THURSDAY, AUGUST 2, 1917.

AMERICAN AND ANTARCTIC GEOLOGY.

(1) *Geology: Physical and Historical.* By Prof. H. F. Cleland. Pp. 718. (New York: American Book Company.) Price 3.50 dollars.

(2) *British Antarctic Expedition, 1907–9. Under the Command of Sir E. H. Shackleton, C.V.O. Reports on the Scientific Investigations. Geology:* Vol. ii., *Contributions to the Palaeontology and Petrology of South Victoria Land.* By W. N. Benson and others. Pp. vii+270+plates 38. (London: W. Heinemann, 1916.) Price 3 guineas net.

(1) PROF. CLELAND'S volume is an attempt to provide a summary of physical and historical geology which shall be both interesting to read and serviceable as a students' text-book. It has many excellent features; it includes a well-selected collection of 587 illustrations and, as the result of the author's wide reading, many interesting facts which are new to general text-books. Its most valuable contribution is in the sections on vertebrate palæontology, which summarise the evolution of most orders of mammals instead of referring only to a few. The account of American stratigraphy and palæogeography should be useful to British readers, and the convenient lists of folios of the United States Geological Survey which illustrate various physiographic forms should increase the educational use of those most instructive maps.

The main defect of the book is that the author, perhaps owing to haste, has not always fully digested the information collected, so that minor errors and inconsistencies are numerous, and space is sometimes devoted to obsolete theories of which current views are also given. Among the mistakes of fact are that the Zambezi flows through a deep gorge above the Falls; that Australia has no native grasses, and that its indigenous fauna belongs to the early Tertiary; that the sea-urchins experienced little change in Palæozoic times (compare Bothriocidaris and Melonites!); that *Thamnastrea prolifera* ranged throughout the Mesozoic; and that eskers are not usually more than a mile long. In a future edition the author might alter the statement regarding Spirula (p. 531) and abandon his inference from the steam-cloud of Stromboli (p. 339).

The student will pounce on many statements which he will be quicker to compare than to reconcile; thus, the Permian is sometimes a subdivision of the Carboniferous, and at others an independent system. Lava, on p. 298, is wisely restricted to rocks which "issue from the earth," yet the intrusive sheet which forms the Palisades of the Hudson are called lava, and some mud volcanoes are attributed to the action of lava at some depth below the surface. Hanging valleys are said to be proof of glacial action on p. 163, although elsewhere in the book glaciers are said to have slight powers of erosion on smooth rock surfaces, and hanging valleys are described which are due to non-glacial agencies. The author gives two comparative diagrams of a group of ridges and valleys, one with spurless walls and faceted ends, the other with serrated crests; yet the former is included as an illustration of stream erosion and the latter as mainly due to ice action. The short chapters on rocks and minerals are below the standard of the rest of the book, and students are unlikely to derive correct impressions from the statements that hornblende has "slender flat crystals," that syenite is granite without quartz, and that diorite and gabbro consist respectively of hornblende and pyroxene with "felspar of any kind."

The effort to simplify palæontology is responsible for the division of the Palæozoic corals into the chain corals, cup corals, and honeycomb corals —which are undefined popular terms that do not form satisfactory classificatory subdivisions.

The references to authorities indicate that the work is based unduly on text-books and semi-popular works rather than on original authorities. Thus, in the accounts of the vertebrates, Hutchinson's "Extinct Monsters" is repeatedly referred to, while in the summary of the evolution of the elephants no direct reference is made to Dr. Andrews, whose results are quoted second-hand. Some pages are devoted to early man, but there is no mention of Eoanthropus.

Though Prof. Cleland's text-book will be useful, it is not up to the usual high standard of American geological literature.

(2) The second volume of the Geological Reports on Sir Ernest Shackleton's Antarctic Expedition of 1907–9 is a magnificent volume prepared through funds raised in part by a lecture tour by Prof. (now Major) Edgeworth David. He has been unable, owing to his important services on the Western front, to edit the volume, a work undertaken by Sir Douglas Mawson. Prof. David has contributed a preface, in which he explains why he considers that the ice-barrier tongues from the Antarctic glaciers are afloat and do not rest on esker-like embankments built of their moraines and subglacial gravels.

The volume consists of a chapter on ice structures by Sir Douglas Mawson and of thirteen technical studies on the geological collections brought back by the expedition. Sir Douglas Mawson's ice studies were made on the ice of the lakes, of the sea, and of the stalactites in the ice caves; his work shows how the ice structures vary with the conditions which determine the elimination and distribution of the brine, and they throw further light on the conversion of névé into glacier ice. Mr. Chapman contributes a series of reports on the foraminifera and ostracods in mud from the floor of the Ross Sea and from various raised marine deposits on the adjacent coasts. Mr. Hedley describes the mollusca from the same marine beds, and remarks that their preservation shows that "their geological age is of the slightest." Mr. Chapman establishes some new species, and reports the presence of some Arctic species, especially *Saccammina sphaerica*, which would give some support to Murray's theory of bipolarity had not the evidence against it by the rest of the Antarctic fauna been overwhelming. He also furnishes further evidence that some arenaceous foraminifera select the material for their shells, since *Reophax spiculifera* rejects sand grains and uses only sponge spicules, which it builds up into funnel-shaped chambers. Mr. Chapman's most interesting Antarctic fossil is a Cambrian calcareous alga, which he has referred to Bornemann's genus Epiphyton from Sardinia as a new species, *E. fasciculatum.*

The rest of the volume consists of a series of petrologic reports by Messrs. Jensen, Allan Thomson, Benson, Walkom, Woolnough, Skeats, and Cotton, Sir Douglas Mawson, and Miss Cohen. Dr. Jensen describes some samples of Antarctic soil on which, though due to mechanical disintegration rather than to chemical decay, plants were found to grow when kept adequately warm. Dr. Jensen also contributes a chapter on the interesting alkaline rocks of Mount Erebus, and discusses the classification of the kenytes and their relations to the trachydolerites. Dr. Allan Thomson has carefully investigated some inclusions in the trachytes and kenytes, and founded for one series a new rock type, *microtinite,* so called as they are aggregates of plagioclase felspars. He discusses the terminology of included rock fragments, and adopts Lacroix's terms "homœogenous" and "enallogenous" as the best yet proposed.

The volume has an excellent index to both volumes. Mr. Dun's promised bibliography of Antarctic geology has been postponed, but its early publication would be a great boon, as the subject has now a very scattered literature.

RADIO-MECHANICS.

Radio-dynamics: The Wireless Control of Torpedoes and Other Mechanisms. By B. F. Miessner. Pp. v+206. (London: Crosby Lockwood and Son, 1917.) Price 9*s*. net.

THIS little volume deals with a subject of considerable interest at the present time, viz. the control of torpedoes or other vessels of war by means of electromagnetic waves. The author has, however, unnecessarily increased the bulk of his book by the introduction of a good deal of irrelevant matter, and by space given to elementary facts connected with wireless telegraphy which might quite well have been taken as familiar to any reader likely to be interested in it. Moreover, he has rather overestimated the importance of the early work of some American investigators, such as Dolbear and Tesla, and done insufficient justice to that of European workers, such as Marconi, Fleming, Lodge, Muirhead, E. Wilson, and others. Too much space is given to the description of methods of communication, such as those of earth conduction, ultra-violet light, and infrared rays, which have never become practically useful.

The proper discussion of apparatus for the control of mechanism at a distance by means of electromagnetic waves does not begin until chap. xi., p. 78, of the book, and even then the treatment is of a rather sketchy character. The essential principles involved are quite easy to understand. A torpedo or other vessel to be directed must have on it some source of motive power such as storage cells, compressed air, or a petrol motor. This power drives the screw propeller and moves the vessel. Also the same source of power is used to put the helm to port or starboard or straight. We have then to set in motion some motor or gearing which starts or stops the driving power, or engages or changes the mechanism for steering. The boat is, therefore, provided with a mast carrying an aerial wire or antenna, by means of which electromagnetic waves sent out from a shore station are absorbed. The feeble electric currents thus set up in the aerial wire are utilised to set in motion a sensitive relay, and this in turn has to control the power which steers or propels the boat.

The first difficulty is the nature of the radiation detector which is connected to the antenna. In the early days of wireless telegraphy this was always some form of coherer, generally the metallic-filings coherer of Branly as modified by Marconi or Lodge. This detector is, however, rather uncertain in action and requires the addition of an automatic tapper to bring it back to the sensitive state after it has received and responded to a signal. Hence of late years it has been entirely ousted as a wave detector by more certain appliances, such as Marconi's magnetic detector, the Fleming vacuum valve, or some form of crystal detector. These modern detectors operate with or control such small alternating currents that they cannot with certainty set in action any electromagnetic relay capable of being used on board a small vessel at sea.

The first difficulty, therefore, in connection with the mechanism of radio-directed vessels is the selection of a suitable wave detector and of a relay. The author found that a form of Lodge-Muirhead self-acting coherer, called the steel-wheel coherer, was a useful one, and he constructed a suitable relay by modifying a type of movable-coil galvanometer. Even when such arrangements are perfected so that the sending out of electromagnetic waves which impinge on the torpedo aerial can be made to steer it by setting in action some mechanism which throws over the rudder to one side or the other, there still remains the difficulty of rendering the radio-receiver immune to vagrant electric waves or to intentional attempts to mis-steer the boat on the part of an enemy.

The reader will find in chap. xiv. an account of the work done in attempts to develop a radio-steered torpedo at the laboratory of Mr. John Hays Hammond, jun. In chaps. xv. and xvi. the difficulties connected with control and interference are discussed.

Although small vessels have been controlled in this manner by electromagnetic waves up to a distance of ten miles or rather more, the practical problem of certain control cannot be said to have been solved. The present book deals, therefore, with an experimental stage of the subject, which may, however, have considerable possibilities of actual utility in warfare.

In any future edition of his book the author would be well advised to cut out all unessential matter. He is not a safe guide on points of history or priority in relation to radio-telegraphic invention. His statement on p. 32 as to "later improvements" is absurdly inaccurate. On pp. 105 and 106 he misspells the name of Prof. E. Branly, the inventor of the metallic-filings coherer. On p. 173 he gives exclusive credit for the vacuum valve detector to Lee de Forest, apparently in entire ignorance that the Court of Appeals in the United States has confirmed Judge Mayer's decision that the de Forest audion is an infringement of the Fleming oscillation valve. He is also seemingly unaware that the so-called Dolbear system of wireless telegraphy was never operative. In spite of the fact that there is a free use of photographs of apparatus which are insufficiently described in the text, the reader who is desirous of learning what can be done in the radio-control of torpedoes will find a good deal of suggestive research described in this little book. J. A. F.

THE ACTION OF ENZYMES.

The Method of Enzyme Action. By Dr. J. Beatty. With Introduction by Prof. E. H. Starling. Pp. ix+143. (London: J. and A. Churchill, 1917.) Price 5*s*.

TWO-THIRDS of this book is devoted to an excellently clear and concise account of the facts and theories to be found in the books named in the preface, so far as they are connected with the action of enzymes. What is new, and the chief object of the book, is the suggestion of a hypothesis of enzyme action. The details can be adequately grasped only from the full description. It is based on two assumptions: (1) the possibility of "combination" between molecules, and (2) the loosening of internal bonds in one or both of the combining molecules as a result of this union. It is held that the action of all enzymes can be reduced to the combination with H and OH radicles derived from water. These radicles are "activated" by the power possessed by an enzyme of "attracting" one or the other. This is a general or unspecific property, but each enzyme has also a specific power of adsorbing some particular substrate. The author will, no doubt, admit that considerable further explanation is required as to the means by which the activation is effected, and criticism is difficult until more is known of the nature of the atom itself and of the way in which it is united to other atoms.

