the atoms.—— **Agafonoff** and Mlle. **Malichef**: Some considerations on the lower loess of the neighbourhood of Paris.—J. **Cabannes** and J. **Dufay**: Measurement of the height of the ozone layer in the atmosphere. The assumption is made that the ozone layer is so high that the sunlight is first filtered by the ozone and then diffused by the lower layers of the atmosphere. The heights deduced are about 50 kilometres.—— **Bordas, François-Dainville**, and **Roussel**: The elimination of benzoic acid and the benzoates in the body economy. In six out of seven cases, the complete elimination of benzoic acid took three days, and it is concluded that the continuous administration of benzoates, as when used as a food preservative, might, owing to accumulation in the body, give rise to serious troubles.—— **Paillot**: The *grasserie* of the silkworm. This disease causes the most serious losses in the silkworm industry, and has been more prevalent in 1925 than in the preceding years. There is no certain cure for the disease, but some precautions are detailed which reduce the chances of infection.

August 31.—André **Blondel**: A modification of Lord Rayleigh's photometric method, rendering possible the use of a diffusing comparison surface in photometry.—Michel **Akimoff**: Confluent hypergeometric functions.—Nicola **Obrechkoff**: The summation of Fourier's series of analytical functions.—— **Kolossof**: General solutions.—Carl A. **Garabedian**: Solution of the problem of the thick rectangular plate having two opposite sides supported and two sides free, and carrying a load uniformly distributed or concentrated at its centre.—— **Hoegelen**: Circular arcs of uniform thickness. Application to arched barrages.—D. **Foucher** and E. **Rougetet**: Contribution to the study of the mistral. The acceleration. An experimental study in the Rhone Valley shows that the velocity of the wind is the resultant of two velocities, one determined by the barometric gradient, the other caused by local conditions (orographic velocity).—Jules **Amar**: The mode of walking known as "*sur la pointe des pieds*." The mode of walking described by the author (with MM. d'Arsonval and Gautiez) has been misunderstood: details of the correct method are given.—Fernand **Wyss**: The biochemical estimation of insulin. A method of testing the strength of insulin *in vitro* is given, based on the retardation of the oxidation of resorcinol by hydrogen peroxide in the presence of insulin.

CAPE TOWN.

Royal Society of South Africa, August 19.—S. H. **Haughton**: On some new mollusca from tertiary beds in the west of the Cape Province. The following new mollusca are described from a deposit at Doornbaai on the Van Rhynsdorp coast, south of the Olifants River mouth: *Mytilus tomlini*, sp. nov. *Donax* (*Iphigenia*) *rogersi* sp. nov. and *Chamelea Krigei* sp. nov. The beds from which the shells were obtained average about 10 feet in thickness and form the upper portion of marine cliffs, which attain a height of 50 to 60 feet above sea-level.—R. S. **Adamson**: On the anatomy of some shrubbery Iridaceæ. In the S.W. Cape region there are five species of the Iridaceæ which form woody stems with secondary growth. The main features of the structure of these plants were described. While the general type of secondary growth is the same as that occurring in other Monocotyledons with secondary thickening, there are many differences in detail. The secondary tissues are much more compact and in some of the plants show a definite arrangement into concentric growth zones.—V. A. **Wager**: The breeding habits and life-histories of some of the Transvaal Amphibia. In this paper the author describes the life-histories and habits of two species of Transvaal batrachia, *Chiromantis xerampelina* and *Rappia marmorata*; both are tree-living, the terminal phalanges being provided with adhesive discs. In the first-named species the eggs are laid in the form of a large white glutinous mass on branches overhanging water. The tadpoles drop from the egg-mass into the water where they complete their metamorphosis. The fore-limbs, before breaking through the operculum, are already provided with phalangeal discs. The tadpole does not increase in size during metamorphosis, and when the tail disappears the young frog leaves the water for an arboreal existence. In *Rappia marmorata* the eggs are laid in a jelly-like mass under water. A peculiarity of the tadpole is the absence of horny jaws, comb-teeth, or papillæ of the mouth, which bears a superficial resemblance to that of the tadpole of *Xenopus lævis*, but from which it can be readily distinguished by the absence of the two tentacles at the sides of the mouth. From this it is concluded that the tadpole feeds on micro-organisms in water drawn through the unusually large spiracle, and this is borne out by an examination of the intestinal contents, which includes amongst other organisms Euglena, Volvox, and a few minute annulates.—B. F. J. **Schönland**: Cathode ray scattering. Preliminary measurements of the scattering of fast cathode rays through 90° have been made under conditions which ensure "single" scattering. Values for the nuclear charges of gold and aluminium are derived from these results which lie within 12 per cent. (the experimental error) of the true values. They support the addition of the relativity correction to the orbit of a β-particle, this correction having the high value of 2·40 in the present case.—C. W. **Kops**: Marriage and mortality rates of the population of the Union of South Africa according to the conjugal condition of the population. The paper is a preliminary investigation into the marriage rates among widowed persons and never-married persons, and the death rates among widowed, never-married, and married persons.