The hypothesis deserves to be kept in mind as more knowledge is gained of the action and the nature of enzymes. At present it is not easy to imagine ways of putting it to experimental test. Indeed, it must not be forgotten that the fundamental assumptions are not universally accepted. The present writer is inclined to think that the use of the word "combination," although very common, in speaking of the union between molecules and even of adsorption, is apt to lead to an obscuring of the great, salient facts of true chemical union. There are, as it seems, various stages of "combination," leading from adsorption, through molecular compounds, to cases where the change of properties is of the most striking kind.

It is somewhat unfortunate that the new hypothesis appears to involve the explanation of all catalytic action by the formation of intermediate compounds. This has been shown actually to take place in one case alone of heterogeneous catalysis, and since the compounds are only supposed to exist momentarily, it seems somewhat hopeless to expect a proof or disproof of their existence. The possibility of representing a reaction by a chemical equation does not necessarily show that it takes place in that way. The division of catalysts into inorganic and enzymes would be better replaced by that into homogeneous and heterogeneous, the latter to include enzymes. There are more differences between catalysis in homogeneous and heterogeneous systems than between inorganic heterogeneous catalysts and enzymes. In fact, more knowledge of the mechanism of heterogeneous catalysis is greatly to be desired. In future developments of his hypothesis the author might also find it of advantage to consider it more fully in the light of the doctrines of energetics.

W. M. B.

OUR BOOKSHELF.

Clinical Bacteriology and Haematology for Practitioners. By Dr. W. D'Este Emery. Fifth edition. Pp. xiii+plates xi+pp. 310. (London: H. K. Lewis and Co., Ltd., 1917.) Price 9*s*. net.

A NEW edition of Emery's "Clinical Bacteriology and Hæmatology" is always welcome, for it is a most useful book for the practitioner and for laboratory work. The general plan has been maintained in this fifth edition, but the text has been revised, some new matter added, and some more illustrations have been inserted.

In the section dealing with syphilis the McIntosh and Fildes method of performing the Wassermann reaction has been inserted in addition to the author's own method, and we think the author has been well advised to do this.

The Dreyer method of performing the agglutination test for typhoid fever is also described in full as well as earlier methods.

Cerebrospinal fever and the recognition of the meningococcus are dealt with more fully than previously, and the examination of carriers is described. Even now this section is none too long, and might be extended with advantage. We doubt if it is wise ever to rely on ordinary agar as a culture medium for this organism, as is suggested.

Malaria is described very briefly, and no mention is made that the crescents of sub-tertian fever are free in the blood-plasma and are not intra-corpuscular. We are surprised also to find no reference to amœbic dysentery; with many cases now coming from abroad the practitioner is quite likely to meet with this disease. While pointing out these few slight blemishes, we can cordially recommend this book as on the whole a simple and reliable guide to clinical bacteriology and pathology.

Soil Conditions and Plant Growth. By Dr. E. J. Russell. Third edition. Pp. viii+243. (London: Longmans, Green, and Co., 1917.) Price 6*s*. 6*d*. net.

THIS book is, as the title implies, concerned with the relationship between soil and plant. After an introductory historical account of the subject the author describes the constitution of the soil and the various factors of plant growth. In the development of these topics and of the question of the relation of the plant to its soil environment, the reader is kept constantly in touch with the best original work at home and abroad.

The author has made numerous additions in his third edition, and has considerably expanded those portions treating of the biological conditions in soils. He has also added a chapter on the colloidal properties of the soil, in which he brings the reader abreast of the recent researches and disputes of Continental workers, as well as the latest Rothamsted work on the interaction of dilute acids and soil colloids.

It is superfluous to say that the book is well written. There is an ample bibliography, which should be invaluable to the investigator in any branch of the subject.

The study of the relationship between soil and plant is exceedingly complex. Progress can only be made by studying the soil in every aspect of importance to the plant. It is a pity that so much labour should have been expended during past years in haphazard manurial trials, designed to instruct the farmer, but yielding generally a scanty harvest of accurate information. Soil investigators owe a debt to Dr. Russell and his predecessors at Rothamsted for enlarging the study of the soil into a respectable field of scientific activity.

G. W. ROBINSON.

Lezioni di Antropologia. By Prof. Fabio Frassetto. Vol. iii. Pp. xiii+422. (Bologna: Mareggiani, 1917.) Price 20 lire.

IN the thirteen lectures contained in this volume Prof. Frassetto covers that part of his course which is devoted to the limbs—their evolution, development, and morphology. In his lectures dealing with the methods which are to be applied to the measurement of bones and to the exact estimate of their anthropological characters he has introduced much that is new and valuable. All through these lectures is reflected that spirit of mutual understanding which has existed between the anatomists of Italy and England since Harvey's time. There is no better summary of the contributions which British anatomists have made to physical anthropology than is to be found in these clearly written and excellent lectures by Prof. Frassetto.

A. K.

LETTERS TO THE EDITOR.

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

The Radiation of the Stars.

I AM sorry that the only reply I can make to Prof. Eddington's remarks in NATURE of July 5 is that his amended equation seems to me neither to be true nor to lead to his supposed laws. But perhaps I may be permitted to offer a few remarks on the general problem.

Suggested sources of stellar energy fall into two broad classes—gravitational and electrical, the latter including chemical and radio-active sources. Of the former the Helmholtz contraction is by far the most powerful source of energy; the contraction of our sun from a state of infinite rarity would provide energy for about 20,000,000 years of radiation at the present rate.

An upper limit to the capacity of electrical sources can be calculated in a way I have not seen elsewhere. Our sun's mass is 2×10^{33} grm., its radiation about 4×10^{33} ergs per second. Thus to radiate for 20,000,000 years (or, say, 7×10^{14} sec.) at its present rate, each gram of matter must provide on the average 14×10^{14} ergs of energy. A gram of matter contains 3×10^{23} negative electrons, so that the average electron must provide $4{\cdot}7\times10^{-9}$ ergs of energy, corresponding to a fall through a potential difference of 10 electrostatic units, or 3000 volts. This is the energy of falling from infinity to a distance of only $4{\cdot}7\times10^{-10}$ cm. from a nucleus $10e$, and so is probably much greater than any energy actually available from changes of electrical structure; it is, of course, enormously greater than any known ionisation potentials.

It accordingly looks as though the Helmholtz contraction will provide much more energy than any other source, and we must apparently adjust our views to the time-scale set by the contraction theory.

If this is accepted, it will be obvious that the calculation of stellar temperatures and emissions of energy cannot be a steady-state problem at all. I do not see how, in any case whatsoever, any new knowledge can be gained from calculations which assume the star to be in a steady state, for the calculated rate of emission can come to nothing but the previously assumed rate of generation of energy inside the star. For progress to be made, this big and difficult problem must, I think, be attacked on dynamical, and not on statical, lines.

July 7.

I HOPE I may state my grounds for disbelief in Prof. Eddington's results more clearly. The results are readily combined in the one result that the total emission depends only on M, and varies as M. Prof. Eddington claims to obtain this result in two ways. In his original paper he assumes (*M.N.*, vol. lxxvii., p. 20) a rate of generation $4\pi M\epsilon$, and after much calculation obtains a result which, on introducing the omitted constants, reduces (*l.c.* p. 29, equations (29) and (25)) to exactly $4\pi M\epsilon$, proving my point. Again, in NATURE of June 14, Prof. Eddington claims to obtain a result which I do not understand, but which is necessarily contradictory to the foregoing, since the emission cannot now involve ϵ at all. He apparently says:—"Tell me the mass of a star and I will tell you its output of radiation without knowing the rate at which energy is being generated in its interior; I can do this by assuming the star to be in a steady state." This I cannot believe to be possible.

Prof. Eddington now says that the star "must settle into a state of density and temperature which would produce an outward flow at the required rate." Perhaps; but surely Prof. Eddington's original contention was that the rate of outward flow could not be affected by density and temperature, but depended only on the mass.

J. H. JEANS.

London, July 13.

I AM in general agreement with Mr. Jeans's remarks on the difficulty of obtaining a source of stellar energy more powerful than the Helmholtz contraction. It may be added that there is a conceivable source, which was, I believe, once suggested by Mr. Jeans himself, viz. a gradual annihilation of matter by positive and negative electrons occasionally neutralising one another. This would provide an almost inexhaustible store of energy, but there is the grave objection that it affords no reason why the dense dwarf stars should liberate so much less energy than rarefied stars of the same mass. One would have expected compression to be favourable to the process of cancelling of electrons. The search for an additional store of energy is not at all encouraging; but, on the other hand, there are important arguments against the short time-scale—notably Prof. Strutt's evidence of the age of terrestrial rocks, and the time needed for the tidal evolution of the earth-moon system. I have not felt myself able to combat the arguments on one side any more than on the other; accordingly, in the paper criticised by Mr. Jeans, the question was left entirely open. In the one place where it was necessary to consider the source of stellar energy, I attempted to show that my formula fairly represented both the radio-activity and the contraction hypotheses—having regard to the necessarily approximate character of the investigation.

The opinions in the last paragraph of Mr. Jeans's letter seem much too sweeping. It is desirable to criticise them, because his disbelief in my results is presumably a corollary to his rejection of the possibility of obtaining information from consideration of a stationary or quasi-stationary state. If energy were generated at a fixed rate within the star, the radiation would no doubt have to take place at the same rate; but to bring this about the star must settle into a state of density and temperature which would produce an outward flow of energy at the required rate. We have thus a triangular equation—generation of energy = theoretical emission (depending on the transparency and temperature-distribution) = observed emission (given by the effective temperature). Mr. Jeans assumes that the imposed rate of generation must necessarily be involved in any results that are derived. But we can dispense altogether with the first member, and obtain "new knowledge" from the equation which remains.

July 11.

I AM afraid we can scarcely trespass on your space to enter on the detailed discussion which seems necessary in order to arrive at an understanding. In a paper about to appear in the June *Monthly Notices* I have rearranged my analysis in what is, I believe, a more lucid form. If Mr. Jeans finds the result still unsatisfactory, I hope he will renew the attack in another place.

With regard to his final point, I may give a word of explanation. It is true that I find that the total radiation of a giant star depends only on the mass—to my order of approximation. If a different rate of generation of energy, fixed and independent of the density, were imposed, the star could not settle permanently in the giant state. If the supply were too small the star would contract, though more slowly than on the Helmholtz theory, and ultimately attain equilibrium in the dwarf state. The case of too large supply scarcely needs to be considered, since it involves an evolution in the reverse direction from that generally accepted. This may, perhaps, be regarded as additional evidence of the difficulty of obtaining a long time-scale by assuming an unrecognised source of energy.

A. S. EDDINGTON.

Cambridge, July 17.

FORESTS AND RAINFALL.

THERE are several questions regarding the mutual relations of natural phenomena that appear at first sight so simple that the obvious answers may be received for generations as too clear to require reconsideration. One of these is the influence of forests on rainfall. It seems so natural that if a large area of bare ground is planted with trees which grow into a forest the moisture of the district will be increased by increasing rainfall, diminishing run-off, and, in hot countries, falling temperature, that one scarcely stops to inquire on what evidence the belief is based. Everyone must remember the vivid picture drawn in Marsh's "Man and Nature" of the desolation wrought in Palestine and other Mediterranean lands by desiccation consequent on the destruction of forests and abandonment of cultivation. But in that work, as in most of the writings on this and cognate questions, the motto of the discussion might be *post hoc, ergo propter hoc.*

The problem has been attacked by innumerable writers in Europe and America, and we do not profess to have the mass of heterogeneous literature at our finger-ends. We do, however, retain a general impression of unsatisfactoriness in the methods and results, and the impression is renewed by the latest contribution to the subject, the Indian Forest Bulletin, No. 33. This consists of a "Note on an Inquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India," prepared by Mr. M. Hill, Chief Commissioner of Forests of the Central Provinces. Mr. Hill has presented an admirable *précis* of what must be a large mass of official documents, and he appends two excellent memoranda by Dr. Gilbert Walker, the Director-General of Observatories in India. That the good work of Mr. Hill should leave an unsatisfactory impression is not his fault, but his misfortune in having to deal with official reports instead of plain scientific data. The history of the investigation as set out in the bulletin is briefly this:—

In 1906 Lord Morley, then Secretary of State for India, sent to the Viceroy a note from Dr. J. Nisbet, formerly of the Indian Forest Service, pointing out that "the relation of forests towards the mitigation of the severity of famines" had never been adequately considered. Sir William Schlich forwarded with Dr. Nisbet's letter his opinion that an investigation of the influence of forests on rainfall would be very difficult and unlikely to lead to any definite result. Nevertheless, the Government of India sent out to all the local Governments a request that the subject should be inquired into and all available information collected. In due time the local Governments sent in reports on their own provinces, and these are tersely summarised by Mr. Hill with an admirable neutrality, which nevertheless fails to conceal the fact that the reports differed widely in quality. The general result is stated officially as follows:—

"After a careful examination of the replies received from local Governments, as summarised above, and after consultation with the Director-General of Observatories, the conclusions arrived at by the Government of India were briefly that the influence of forest on rainfall was probably small, but that the denudation of the soil, owing to the destruction of forests, might, as far as India is concerned, be looked upon as an established fact; while as regards the effect of forest preservation on rainfall and the underground water supply, the papers forwarded did not provide sufficient information to justify any change in the principles on which the forest policy of the Government has hitherto been based. It was remarked that these principles were founded mainly on considerations of a directly economic character, connected with the conservation of the grazing resources and forest produce of the country, and that the climatological considerations did not in any way affect these well-established principles."

The Government of India forthwith sent a second series of questions to the local Governments with the view of ascertaining whether experiments might not be instituted in order to obtain fresh data. These dealt with the local differences within and without forest areas in rainfall, soil water level, and height and duration of floods. The local Governments duly prepared and sent in reports, which were considered by the Government of India in consultation with the Board of Scientific Advice, and the final decision, expressed in five paragraphs, may be summarised thus:—(1) Meteorological stations in specially selected positions inside and outside forest areas would probably yield valuable results, and "if it be found possible to initiate inquiries of this nature further action would be taken." (2) Observations on soil water level need not be initiated, as the data would be of little value in showing forest influence. (3) Satisfactory experiments on floods could not easily be undertaken, but the belief that forests are beneficial in this respect is confident and almost universal. (4) No material change in the forest area of any province seemed to be contemplated, but if such changes should be made the Government of India desired that local Governments should make efforts to ascertain the effect of such changes on average rainfall. (5) The system of shifting cultivation, by which large areas of forest are annually destroyed in Native States and elsewhere, should be discouraged.

To our mind the method adopted could produce no better result than it appears to have done. In a scientific problem such as was set forth, the only function of the State seems to us to be to decide that such an inquiry shall be carried out at the public expense, and that every facility for obtaining data shall be given by all the departments of all the Governments concerned, local and central. It should then be handed over to a competent man of science set free from all other duties and supplied with necessary assistants. His report when complete would be authoritative and epoch-making, if not final, and incidentally his own reputation would be made or marred by his handling of the facts. The total expense would probably be no greater, and the labour of many public servants would not be diverted from the work for which they were trained.

Dr. Gilbert Walker's contributions on the relation of forests and rainfall are given as appendices, but are deprived of most of their scientific value by the omission of the tables and diagrams to which constant reference is made. These, of course, have been published in the memoirs of the Indian Meteorological Department. Dr. Walker fully grasps the difficulty of the inquiry. He shows that in India, as elsewhere, the annual rainfall has a tendency to run in spells of excessive and deficient years, and that if this fact is neglected totally false conclusions as to the influence of forest growth or destruction could easily be arrived at. He lays stress also on the short period available for comparisons on account of the very untrustworthy nature of the Indian rainfall statistics in the earlier years of the work of the Meteorological Department.

Dr. Walker considers that, as Blanford pointed out in 1887, "the only satisfactory evidence would be that obtained by comparing the rainfall of a district when well supplied with forests with that of the same district when the trees were very few." In our opinion the comparison should not be that of a district A at the time t with the same district at the time t'; but to compare the relation of district A to a contiguous district B at the time t with the relation of A to B at time t', where A is a district that has undergone a great change as regards forest covering, while B has remained unchanged. The reason for this indirect comparison is, of course, to eliminate the effect of the two periods falling in what Prof. H. H. Turner calls different climatic chapters. Another method would be to determine the relation of the isohyetal lines to the configuration of the land on wooded and treeless districts of similar character. As pointed out in the report on the rainfall in the Geological Survey's "Water Supply Memoirs of Hampshire," the district of the New Forest shows a considerably higher general rainfall than its elevation above sea-level appears to suggest. The subject is both fascinating and important, and the time will no doubt come when increase of accurate observations will enable the vague belief in the beneficial influence of forests on climate to be supported or corrected by definite meteorological evidence.

HUGH ROBERT MILL.

INDIAN SALTPETRE.[1]

THE brochure before us, issued by the Agricultural Research Institute, Pusa, is the work of the Imperial Agricultural Bacteriologist, and is an interesting and valuable account of an important village industry, which, as is well known, has long been carried on in various districts of India where the factors determining the formation of potassium nitrate, as a soil constituent, are sufficiently favourable. These factors, as summarised by the author, are:—

(1) *Nitrifiable organic matter* in suitable proportion in the soil.

(2) *Lime.*

(3) *Water,* not only in sufficient amount for nitrification, but also distributed in the soil in such a way as not to interfere with aeration, and to provide for continual capillary rise to the surface.

(4) *Soil* of such a texture as to allow of continuous upward movement of water from the subsoil to the surface.

(5) *Climate* ensuring a provision of adequate moisture and temperature during part of the year and complete, or nearly complete, absence of rainfall, coupled with low humidity during a sufficiently long period to ensure the capillary rise of subsoil water consequent on rapid surface evaporation.

The methods employed by the *nuniah,* as the operator is termed, for extracting saltpetre from the surface layer, or calcareous portions, of the alluvium have been frequently, although not always accurately, described. Mr. Hutchinson has studied these methods in detail, and his observations throw considerable light upon a procedure which shows little variation throughout India and is based upon the accumulated experience of generations of predecessors.

FIG. 1.—A *nuniah's* factory. From Bulletin No. 68, Agricultural Research Institute, Pusa.

The supply of saltpetre is almost entirely obtained from the soil in the immediate neighbourhood of human habitations, or of abandoned village sites where nitrogenous organic refuse, consisting largely of excrementitious matters of men and animals, has accumulated.

The surface-soil, or *chhilua,* scraped to the depth of a quarter of an inch, is mixed with an equal quantity of residual earth from previous extractions, known as *bhinjua,* and is placed by treading into a circular filter-bed, or *kuthia,* consisting of a mud wall and floor plastered with clay, and having a bottom layer of bamboos and straw. Water is poured over the earth and, percolating through the loosely compacted soil, is collected in an earthen vessel. The first runnings, or *murhan,* contain most of the nitrate, mixed, of course, with a greater or less quantity of common salt. The solution is concentrated to the crystallising point by boiling in an open pan over a fire of dead bamboo leaves, the ashes of which, being rich in potash, are added to the extracted earth, or

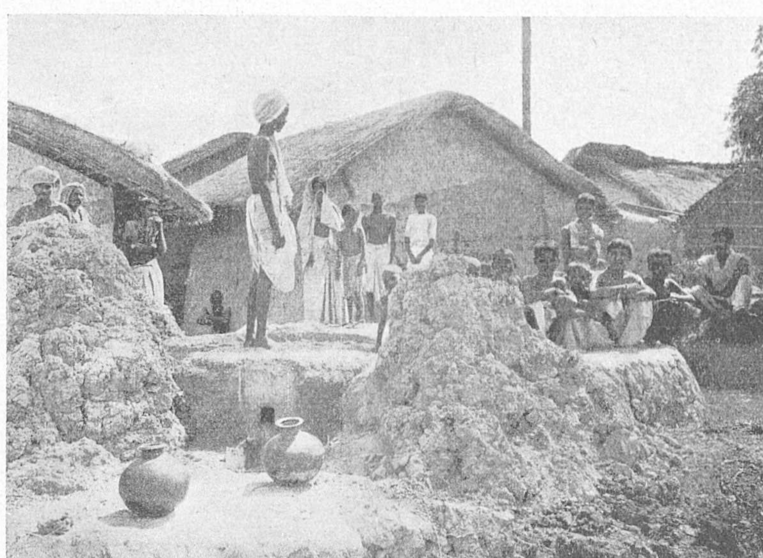

FIG. 2.—Treading the earth into the *kuthia* for extraction. From Bulletin No. 68, Agricultural Research Institute, Pusa.

[1] "Saltpetre: Its Origin and Extraction in India." By C. M. Hutchinson. Bulletin No. 68 of the Agricultural Research Institute, Pusa. (Calcutta: Government Printing Office, 1917.)

bhinjua, to be mixed afterwards with fresh *chhilua.* The *nuniah* seldom or never attempts to separate the mixed salts, as this is forbidden to him by the Salt Department. The crude product is sold, usually through a middleman, to the refiner, who works under Government supervision.

The restrictions of the Indian Salt Department, according to Mr. Hutchinson, undoubtedly hamper the operations of the *nuniah*, who has no inducement to improve his methods so as to turn out a better article. The whole process as at present carried on is essentially wasteful and uneconomical, and might be greatly improved in the absence of official interference. The conditions for the most economical production of saltpetre are well understood by the *nuniah*, and it is to be regretted that he should not be encouraged to make full use of his knowledge and experience.

The Bulletin is an important contribution to an interesting process of manufacture based primarily upon bacteriological agencies. It forms an excellent example of a purely empirical method which has been elaborated by the accumulated experience of centuries, but the rationale of which has only been made clear by modern biological science. In view of the growing scarcity of nitrates and of their increasing importance in the arts, especially in agriculture, it is to be hoped that the Indian Government will neglect no opportunity of conserving and extending an industry which is peculiarly well adapted to Indian conditions.

T. E. THORPE.

THE PROMOTION OF TECHNICAL OPTICS.

THE long-delayed steps which—as announced in NATURE of May 24 (p. 257) and June 14 (p. 317)—have been taken by the Government and the London County Council in concert for establishing the study of optics and of the manufacture of optical appliances upon a proper footing in this country, have given great satisfaction to all who are in a position to appreciate the importance of that measure. That the turning of this new leaf should be among the earliest consequences of the war is a fact both of intrinsic importance and of good augury. The importance of properly organised manufactures of optical glass and of optical instruments has been manifest, and has been pressed upon the Government with great weight of expert authority by the British Science Guild and other bodies for many years past. But in the days before the war, when the optimist was accounted the best as well as the pleasantest of counsellors, it was impossible to secure the attention of our rulers for so modest a proposal as the establishment upon an adequate scale of a school of practical optics.