Official Publications Received.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 24, Part 6: A Bibliographic Study of Beauvois' Agrostographie. By Cornelia D. Niles. With Introduction and Botanical Notes by Agnes Chase. Pp. xix+135-214. (Washington: Government Printing Office.) 15 cents.

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 276: Motor-Vehicle Headlighting. Pp. 28. (Washington: Government Printing Office.) 20 cents.

Institut de France: Académie des Sciences. Annuaire pour 1925. Pp. 379. (Paris: Gauthier-Villars et Cie.)

Sitzungsberichte der Physikalisch-medizinischen Sozietät in Erlangen. Herausgegeben im Auftrag der Sozietät von Oskar Schulz. 54. und 55. Band, 1922, 1923. Pp. xxiii+429+8 Tafeln. (Erlangen.)

Fifty Years of Local Science, 1875–1925: a Record of Fifty Years Work done by the Members of the Bradford Natural History and Microscopical Society and the Bradford Scientific Association. Edited by H. J. M. Maltby and W. P. Winter. Pp. 34+2 plates. (Bradford.) 6*d.*

County Council of the West Riding of Yorkshire: Education Committee. Report on the Examination for County Minor Scholarships, 1925. Pp. 33. (Wakefield: Education Department, County Hall.)

The Edinburgh and East of Scotland College of Agriculture. Calendar for 1925–1926. Pp. 94. (Edinburgh.)

Proceedings of the Royal Society of Edinburgh, Session 1924–1925. Vol. 45, Part 3, No. 25: Some Points in the Anatomy of Dicksonia. By Samuel Williams. Pp. 286-296+2 plates. 1*s.* 6*d.* Vol. 45, Part 3, No. 26: On the Vertical Force Changes during the "Sudden Commencement" of a Magnetic Storm. By Dr. A. Crichton Mitchell. Pp. 297-301+1 plate. 9*d.* Vol. 45, Part 3, No. 27: A Colour-Vision Spectrometer. By Prof. W. Peddie. Pp. 302-307. 6*d.* Vol. 45, Part 3, No. 28: A Ball-and-Tube Flowmeter. By Sir J. Alfred Ewing. Pp. 308-321+3 plates. 2*s.* (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.)

New Zealand. Nineteenth Annual Report (New Series) of the Mines Department, Geological Survey Branch. Pp. 13. (Wellington, N.Z.: W. A. G. Skinner.) 6*d.*

Prospectus of the Royal College of Art, S. Kensington, London. Session 1925-1926. Pp. iv+28. (London: H.M. Stationery Office.) 6*d.* net.

Comptes rendus des séances de la Conference géodésique réunie à Helsingfors du 28 juin au 2 juillet 1924. (Verhandlungen der in Helsingfors vom 28 juni bis 2 juli 1924 abgehaltenen Geodätischen Konferenz.) Rédigés par le Secrétaire-général, Ilmari Bonsdorff. Pp. iv + 150. (Helsinki: Valtioneuvoston Kirjapaino.)

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1922–23. Vol. 2: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment, in certain Indian States. Pp. vii+85. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s.* 3*d.*

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 8, No. 2: On some Paleozoic Molluscs of Japan. 1: Lamellibranchiata and Scaphopoda. By Ichirô Hayasaka. Pp. 34+2 plates. (Tokyo and Sendai: Maruzen Co., Ltd.)

The Memoirs of the Imperial Marine Observatory, Kobe, Japan. Vol. 2, No. 1. Pp. 81+20 plates. (Kobe.)

Contributions to Palæontology from the Carnegie Institution of Washington. Studies on the Fossil Flora and Fauna of the Western United States. (Publication No. 349.) Pp. iii+130+25 plates. (Washington: Carnegie Institution.)

Diary of Societies.

SATURDAY, OCTOBER 17.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow), at 5.—Discussion on paper by E. H. Frazer on Safety First in Mines.—Prof. R. W. Dron: Notes on Cleat in the Scottish Coalfield.

PHYSIOLOGICAL SOCIETY (at Guy's Hospital).

MONDAY, OCTOBER 19.

SOCIETY OF SUPERINTENDENTS OF TUBERCULOSIS INSTITUTIONS (at 122 Harley Street, W.), at 3.—Dr. J. W. Linnell: Some Reflections on the Diagnosis and Treatment of Tuberculosis.—Dr. F. R. Walters: Needs and Indications in Pulmonary Tuberculosis.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 4.—Sir Frederick Mott: The Progressive Developments of Harvey's Doctrine of *Omne vivum ex ovo* (Harveian Oration).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Specimens illustrating Lips and Tongue.

JUNIOR INSTITUTION OF ENGINEERS (North-Western Branch) (at 16 St. Mary's Parsonage, Manchester), at 7.30.—A. N. Haworth: Engineering Troubles.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Graduate Section) (at Middlesbrough), at 7.30.—T. B. Lewis: Chairman's Address.