It is with something more than a sigh of relief that we find ourselves after three years of war able to record this sound decision of the British Government. For, indeed, the matter for congratulation is that there is a British Government still in a position to act. The thought of what range-finders mean to the British Navy, and of how narrowly we escaped being dependent upon the enemy for our supply of these essential instruments, is almost enough to make one shudder even under the wing of a Royal Navy that has swept the sea. It chanced by the happiest of happy accidents that the range-finder which finds the range for our own and all the other navies was of British invention, also that the inventor took the trouble to establish its manufacture in this country as a private enterprise, and, by consequence, that when the war commenced we were in the best possible position to provide both Army and Navy with these important instruments. The Army can, indeed, use alternatives, but the Navy is shut up to the range-finder. Had that been a German monopoly the battle of Jutland might quite conceivably have been the end of British sea-power. Considerations such as these lead us to place on record the sense of immense relief with which we note the new attitude of the Government towards one of the things that matter.

The task before the new department is a large one, and it is beset with many difficulties. That task is chiefly educational, but it is by no means only the education of the student of optics that is here in question. Parliament, and the greater public to which Parliament is responsible, stand in need of education also. The facts just now alluded to concerning the supply of range-finders afford one illustration, and a very striking one, of this necessity. A necessity of a totally different kind is exhibited by the conditions governing the supply of optical glass. This, as is perfectly well known, has been for many years past, in large measure, a monopoly of one Jena glass manufacturer. That arrangement was in a certain sense a good and convenient one. The Jena glasses were excellent in quality—no one could reasonably expect to better them. Specialising in this line, the Jena house was able to produce them in great variety, and did, in fact, list and stock many varieties of optical glass for which the market demand was inconsiderably small.

Competitive manufacture under these conditions could only be wasteful manufacture, and the British glass-makers took what was, from the commercial point of view, the sound position that it was not worth while to spoil a market for a rival which they had no chance of exploiting for their own advantage. Indeed, when it is recognised that the whole world's trade in optical glass would not yield a profit that any successful stockbroker would think considerable, it is easy to understand the reluctance of business men to embark upon a troublesome business with no better prospect than that of largely destroying this modest prosperity and then joining in a scramble for the residue.

How, then, are Parliament and the British nation to be made aware of the technical importance of an industry which is commercially of so small account? That is one of the problems with which the new department is faced.

There is another problem of no less consequence growing out of the same conditions, which will, with equal insistence, demand the attention of Prof. F. G. Cheshire and his colleagues. We have referred to the multiplicity of the varieties of optical glass to which the manufacturers of optical instruments are accustomed. This is, on the face of it, a great point in their favour; but when more narrowly considered it will be found to handicap them appreciably. Let the matter be considered from this point of view. A manufacturer develops by trial and error a very successful optical instrument—a field-glass, for example. He uses a particular combination of optical glasses in its construction. His whole design is built upon the special properties in respect of refraction and dispersion of these particular glasses. So long as he can procure a supply of them upon the open market he does not need to modify any feature of his manufacture. It is a question of repetition merely, and he closely guards the secret of his success. But the time may come when the particular variety of optical glass upon which he relies is no longer available, or not available in the required quantities. What can he do then? Speaking in general terms, he can then do nothing. The practical optician cannot tell him how to substitute staple glasses for the special varieties which he has been accustomed to employ, and hence he insistently demands the accustomed supplies. Thus the lavish variety of optical glasses available to the manufacturing industry has actually tended to restrict growth of output and to reduce adaptability.

Here is one of the practical questions awaiting solution by means of laboratory research. If the optical glass industry is to be well established in this country, it must be an industry which will satisfy the requirements of the manufacturing trade; if it is to be established with a minimum of effort, those requirements must be reduced to the narrowest limits which can suffice. To work out the principle of equivalence between varieties in the combination of glasses, and so to concentrate the glass-maker's labour, so far as is practically possible, upon the production of a few staple varieties, will be a very important object of practically applied research.

These instances may serve to illustrate some of the less generally recognised fields for the activity of the new department. We have not adverted to the more obviously important objects of training teachers, instructing workmen, educating experts, and advising manufacturers. These may be left to speak for themselves, since the limits of our space preclude any adequate exposition of them in the present article.

With one word of congratulation we may close, and that upon the choice of a director for the new undertaking. Prof. Cheshire brings to his task a mind not only well stored with the technical knowledge of his subject, but also instructed by a wide experience of its practical side. We have every confidence that in his hands the machinery of the new department at the Imperial College of Science and Technology will be directed to practically important ends, and while reserving our congratulation of him personally, upon the sound principle which forbids premature compliments to the warrior who is girding on his armour, we congratulate the authorities who, by their choice of him for the important post which he is about to fill, have shown how large practical considerations, such as those to which we have here adverted, bulk in their view. That, at least, is as it should be.

THE AEROPLANE BOMBER'S PROBLEM.

THE problem which the bomber on board an aeroplane has to solve is more difficult than the corresponding problem of the bomber on board an airship, since the aeroplane must move with respect to the air to support itself, while the airship may be brought to rest over the object to be bombed. The bomb on release has a horizontal speed equal to that of the aeroplane, and if the air were at rest and offered no resistance to the motion of the bomb through it, the path of the bomb would be a parabola with its axis vertical and its vertex at the point of release. The resistance of the air prolongs the time of fall of the bomb to an extent which depends on its size and weight, and may be 50 per cent. if the overall density of the bomb is small. Any horizontal motion of the air causes a drift of the bomb down the wind which depends on the speeds of the various layers of air through which it passes during its fall, and on the resistance the air offers to the sideways motion of the bomb through it.

The dynamical equations which express the above facts have not yet been rigidly solved, but they are so closely related to the equations for high-angle fire in gunnery that the approximate methods of Col. Siacci or of Capt. Ingalls, or the recently published graphical method of Prof. Dalby, are all applicable, when the weight, altitude, and initial horizontal speed of the bomb, the mean speed and direction of the wind, and the resistances to downward and sideways motion of the bomb through the air are known. The altitude is shown on the aneroid of the aeroplane. The speeds of the aeroplane with respect to the ground and of the wind at the aeroplane are found by passing over an object with and against the wind respectively, and noting how long it takes the aeroplane to pass from the vertically overhead position to one, say, 10° or 20° up or down the wind from it. From the speed of the wind at the aeroplane thus found an estimate of the mean speed of the wind in the layers of air through which the bomb has to pass must be made, and this estimate can only be a rough one. With these data the bomber consults tables or curves previously prepared for the bombs to be used, which give him the bearing from the machine of the spot at which a bomb released at the moment should fall if the conditions remain unchanged. Thus the bombing aeroplane requires to be equipped with apparatus for measuring horizontal and vertical angles and times.

The description in *La Nature* for June 16 of the equipment of one of the large German bombing aeroplanes made by the Gotha Wagonenfabrik and captured by the French in February shows that at that date these planes were only intended to drop bombs when moving with or against the wind, and not athwart it. The bomber sits in front of the pilot and is provided with a telescope about a metre long with a small magnification and a wide field of view. It is fixed in gimbals near his feet, and can be kept vertical by him with the help of a circular level, an image of the air-bubble of which is projected into the eyepiece. Below the objective an achromatic prism is placed with its refracting edge perpendicular to the axis of the telescope. By means of a graduated disc close to the eyepiece the prism can be rotated about a line perpendicular to the axis of the telescope, so that the line of sight of the telescope continues beneath the prism at any required angle up to about 30° with the axis of the telescope.

A stop-watch with its dial close to the eyepiece enables the preliminary speed observations to be readily made. The prism can then be clamped at the proper angle for the conditions found, and on looking down the telescope the bomber sees at each instant in the middle of the image of the air bubble and in the centre of his field of view the spot on which a bomb released at that instant would drop. If the aeroplane is moving directly towards a point in the air from which a given object can be bombed, the image of that object will move towards the centre of the field along a fore-and-aft line in the field. If the aeroplane is not moving directly towards the object, the observer has to rotate the telescope about a vertical axis to bring the object into the fore-and-aft line. The rotation of the instrument is recorded on a dial before the pilot, who alters the direction of flight until the observer can bring the telescope back to its normal position and the dial in front of the pilot shows no error of direction.

The instrument is made by the firm of Goerz, and there is no difficulty in modifying it so that the restriction of its use to flights with or against the wind no longer holds. Whether this has been found advisable may be doubted, in view of the uncertainty which always exists as to the character of the air movements between the aeroplane and the ground. C. H. LEES.

NOTES.

WITH reference to the paragraph which appeared in a recent issue of NATURE regarding the Société de Chimie Industrielle, further particulars as to the scope of the new society appeared in *L'Echo du Commerce* for July 20. The object of the society will be to promote the science of chemistry as applied to industry. Local provincial branches will be formed which, while being self-governing, will keep in touch with the parent society at Paris. The society will institute research work with the view of assisting manufacturers and agriculturists. An institute and library are in contemplation which will contain a complete collection of French and foreign periodicals devoted to industrial chemistry, and the society hopes to arrange for meetings, exhibitions, etc., to stimulate activity. A review —the first number of which is expected to be published shortly—will keep manufacturers posted in the latest developments at home and abroad, describe inventions and processes, and, generally, fill a want that has been long felt in France. The first council of the society contains many names prominent in the scientific and industrial world.

FOR some days the firing in Flanders has been unusually heavy, culminating in the Allied attack on Tuesday, July 31. On Saturday last, July 28, according to a message from Amsterdam, the thunder of the guns reached a greater pitch of intensity than ever experienced previously. A similar remark is made by the Dover correspondent of the *Times* (July 30). The firing heard in that town was almost continuous throughout the night of July 28–29, and was particularly heavy about midnight and just before daybreak. A correspondent of the *Daily Telegraph* states that, on the afternoon of July 25, "while yet the hum of the London traffic was dominant, the sullen boom of the guns in Flanders was heard in many districts in South London. As the evening advanced the sound became a low growl, unmistakable, and practically continuous." The sound of the heavy firing on Tuesday was also heard distinctly in London.

THE current *Quarterly Review* contains an article by Dr. C. Davison on his investigation of the sound-waves of the East London explosion of January 19 last. As stated in NATURE for February 1 (p. 438), the sound-area consists of two detached portions. The inner sound-area is distorted in two main directions. Towards the east-south-east it reaches Canterbury, 48 miles, and to the north-west Wellingborough, 66½ miles; but to the north-east and south the boundary is only 19 or 20 miles from the source. The outer sound-area reaches from near Nottingham, across the south of Lincolnshire and Norfolk, to, and no doubt beyond, the east coast of the latter county. The most distant place at which the sound was certainly heard is Stow, near Lincoln, 128 miles. The width of the silent zone varies from 28 miles at the western and higher end to 48 miles at the eastern end. Speaking generally, the inner sound-area was one of single reports and the outer area one of multiple reports—two, three, and sometimes four reports being heard in quick succession. The existence of inaudible air-waves was manifested by the shaking of windows and the disturbance of pheasants, and the arrival of these waves was not, as a rule, coincident with that of the sound-waves. Within 15 or 20 miles of the source the air-waves passed after the sound was heard, at greater distances usually before. The air-waves were not, however, confined to the sound-areas, for their effects were noticed at sixteen places within the silent zone, nine of them being in the narrow western portion. The sound was heard at Ipswich, which lies a few miles from the northern boundary of the silent zone, and possibly also at Uppingham and Lilford, near the western end. It is inferred that both the inaudible air-waves and the sound-waves crossed the silent zone at moderate heights above the ground, but that the air-waves followed a lower path than the sound-waves.

EARLY in July Mr. Erik Andersson, of Uppsala, again led to Spitsbergen a geological expedition, which included Messrs. Adam Reuterskiöld, Sven Ydén, and Karl Samuelsson. The main object was to continue the investigation of the Trias and to collect saurians and fishes. The occurrence of phosphorite at Cape

Thordsen was to be investigated, as well as the extent of the coal beds at Pyramid Hill and Bünsowland. Investigations in the Devonian rocks are to be continued and their vertebrate fossils collected. A large expedition of miners and mining engineers also left Sweden about midsummer to exploit the Coal Measures of Spitsbergen, and was accompanied by Dr. Anteus as geologist.

THE Committee of the Privy Council for Scientific and Industrial Research, on the recommendation of the Advisory Council and at the request of the Home Office, has sanctioned the appointment of a committee with the following terms of reference:—"To inquire into the types of breathing apparatus used in coal mines, and by experiment to determine the advantages, limitations, and defects of the several types of apparatus, what improvements in them are possible, whether it is advisable that the types used in mines should be standardised, and to collect evidence bearing on these points." The members of the committee are:—Mr. W. Walker, Acting Chief Inspector of Mines under the Home Office (chairman), Dr. J. S. Haldane, and Dr. H. Briggs. Mr. A. Richardson has been appointed secretary to the committee, and Dr. H. Briggs has been constituted director of the inquiry.

AT the representative meeting of the British Medical Association held on July 26, the council reported that the only possible method of placing the health administration of the country on a sound basis was by the creation of a Ministry of Health. The recommendations of the council were as follows:—That a Ministry of Health should be created to take over from existing Government Departments such duties as are concerned with the health of the community, and to deal with those duties only; that the administrative functions of the Ministry should be carried out by a Board presided over by a Minister of Cabinet rank; that the country be divided into suitable administrative areas under local administrative health centres consisting of representatives (*a*) of the rating authorities; (*b*) of the education authorities; (*c*) of the persons contributing to a scheme of health insurance (including employers of labour); (*d*) the medical profession; (*e*) public hospitals; (*f*) dentists; (*g*) pharmacists; and (*h*) nurses; that the principal medical officers of each centre should be two, of equal status, one representing the clinical side (chief clinical officer) and the other the preventive side of medicine (medical officer of health); that for each area, hospitals, clinics, or treatment centres should be recognised or established at which persons entitled to treatment under the public scheme should be able to obtain institutional, consultative, or specialist services on the recommendation of their medical attendant. The meeting approved of the appointment of a Ministry of Health by a large majority.

NEWS of the American Crocker Land expedition is published in *Science* for June 29 from information supplied by Dr. H. J. Hunt, surgeon of the expedition, who arrived in New York on June 20 from Greenland *via* Copenhagen. The expedition was at Etah in northern Greenland when Dr. Hunt left it last December. He reports that it had enough provisions to last until about August 1 this year, after which it must depend upon walrus and caribou. However, the relief steamer *Danmark* was at North Star Bay, a sledge journey of about 150 miles from Etah, so there should be no fear of the expedition starving. The *Danmark,* when Dr. Hunt left her, was frozen in and short of coal, but had ample stores. She will probably get free from the ice this summer, but in order to ensure the safety of the explorers, the *Neptune* has been chartered and sent north under Capt. R. A. Bartlett. Dr. Hunt, in his journey to the Danish settlements of Greenland, had to sledge 1400 miles between December 18, 1916, and April 16 of this year. Part of the way he was accompanied by the Danish explorer, Knud Rasmussen. Eskimo were with him throughout the journey. The expedition, which is under the leadership of Mr. D. B. Macmillan, reports a considerable amount of work, especially geological. Seismological observations have been taken at Etah.

THE Trematode, *Schistosoma* (*Bilharzia*) *mansoni,* occurs frequently in man in Venezuela; adult specimens of this parasite were found by Dr. Risquez (1916) during post-mortem examinations in the School of Medicine at Caracas in 20 per cent. of the cases. Drs. Iturbe and González have recently published, from the laboratory of the former, an account (8 pp., two plates) of experiments made with the view of finding the intermediate host of this parasite in the neighbourhood of Caracas. The four common fresh-water "snails" of that area are two species of Planorbis, an Ampullaria, and a Physa, and the first three can be infected experimentally by adding to the water in which they are living the ciliated larvæ, or miracidia, of *S. mansoni,* but it is evident that *Planorbis guadelupensis* is the only species which naturally serves as the intermediate host of *S. mansoni.* The development of the miracidium in this Planorbis, and the formation of rediæ (described as having a widely open mouth and a rudimentary gut) and cercariæ, are in accord with the account by Miyairi and Suzuki of the corresponding stages of *S. japonicum.* The cercariæ of *S. mansoni,* after escaping from the infected Planorbis, can live in water for at least twenty-four hours. Experiments on white rats and on young rabbits and dogs showed that they acquire the parasite by the entry of cercariæ by the mouth or through the skin, though the actual penetration of the skin by the cercariæ was not observed. Naturally infected *Planorbis guadelupensis* were found in six of the seven localities examined near Caracas, and of 400 specimens from one of the canals 120 proved to be infected.

Two interesting and timely contributions on experimental work at the South-Eastern Agricultural College, Wye, furnish the main features of the June issue of the *Journal of the Board of Agriculture.* Prof. E. S. Salmon summarises the results of several years' experiments in potato-spraying with Bordeaux and Burgundy mixtures at the college in an article which, by the results quoted and the accompanying photographs, is calculated to remove the last doubt as to the economic soundness of the practice. In each of the five years the sprayed crops produced, not only an increase in the yield of tubers ranging from one ton to five tons per acre above the yield of the unsprayed crops, but the proportion of "ware" and of sound tubers was also markedly superior. The results further indicate that spraying is only effective when applied before the appearance of the "blight," and that the benefits of an early spraying can be substantially increased by a second spraying. Wet spraying proved superior to dry spraying in the one comparison made.

DR. J. VARGAS EYRE and Mr. S. T. Parkinson contribute to the June issue of the *Journal of the Board of Agriculture* a report on an inquiry carried out at Wye into the possibility of conserving surplus plums by drying. The investigations cover the preliminary treatment of the fruit to facilitate drying, the relative merits and efficiency of hot-air and vacuum drying, and the final treatment of the dried product to render it more attractive. The best results and most speedy drying were obtained with the vacuum machine and at a temperature of 70° to 80° C. The most effective preliminary treatment was to expose the plums to the vapour of chloroform, whereby the rate of drying was appreciably reduced and a somewhat superior product obtained. A substantial improvement in the quality of the product was obtained by heating the dried plums in a limited quantity of steam in a closed vessel for a few hours. Further articles of interest in the same issue of the *Journal* are an account, by Mr. G. P. Berry, of studies of pollination problems carried on in cherry orchards in Kent, and a summary by Miss W. Brenchley of observations made at Rothamsted on the viability of buried weed seeds.

MR. S. HIBINO, in vol. xxxix. of the Journal of the College of Science, Tokio, has made some observations on the effect of "ringing" the stem of *Cornus controversa*. In these experiments either the cortex alone, or the cortex together with the outer layer of wood, was removed. One of the effects of ringing is to cause a development of anthocyan in the leaves, not only above, but also below, the seat of injury. The leaves also, especially if the wood is injured, gradually lose their colour and fall earlier than normal ones. The water content of the leaves of a "ringed" tree gradually decreases, the uppermost leaves being the first to be affected. The leaves above the position of ringing contain more starch and show a much greater diastase activity and a larger content of reducing sugar, also an excess of oxydase and peroxydase. The buds of ringed trees unfold their leaves much later the next spring than do those of normal trees; on the other hand, the ringed plants flower earlier and more freely than normal ones, and produce a bigger crop of fruit. Immediately below the seat of injury there is a marked development of adventitious shoots.

IN the July issue of *Man* Sir D. Prain endeavours to decide the geographical diffusion of kava and betel. The former, an infusion of *Piper methysticum*, is said by Drake del Castillo to occur spontaneously and as a cultivated plant in the Society and Marquesas Islands. But it has to be kept in mind that such a plant may be spontaneous without being necessarily native, and we have no record save that of Drake as to its having been found in a wild state. It is not wild in the Sandwich Islands, and it seems to be only a cultivated plant in Fiji, while it is said not to be known in those islands which are inhabited by Papuans. The case of betel (*Piper betel*) is not so uncertain. It clearly came to India from the Malay Peninsula, but it is doubtful if it is a true native of Java. It is said to be wild in Celebes and probably in the Moluccas—an interesting point, because these islands lie east of the "Wallace Line," and from the botanical point of view all east of the "Wallace Line" is Papuasia, though it is more usual to consider Celebes and the Moluccas as integral portions of Malaysia. The result of the inquiry is that betel is of Papuasian origin, and that its use spread thence westward to Malaya proper, and from there to India; while kava is of extra-Papuasian origin, though where that origin is to be sought is far from certain. All that can be said with safety is that the probabilities point to Polynesia.

IN the *Meteorological Office Circular*, No. 13, attention is directed to the official substitution of the names "Richmond" and "Cahirciveen" for Kew and Valencia Observatories respectively. The auxiliary sunshine station which has been called Richmond in the Monthly Weather Report will be known as Richmond Hill. It is of interest to note that Valencia Observatory was originally on Valencia Island, but was moved to Cahirciveen in 1891.

THE *Jahrbuch des Norwegischen Meteorologischen Instituts* for 1916 has been published. This useful volume contains detailed observations at the observatories of Christiania and Aas, a summary of the year's observations at twelve stations, and the yearly and monthly means of all the stations in Norway. In addition there is an appendix giving the detailed pressure, temperature, and other readings at Green Harbour, Spitsbergen (lat. 78° 2′ N., long. 14° 14′ E.), from September, 1915, to June, 1916.

RECENT monthly and annual results of magnetical, meteorological, and seismological observations, made at the Royal Alfred Observatory, Mauritius, under the directorship of A. Walter, give valuable data for the several elements of specified branches of work. Observations are brought into line with the change of units now generally adopted in this and other European countries, except that for meteorological results the temperatures are given in degrees Centigrade, and to obtain temperatures in Absolute scale 273° have to be added. This method of giving temperature results has much in its favour, and little exception can be found provided that the method adopted is always clearly stated. The magnetical and meteorological observations in the monthly results are given for each hour, and the range in the various elements affords material of value for the inquirer. A table of monthly rainfall is given for about 150 stations in the island. As 1915 closes the eighth quinquennial period of observations, the annual report gives the monthly and yearly normals of the meteorological elements for forty years. Modern units are employed. Attention is directed to a marked periodicity with an interval of about eighteen and a quarter years between successive maxima in certain elements, and a more detailed discussion of the forty years' records is promised. More information on methods employed would enhance the value of results and would prevent possible misunderstanding; for instance, the table of results for forty years bears no evidence that the atmospheric pressure observations are uncorrected for height above sea-level, 181 ft., or that all other corrections have been applied, but the system generally adopted can be culled from parts of the monthly publications.

AT the meeting of the conference of delegates of the Corresponding Societies of the British Association held in London on July 5 Mr. T. Sheppard was asked to open a discussion on the metric system, as showing the need for some such scheme in the interests of the advancement of science. Mr. Sheppard gave an account of the various specimens of money scales and weights in use from early Greek and Roman to Victorian times. By far the finest collection of these money scales in the country, consisting of more than 200 varieties of boxes, now in the Hull Museum, was brought together by Mr. Sheppard, with the help of Mr. J. F. Musham, of Selby. The lecturer dealt with the absurdities of the system of weights and measures, illustrated, as regards money weights, by a series of specimens from the Hull collection. A long discussion ensued, which was continued on the following day. Mr. Sheppard's paper will be printed *in extenso* in the annual report of the British Association.