HUNTERIAN SOCIETY (at Simpson's Restaurant, Cheapside), at 7.30.—Dr. F. H. Humphris: Light (Presidential Address).

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court, S.W.), at 8.—Annual General Meeting.

TUESDAY, OCTOBER 20.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the months of June, July, August, and September.—L. C. Bushby: Exhibition of Insects recently exhibited in the Insect House.—Capt. E. W. Shann: Exhibition of Cinematograph Films taken on board the *Salpa* at Plymouth.—Dr. G. K. Noble: Voice as a Factor in the Breeding of Batrachians.—Dr. J. Stephenson: The Oligochæta of Spitsbergen and Bear Island; some Additions and a Summary.—R. I. Pocock: The External Characters of the Catarrhine Apes and Monkeys.—G. C. Robson: The Deep-Sea Octopoda.

INSTITUTE OF MARINE ENGINEERS, at 6.30—Presidential Address.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. J. G. Noel: The Mount Everest Expedition (Lecture).

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Discussion on paper by A. J. T. Taylor entitled The Ruths Steam Accumulator.—D. MacNicoll: The Jubilee of the Marine Spring-loaded Safety Valve.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Miss Winifred S. Blackman: The Customs of the Modern Peasant Population of Egypt.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—The Coal Crisis as illustrating the Modern Transition:—Prof. Geddes: Changes in the Coal Industry as Symptoms of Social Transition.—J. A. Hobson: The Required Economic Adjustments.—Dr. Saleeby: The Required Hygienic Adjustments.—Prof. Abercrombie: The Regional Planning of New Coalfields.—Prof. Desch: The Required Technological Adjustments.—E. Kilburn Scott: The Adaptation of the Coal Gas Industry.

WEDNESDAY, OCTOBER 21.

SOCIETY OF GLASS TECHNOLOGY (at the University, Sheffield), at 2.30.—T. C. Moorshead: The Glass Industry and Future Developments (Presidential Address).

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. J. D. Rolleston: Voltaire and Medicine. Part I.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Chamber of Commerce, New Street, Birmingham), at 5.30.—J. W. Hall: A Precis, with Annotations, of a Diary of a Tour in the Midlands in 1823, kept by Joshua Field.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Graduates Meeting) (at Chamber of Commerce, Birmingham), at 7.30.—T. Grover: The Influence on Engine Performance of Cylinder Arrangement and Construction.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Prof. A. G. Hornyold: Otoliths of Large Eels from the Albufera of Valencia.—Dr. Helen Ingleby: Note on the Termination of the Podic (Perivascular Foot) of Fibrous Neuroglia Cells.

INSTITUTE OF CHEMISTRY (London Section).

THURSDAY, OCTOBER 22.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—R. A. Chattock: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates Meeting) (at Luton), at 7.30.—A. J. Hancock: Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham and Coventry Centres) (at Queen's Hotel, Birmingham), at 8.—H. K. Thomas: Presidential Address.

FRIDAY, OCTOBER 23.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—H. E. Smith: The Influence of Strain on the Thomson Effect.—W. Mandell: The Measurement of Temperature by Thermocouples in Unequally Heated Enclosures.—W. Clarkson: On the Flashing of certain Types of Argon-Nitrogen Discharge Tubes.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Preparations and Models to illustrate the Mechanism of the Internal Ear.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. E. Saunders: Old and New Friends in the Zoo (Lecture).

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—H. S. Bower: The Construction and Laying of Reinforced Concrete Pipes.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.—Dr. T. S. Wilson: On the Management of Scarlatinal Epidemics in Boarding Schools.

SATURDAY, OCTOBER 24.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Bridgwater), at 11.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.15.—B. Stevanovic: Conational Phenomena in Processes of Judgment.—Miss Ethel Stoneman: Apparatus used to investigate Electrical Changes accompanying Emotional States in the Insane. The Waller Emotometer and the Godefroy Tachogram.

PUBLIC LECTURES.

SATURDAY, OCTOBER 17.

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

MONDAY, OCTOBER 19.

UNIVERSITY OF LEEDS, at 5.15.—Prof. E. G. Coker: Photo-Elasticity.

KING'S COLLEGE, at 5.30.—R. J. Bartlett: Psychology and Education.

WEDNESDAY, OCTOBER 21.

UNIVERSITY COLLEGE, at 3.—Prof. E. G. Gardner: Barlow Lectures on Dante: The Purgatorio. (Succeeding Lectures on October 28, November 4, 11, 18, and 25.)

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE, at 5.—Dr. C. S. Myers: Hindrances to Output.

THURSDAY, OCTOBER 22.

KING'S COLLEGE, at 5.30.—Dr. B. Malinowski: The Contributions of Anthropology to Social Hygiene.

SATURDAY, OCTOBER 24.

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