THE Canadian Department of Mines has issued the annual report on the mineral production of Canada for the year 1915, and it is satisfactory to note that, in spite of the adverse conditions necessarily created by the war, the mineral industry is in a flourishing condition. Although the value of the production has not reached the high record of 1913, it nevertheless shows an increase of 6·4 per cent. over that of 1914, this increase being, however, by no means uniform all round. There have been considerable decreases in the production of such building materials as clay, lime, sand, etc., whilst the quantities of all the metals produced, with the sole exception of silver, show marked increases; the increase in the output of pig-iron produced from Canadian ores amounts to nearly 63 per cent., and in the output of copper to 33 per cent. Of non-metallic minerals, coal is still by far the most important, its value being returned as 23·42 per cent. of the total value of all Canadian mineral products; the output, practically $13\frac{1}{4}$ million (short) tons, shows a trifling falling off from the output in 1914; this decrease appears to be entirely due to shortage of labour. In this connection, attention may be directed to Bulletin No. 14, recently issued by the department, on "The Coalfields and Coal Industry of Eastern Canada," which gives an excellent account—historical, geological, technical, and economic—of the coalfields of the maritime provinces. The important part that these coalfields are playing in the industrial development of Canada is well brought out in this useful monograph.

IN the Christiania *Forhand*, 1907, Prof. C. Størmer gave a theoretical discussion of the motion of an electron round a centre of force from which a magnetic and also an electrostatic field originated, a problem which has also been treated by Principal Hicks in the Proc. Royal Soc. (vol. xci., A). In a publication recently received, "Sur un Problème relatif au mouvement des Corpuscules Electriques dans l'espace cosmique" (Christiania: Videnskabssel Rabets Skrifter, 1917), Prof. Størmer gives a series of numerical calculations of orbits about a magneto-electric centre. Obviously orbits of given energy must be confined to surfaces of revolution about the magnetic axis. Diagrams and photographs of these surfaces are given in profusion, the latter being obtained by photographing the rapid rotation of a whitened wire bent to the shape of the generating curve. The title of the memoir is somewhat misleading, for it is purely mathematical, and there is no discussion of the bearing of the results obtained upon the problem of the motion of electrons in cosmic space.

THE paper on dielectric losses in insulating materials read before the American Institute of Electrical Engineers in March by Mr. C. E. Skinner, of the research department of the Westinghouse Company, is published in full in the June number of the Journal of the Franklin Institute. The material is tested either in sheets or when built into the transformer or alternator in which it is used. It is subjected to an alternating voltage up to 50 kilovolts at a frequency of 25 to 60. The power absorbed by the insulator is measured by the quadrant electrometer wattmeter method, the difference of potential between the needle and quadrants of the electrometer depending on the voltage applied to the specimen, while the difference of potential between the pairs of quadrants is proportional to the current taken by the specimen. The curves for the various materials given in the paper show that the power absorbed by the dielectric is equal to the product of a constant into the nth power of the voltage applied. The value of n is not given, but from the curves it appears for a given material to be nearly independent of the temperature and of the frequency of the alternations, while the constant depends on both these quantities.

A PAPER on "The Action of Chemical and Physical Agents on some Types of Scientific Glassware," by J. D. Cauwood, S. English, and W. E. S. Turner, was read at the meeting of the Society of Glass Technology held in Manchester on July 25. Soon after the outbreak of war, chiefly owing to the insistent demands of the Sheffield steel works' chemists, steps were taken to promote the manufacture of high-grade chemical ware in this country. How well the glass manufacturers have risen to the occasion is shown by the results given in the paper, for it appears that glasses have been produced as good as, if not better, in some respects, than, the best German glasses. The method employed in the research had been to subject Jena glass, five new British resistance glasses, and a few chemical glasses made in Allied and neutral countries to a series of fourteen definite tests. In every test applied the British glasses compared most favourably with Jena glass, in some of the tests even surpassing it.

PROF. J. SEBELIEN, of the Norwegian Agricultural High School of Aas, has recently (*Tidsskr. for Kemi, Farmaci og Terapi*, Nos. 5–8, 1917) published the results of a comparative examination of chemical glass and porcelain ware and of filter paper from various sources. It would appear that owing to the war the former German monopoly is also threatened in neutral laboratories. The Swedish glass of the Limmared works compares favourably with Jena glass as regards resistance to chemical reagents, particularly to potassium hydroxide, which dissolves considerable quantities of silica and of boric acid from Jena glass. The laboratory porcelain of the Royal Porcelain Works at Worcester was found to be quite as good as that of the Berlin factory; both these are superior to the Haldenwanger and the Bayeux products. The author confirms the findings of the National Physical Laboratory with regard to the Worcester porcelain, which is slightly less resistant to heat changes than that manufactured in Berlin, and slightly more resistant to chemical reagents. Munktell's Swedish filter paper was found superior to others tried as regards low ash content and uniformity, some of the German kinds showing considerable variations. The Whatman papers compare favourably with the German makes, the excellence of which is by no means so exclusive as the makers would suggest. With respect to chemicals, Norway appears to have been almost absolutely dependent on imports from Germany, but some substances are now being manufactured. The author points out that the war has taught Great Britain to free herself from Germany in the matter of pure laboratory reagents, and expects that after the war these will be obtainable in his country at the same prices as the German products.

Engineering for July 27 contains an account, with drawings, of the wooden ships which are being built in the United States in order to compensate for the war losses in the mercantile marine without making great demands on steel, which is required in ever-increasing quantities for war munitions. The specifications for the ships illustrated were prepared by Mr. Theodore Ferris, the naval architect of the United States Government Shipping Board. The vessels are of the single-deck type, 281 ft. 6 in. long, 46 ft. beam, and 26 ft. moulded depth. The total estimated deadweight is 3500 (long) tons; the sea speed, loaded, will be 10 knots, and two 3-in. guns will be carried. Four caulked watertight wooden bulkheads extend to the upper deck, forming two cargo holds and the machinery space. The propelling machinery may consist of one triple-expansion engine, or twin-screw reciprocating engines, or geared turbines, subject to the approval of the owners. The timber used in the construction of the vessels may be either dense southern yellow pine or Douglas fir, with stern-post, rudder-post, etc., of white oak. Wood knees will be of hackmatack or oak. Joiner sheathing and decks will be of cypress.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have published a useful catalogue (No. 166) of scientific books, periodicals, and publications of scientific societies, which will be sent upon written application. It is conveniently classified under the headings of agriculture and husbandry; horses and horsemanship; botany; chemistry; geology, mineralogy, and palæontology; zoology, biology, and Nature-study; physiology, anatomy, and medicine (sub-section, dentistry); mathematics, physics, and engineering; and astronomy. It includes a selection from the library of Dr. L. C. Miall, and works on conchology and malacology, mainly from the library of the late Prof. H. M. Gwatkin.

SOTHERAN'S "Price Current of Literature" (H. Sotheran and Co., 140 Strand, W.C.2), No. 769, has just appeared under the appropriate title of "The History of Civilisation," seeing that it deals with works on anthropology, folk-lore, archæology, and sociology. It is a valuable catalogue, classified under the headings of general works, early and primitive man, and the dawn of civilisation—(*a*) Oriental and (*b*) Occidental—and contains particulars of the library of the late Sir Laurence Gomme.

A NEW and revised edition of vol. i. of Dr. G. McCall Theal's "History and Ethnography of Africa South of the Zambesi" is announced for immediate publication by Messrs. George Allen and Unwin, Ltd. The work covers the period from the settlement of the Portuguese at Sofala in September, 1505, to the conquest of Cape Colony by the British in September, 1795.

A CATALOGUE (No. 376) of books on architecture, art, archæology, etc., has just been issued by Mr. F. Edwards, 83 High Street, Marylebone, W.1.

OUR ASTRONOMICAL COLUMN.

COMET 1916*b* (WOLF).—The following is a continuation of Messrs. Crawfurd and Alter's ephemeris, of this comet for Greenwich midnight, as given in Lick Obs. Bulletin, No. 295:—

1917	R.A. h. m. s.	Decl. ° ′ ″	Log Δ	Brightness
Aug. 1	23 29 14	+22 10 13	0·0088	2·68
3	30 48	21 44 21	0·0065	
5	32 15	21 16 23	0·0043	2·68
7	33 33	20 46 20	0·0023	
9	34 44	20 14 14	0·0005	2·67
11	35 48	19 40 6	9·9989	
13	36 44	19 4 0	9·9976	2·65
15	37 32	18 25 58	9·9965	
17	38 14	17 46 5	9·9957	2·61
19	38 49	17 4 26	9·9953	
21	39 18	16 21 8	9·9951	2·55
23	39 41	15 36 17	9·9953	
25	39 58	14 50 2	9·9959	2·48
27	40 10	14 2 31	9·9968	
29	40 18	13 13 55	9·9981	2·39
31	40 22	12 24 23	9·9998	

The unit of brightness is that on April 21. An ephemeris by Dr. Kobold (*Ast. Nach.*, No. 4892) gives the magnitude of the comet during early August as 10·0. The comet will be in opposition on September 17.

VARIABLE PROPER MOTION OF δ CASSIOPEIÆ.—An investigation of the Pulkowa observations of the zenith star δ Cassiopeiæ has been made by L. Courvoisier in relation to Guthnick's discovery that this star is an eclipsing variable having a period of about 2·1 years (*Ast. Nach.*, 4891). It results from the discussion that there is a variation in the proper motion arising from the binary character of the star, and that the amplitude in declination of the two-yearly oscillation amounts to $0{\cdot}04'' \pm 0{\cdot}01''$. The correction to the assumed value for the aberration constant, $20{\cdot}47''$, is $+0{\cdot}01''$, and the deduced parallax of the star is $+0{\cdot}11''$.

THE NEEDS OF ASTRONOMY.—The Astronomy Committee of the National Research Council of the United States has issued an interesting report on the most pressing needs of astronomy. The best immediate use of a fund for astronomical research is considered to be the provision of increased facilities for observations in the southern hemisphere, and the erection of large reflectors in both hemispheres for the extension of nearly every research to very faint stars. The provision of more assistants to aid in carrying on extensive routine observations would also secure a relatively great increase in the output of existing institutions. The twenty examples of work of a more or less routine character which are specified include determinations of the positions of all stars of ninth magnitude and brighter, proper motions of all stars down to magnitude 7·5, and parallaxes of all stars down to magnitude 6 and of specially selected fainter stars. Photometric observations of all stars to ninth magnitude, determinations of the radial velocities of all stars of magnitude 6 and brighter, and the more systematic observation of double and variable stars also form part of the suggested programme. One important outcome of such routine work would be the publication of a catalogue of all stars down to magnitude 6·5, giving for each the approximate position, proper motion, radial velocity, magnitude, spectrum, colour index, etc., which, it is suggested, should be brought up to date every three years. The possible services that astronomers can render in the war are under consideration.

THE TRANSLITERATION OF RUSSIAN.

THE transliteration of Oriental and other characters into Roman script naturally varies with the genius of the language into which the transliteration is made. The diversity of the resulting metamorphoses is bewildering, and any attempt to evolve cosmos out of this chaos should be welcome. As regards Russian names, with which we are immediately concerned, such an attempt has been made, for bibliographical purposes, by the Russians themselves, under the auspices of no less an authority than the Academy of Sciences of Petrograd.

To give some idea of the importance of this system of transliteration, the use of which has not yet extended beyond scientific circles, a brief relation of the circumstances which led to its inception may not be out of place. The beginning of this century witnessed the birth of a great scientific bibliography, published by the Royal Society of London under the title of "The International Catalogue of Scientific Literature." It is, in effect, a continuation of the Royal Society's "Catalogue of Scientific Papers," which is now in course of completion up to the close of last century. It is carried on, as its name implies, by international co-operation, and it is supported by almost the whole of the civilised world. One of its distinctive features being that it records the work of scientific investigators in their original language, the alphabetical arrangement of authors' names necessitated the adoption of a system of transliteration for each language which does not employ Roman script. The Petrograd Academy of Sciences thereupon applied itself to the problem of Russian names, and referred the matter to a special committee consisting of H. G. Zaleman (chairman), F. E. Korš, E. I. Lamanskij, N. A. Menšutkin, and A. A. Šachmatov. The result of its deliberations was the elaboration of a system of which the underlying principle can be explained in a very few words. It is based on the phonetic value of the Bohemian alphabet. Bohemian being a Slav language which employs Roman script, the materials for a consistent and intelligible scheme of transliteration lie ready to hand. This alphabet with its diacritic signs enables us in most cases to represent one Russian letter by one Roman letter, and this in itself constitutes an improvement on the systems previously in vogue, notably on the Continent of Europe, most of which are vitiated by imperfect phonetic apprehension.

The following is a summary of the report of the committee :—

"The basis of the transcription is the phonetic value of Roman letters in the Bohemian alphabet :—

а б в г д ж з і, и й к л м н о п р с т у ф
a b v g d ž z i, j k l m n o p r s t u f

х ц ч ш щ ы ѣ э ѳ ѵ
ch c č š šč y ě e f i

я, ю, at the beginning of a syllable, and consequently also after ъ, ь, which are omitted, are written ja, ju, but, after consonants with which they form one syllable, ĭa, ĭu. In like manner е and ѣ after ь, ъ are written je, jě, but after consonants simply e, ě. At the beginning of proper names the simple e should be used, *e.g.* Egorov, not Jegorov. After ь, i should be replaced by ji.

"The letter ъ is not transcribed, but ь at the end of a word and before consonants is written ĭ, *e.g.* дать = datĭ, конь = konĭ, большой = bolĭšoj. The accented е pronounced jo is represented, as in Russian, by ë, but in the case of proper names the diæresis should not be used unless the author himself uses it, *e.g.* Чернышевъ = Černyšev, Ëвшинъ = Ëvšin, Берёзинъ = Berëzin."

To attempt by any system of spelling to reproduce the well-nigh infinite inflexions of the human voice is to attempt the impossible, but there is one important point in the above scheme which, whether by inadvertence or design, seems to have been passed over. No mention is made of the genitive termination го, where г invariably has the sound of v. Добраго were better transcribed Dobravo than Dobrago.

It may be objected that such a system is not suited to English-speaking countries, that the introduction of the Bohemian alphabet further complicates matters. The reply is that it was devised, not with special reference to English or for the purposes of teaching, but primarily to meet the needs of international bibliography. It should be mentioned that it has been adopted by the Royal Society in its "Catalogue of Scientific Papers" and by "Minerva: Jahrbuch der gelehrten Welt," published at Strassburg, and that it is obligatory for all work in connection with the International Catalogue of Scientific Literature. It seems opportune at the present moment to direct attention to the existence of a system of transliteration which it is hoped will in time supersede all others for bibliographical purposes, and which bears the imprimatur of the Russian authorities, who earnestly desire its extended adoption.

EDWARD FOORD.

SCIENCE IN EDUCATION AND ADMINISTRATION.

THE subjoined Memorandum has been approved by the Senate of the University of London and transmitted to the Treasury, the Board of Education, the Civil Service Commission, the Committee on Science in the Educational System of Great Britain appointed by the Government, and the Royal Society :—

1. Primary and secondary education should be directed towards making active and useful citizens, and should include the development of mind and character and instruction in the fundamental branches of knowledge.

Literary, linguistic, mathematical, and scientific studies should be regarded as fundamental branches of knowledge, and each pupil should receive some instruction in all these branches. In the case of pupils who pursue their education beyond the age of sixteen, these subjects should as a rule be continued, and public and secondary schools should not undertake specialised training in professional subjects.

Opportunities for learning Latin and Greek should be given in one or more schools in every educational area.

While it is not desirable that it should be compulsory on all pupils, some form of artistic and manual training is to be regarded as of very high importance.

2. The teaching of natural science (including physics and chemistry) should be compulsory in all secondary schools, both boys' and girls' schools.

3. All secondary schools retaining pupils beyond the age of sixteen should be capable of providing instruction in the science subjects of the entrance examinations of the universities up to the standard required for these examinations.

4. Special technical day schools, in accordance with local needs, should be established in all industrial centres for boys and girls between thirteen and sixteen years of age who wish to enter the technical (including engineering, chemical, and artistic) industries at the age of sixteen.

5. In order to secure for science teaching the position to which it is entitled, and which for the benefit of the nation it ought to occupy, the schemes under which the great public schools are administered should in each case contain provisions to the effect :—

(*a*) That the governing body shall include a substantial number of representatives of the learned and scientific societies, and

(*b*) That members of the governing body shall not hold office for life.

Without such provisions, it is probable that men distinguished by mathematical or scientific attainments will continue to be at a disadvantage in applying for appointment to headmasterships of public schools.

Greek should not be a compulsory subject for entrance scholarships to these schools; and adequate facilities (including equipment) for learning science should be available for, and accessible to, all their pupils.

6. The number of branches in which a first university degree can be taken should not be unduly multiplied, but students who have taken a first degree in science should be encouraged by the institution of higher [M.Sc.] degrees, especially in technical branches, to specialise in particular branches of science, or in their applications to industry. The preparation for such degrees should include some training in the methods of research.

7. The present arrangement for the selection of first division clerks in the Civil Service should be modified so that on every occasion an adequate proportion of those appointed must have had mathematical or scientific training.

8. In all selections for the higher administrative posts for the Government Departments the work of which is of a scientific or technical character the official selected ought to have received such a scientific training as will fit him to understand the character of the work for the organisation of which he will be responsible.

RADIO-ACTIVE HALOS.[1]

THIS discourse is concerned with certain very minute objects of the rocks—so minute as to be visible only with the aid of the microscope—known to petrologists by the cumbersome name of "pleochroic halos." Although we shall be occupied mainly in considering quite recent additions to our knowledge of halos, yet, in view of the fact that many of this audience will probably hear of them now for the first time, it is necessary to begin with some elementary remarks.

The halos of the rocks have been known since the application of the microscope to rock study; but until recently their origin and nature were quite unknown. Nor could it have been otherwise, for they find their explanation in the facts of radio-active science only—a science the origin of which dates back but little before the beginning of the present century. The student of the rocks in past times seems to have regarded these objects with but little more than passing interest. Had he paid more attention to them a case replete with extraordinary mystery could have been made out, and one which at the time must have remained absolutely inexplicable. The lack of attention to the detail displayed by halos, and the failure of the earlier observers to notice the mathematical regularity of their dimensions, well illustrate how advance in one domain of science may influence our recognition of facts in another.

The most familiar type of halo consists simply of a darkened border surrounding some minute mineral particle within the rock. The formation of the coloured border indicates some alteration in the medium in which it is formed, and this alteration is evidently conditioned by the presence of the central mineral. If the latter is very small and about equally developed in all directions, the halo takes on the form of a sphere having at its centre the mineral which has originated it. In a section of the medium containing the halo this sphere appears as a coloured disc; but as we find the same appearance, no matter in what direction we section the halo, its spherical form is beyond doubt.

Certain facts respecting the formation of halos have for long been available. Only quite a few substances can originate a halo. Of these the minerals zircon and orthite are the commonest, and the first much more so than the second. Again, only in certain media surrounding such minerals can a halo be developed. Of such media the several varieties of brown mica are the most abundant and the most valuable. It would appear that all media sensitive to the formation of halos contain iron as a constituent.

While these facts have long been available, the next I have to mention is a recently discovered one. All those minerals which give rise to halos are found, when examined in large crystals, to contain radio-active substances.

Now, such substances, we well know, are continually radiating. They give out various sorts of rays. This leads us to suspect that the halo may, in fact, be generated in some way by these radiations. There are three sorts of radiations—the α, β, and γ rays. The last two cannot possibly be responsible. They are far too penetrating to account for these microscopic effects. The α rays can alone be concerned.

Before pursuing further our inquiry in this direction, let us examine the nature of the halo itself. It is not merely a stain or lodgment of colouring matter in the medium. If we apply optical examination with polarised light to a halo in brown mica we find that the peculiar optical properties of the mica, which are, of course, referable to the orderly arrangement prevailing among its molecules, exist within the halo just as elsewhere. In fact, we might say they are accentuated. The remarkable absorption of the ray polarised in the plane of cleavage of the mica is more complete in the halo. We occasionally see a halo which extends across the edges of two distinct flakes of mica. If the light is polarised and the plane of polarisation is in the plane of cleavage of one of the flakes, and is inclined to the cleavage of the other flake, that part of the halo which is contained in the first crystal of mica is intensely black. In the other crystal of mica the halo is much lighter in colour. Plainly the effect upon the mica, however exerted, has been such as to increase the absorption of a ray vibrating in the plane of cleavage. The crystallographic structure has not been disturbed. If iron is not a constituent of the medium no visible effect is produced.

Of the last statement we sometimes find very beautiful evidence in the case of halos which originate from a nucleus located outside the sensitive medium, but within a certain distance of it. Fig. 1 will explain. The originating crystal is in quartz, a substance which never contains halos. There is no iron in its constitution. But the halo-forming influence extends to a neighbouring crystal of mica. This influence, which develops an outlying part of the halo-sphere in the mica, must have traversed the quartz. It has left no record therein. If the halo was something of the nature of a stain diffused outwards from the central substance—as some of the earlier observers maintained—the absence of the colouring material from the quartz is not easily explained. But if the halo is—as we have hinted—due to radiations proceeding from the zircon—radiations which only affect certain unstable atoms—the appearance at once finds simple explanation. The quartz is not sensitive to the rays; the mica is.

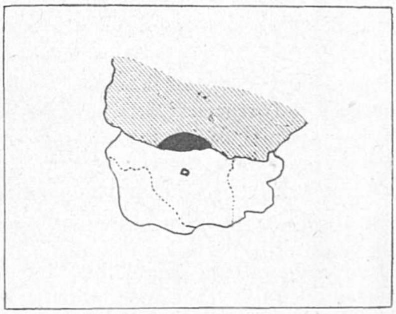

FIG. 1.—Nucleus of halo located outside a sensitive medium.

But the primary evidence for the radio-active origin of the halo is to be found in its dimensions. The fully developed halo has been found in two sizes. One of these shows a radial dimension of 0·0333 mm.; the other scales, radially, 0·0408 mm. There are two primary radio-active elements, as everyone knows—uranium and thorium. If the central or originating substance contains uranium it will of necessity contain all the eight α-ray-emitting substances which the uranium-radium series embraces. Similarly, if the central substance contains thorium, there are seven α-ray-producing substances which must be present. Now each of these various radiating substances emits α rays which possess a certain specific velocity of emission, and, consequently, a specific power of penetration. The most penetrating ray of the uranium series is that of radium-C. In air this ray will travel 6·94 cm. before it comes to rest. The most penetrating ray of the thorium series is that of thorium-C_1. This will penetrate 8·60 cm. before coming to rest. A very few rays travel further, but this does not affect the matter. Now Bragg has shown how we may calculate the range in any medium if we know its chemical

[1] Discourse delivered at the Royal Institution on Friday, May 11, by Prof. J. Joly, F.R.S.

composition and its density. We can, accordingly, calculate what the range of these extreme rays should be in mica. When we do so we get exactly the dimensions of the two sorts of halo. We shall presently see that even this evidence is but a part of the case for the radio-active origin of the halo.

Uranium halos—that is to say, those in which uranium is the parent radio-active mineral contained in the central zircon—are common. Such are not generally capable of accurate measurement. But in clear, flawless mica, viewed on the plane of cleavage, halos of extraordinary delicacy and sharpness of outline are sometimes met with. Again, the halo is often completely blackened up. Such halos may be described as "over-exposed." As in the case of different exposures in photography, we find every gradation in the amount of detail according to the amount of action which has taken place.

We must remember that the causes which have given rise to the halo are highly complex. We may represent the several rays concerned as generating a number of concentric spheres of ionisation, the radii of which are in correct relative proportion to the penetration of the several rays.

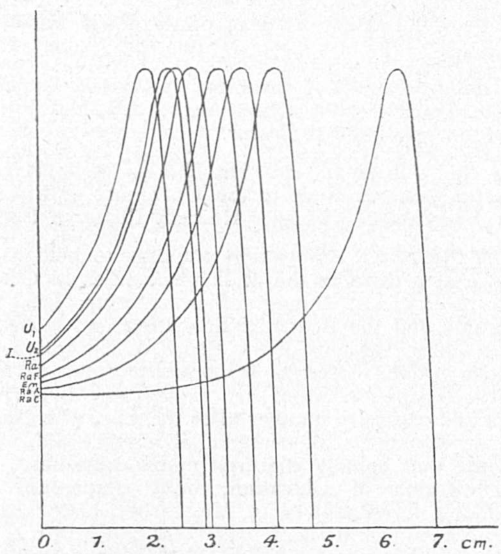

FIG. 2.—The eight ionisation curves forming the uranium halo.

But this fails to represent the full complexity of the conditions. Each ray behaves in a very remarkable way. To enter into this matter here is impossible. We must be content to recall that the effects of the α ray in ionising the medium in which it travels varies along its path. It appears certain that its influence on the mica, or in whatever mineral it generates the halo, depends upon its power of ionising the atoms with which it comes into effective contact. Now the number of ions created along its path remains at first fairly constant, but rapidly increases towards the close of its career, just before its effects become naught. Bragg's well-known curve shows the manner in which the ionising effects in air of a single α particle vary along its course. This curve applies to all rays, however short the range; we must simply curtail the length of the earlier part of the curve when the range is short.

Now, if we assume that the distribution of effects of the ray along its course in the mica are much the same as they are in a gas, we see that along any radius of the halo-sphere we must admit the effects of eight rays, each ray penetrating a distance depending on its initial velocity and acting upon the mica in the manner represented by the Bragg curve of ionisation. Fig. 2 shows you this state of affairs. We assume that by adding the ordinates at any point we can find the integral or total ionisation due to all eight rays so far as they produce an effect at that point. The curve of total ionisation follows (Fig. 3).

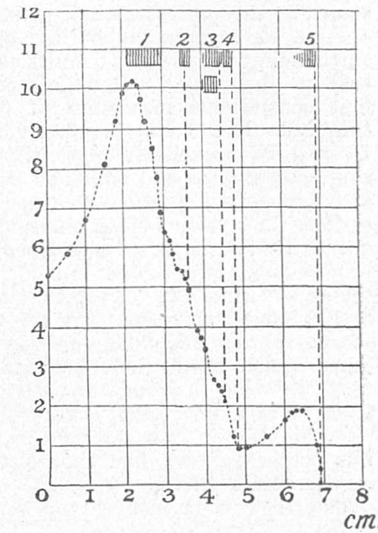

FIG. 3.—Integral curve of ionisation for uranium halo.

But even this curve does not represent the entire conditions. It may be said to represent the effects along a radius of the sphere which has been traversed by all the eight rays. But the radii of the sphere are, of course, diverging from the centre. The net effects which generate the halo must therefore grow weaker outwards. When we make the requisite allowance for this, nearly all the detail of the last curve disappears, and we are given as the theoretical structure of the halo a steadily diminishing density outwards until we reach such a distance from the centre that RaC_1 or ThC_1—as the case may be—begins to exert its separate effects. These effects then appear as a penumbra-like border surrounding the inner darkening. I now show you, for the case of the uranium halo, this final curve of development (Fig. 4). Halos exhibiting a character in fair conformity with the curve are not uncommon.

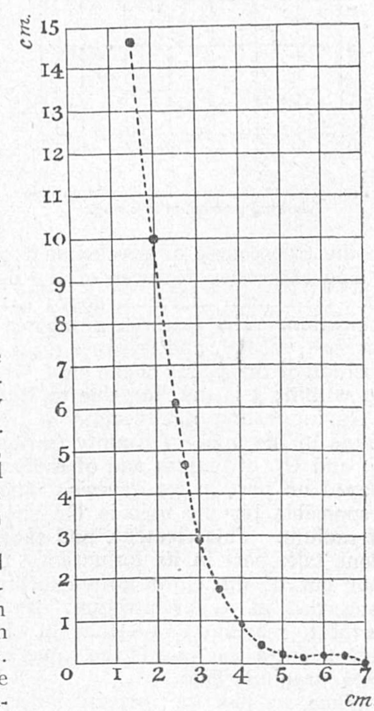

FIG. 4.—The integral curve modified by spreading of the rays.

But, as I have said above, less exposed halos show considerable detail. We find, in fact, that separate and individual rings are developed in the growing halo. Plainly this should not be if the development was in accordance with the last curve. Under favourable conditions such recalcitrant halos are met with. It is quite evident that they are out of agreement with the theoretical curve. The growth has not been one of uniform darkening outwards with the final addition of the penumbra due to RaC_1. And, most contradictory of all, we see that the effects of RaC_1 show themselves while the inner rings are still in an early stage of development.

But if now we return to the first curve of development—that one which takes no account of the spreading of the rays—we find a scheme of development which closely coincides with the actual details as observed in the process of halo-growth.

First, we have a solitary ring, or shell, of ionisation surrounding the nucleus. In its earlier stages it is not easy to photograph. It plainly corresponds with the first conspicuous maximum of the ionisation curve (Fig. 3). This I call the first ring. The rays from U_1 and U_2 are chiefly responsible for it. This first ring, accentuated and darkened within, is often found in a succeeding stage of development along with the earliest impression of the outermost ring of all, that due to RaC_1. Next, outside the first ring, appears a very delicate and seldom-found ring, which I name the second ring. It corresponds, apparently, with the first notable excrescence on the downward slope of the curve. By the time this ring has developed, the inner region of the halo has considerably blackened up. Nor have I found this second ring without the presence of a third ring surrounding it, and evidently referable to the next excrescence on the curve. At this stage, too, we find that RaC_1 has still further registered its effects.

The stage which succeeds shows the inner detail out to the third ring obliterated in the accumulating ionisation. There is now, therefore, a central pupil surrounded by the third ring and outside all the border due to RaC_1. A yet more advanced stage finds the third ring also swallowed up in the inner darkening. This is the stage which in itself is deceptive as to the true course of development of the halo.

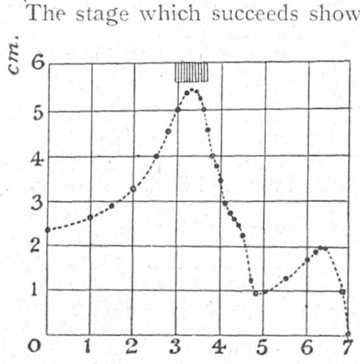

FIG. 5.—Integral curve for emanation halo showing position of first ring.

The successive features of the developing uranium halo have been indicated above the curve of integral ionisation. The features numbered 1, 2, and 3 are the first, second, and third rings; 4 shows the limiting position of the radius of the pupil when all is blackened up within; 5 is the ring due to RaC_1.

An interesting modification of the uranium halo is found in the mica of County Carlow. The α rays of U_1 and U_2, of ionium and of radium, have apparently played no part in its genesis. The parent substance responsible for the halo is the short-lived emanation of radium. This element, and those derived from it, alone take part in its formation. Consequently, only four out of the eight α-ray-expelling substances are concerned in its architecture. As these include the furthest reaching ray—that of RaC_1—the outside dimension of the halo is the same as that of the complete uranium halo.

When we plot the integral ionisation curve of this halo we get an initiating ring of appreciably larger radius than is associated with the beginning of the uranium halo (Fig. 5). And it is by this larger initiating ring that the new halo is identified. In later stages it is difficult to differentiate it from the uranium halo.

The mode of origin of the emanation halo is interesting. All through the mica in which these halos are found there is evidence that radio-active solutions or gases were at one time transported along minute channels or cracks. These channels are bordered with radio-active darkening, showing just such an appearance as Rutherford got in the walls of a capillary tube containing condensed emanation of radium. Again, the darkening around the conduit in the mica may often possess the radial dimension of the first ring. Along such conduits we find every now and again a refracting particle which acts as the nucleus of an emanation halo. Apparently the particle has served to condense the emanation or to absorb it, and thus becomes the centre of radiation for α rays given out by substances which are derived from the emanation by further disintegration. Consequently, emanation halos are found developed along such cracks or conduits, often presenting the appearance of beads upon a string.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. H. ROGER has been elected to succeed the late Prof. Landouzy as dean of the Paris Faculty of Medicine.

A CHAIR of tropical pathology has been established in the University of Lima, Peru, and Dr. J. Arce has been appointed professor.

BY the will of the late Sir Charles Holcroft a bequest of 5000*l*. is made to the University of Birmingham, to establish a Charles Holcroft Research Fund.

THE Museums' Association proposes to hold a conference at a town in the midland counties in October next to discuss, among other subjects, local war museums and the Board of Education and museums. Mr. Fisher, President of the Board of Education, has pointed out the necessity for promoting the advancement and application of art to industry in a more direct and extensive manner after the war, when industrial development will demand all possible aid. This is work that equally concerns many museums. The reorganisation of education, both elementary and secondary, foreshadowed by Mr. Fisher, also calls for the active co-operation of museums, and is the opportunity for closer co-ordination of their work with the schools. Both subjects to be considered concern museum committees, as well as curators, and members of museum committees are, therefore, specially invited to attend the proposed conference.

FOLLOWING the lead of other educational bodies, the Association of Assistant-masters in Secondary Schools has issued a statement of the educational policy of its members. The aim of education, it is said, should be to secure the healthy, physical, mental, and moral development of the child, so that he will take his place in the community as an efficient citizen. The national system of education should provide, the policy urges, for the compulsory full-time education of every child up to the age of sixteen years at least. Continued secondary education, from the age of sixteen to eighteen, should be preparatory to university education or to business or professional life. No child who has shown capacity to profit by a course of secondary education should be refused admission to the schools, even if the child has to be fed and clothed at the public expense to enable him to attend. No boy should be admitted to a university under the age of eighteen. Science should be included in the curriculum of pupils under fourteen years of age, and it is laid down that every candidate taking the first school examination at about sixteen years of age must have completed an approved course in science. These are a few only of the demands of the assistant-masters, but they will serve to show how far behind the ideals of this body of schoolmasters is the present system of education in this country.

Two courses of twelve lectures each on "The Designing and Computing of Telescope Systems" will be delivered at the Imperial College of Science, South Kensington, by Prof. A. E. Conrady, during this month and next, commencing on August 13. The lectures will be given in connection with the newly formed department of technical optics at the college, under the direction of Prof. F. J. Cheshire. The importance of optical designing and computing, together with evidence of its neglect in the past by English opticians, has been one great lesson of the war. Serious delays in the production of optical munitions have arisen from the inability of manufacturers to obtain the necessary constructional data for the systems required. Many manufacturers are still under the impression that satisfactory designs cannot be obtained without the making up of a succession of samples in the workshop, in each one of which an attempt is made to correct the errors found by the testing of the sample which immediately preceded it. Experience has shown, however, that the necessary constructional data, such as curves, diameters, thicknesses, and separations for given glasses, can be obtained by calculation alone, and that so satisfactorily that a manufacturer is justified in putting in hand an order for a large number of systems without the making up and testing of a single sample. In first-class designing the trial-and-error work is done on paper only, whereas by the older and less efficient methods the theoretical trial-and-error work of the computer must be checked and tested from time to time by practical trial-and-error work on a number of workshop constructions. The manufacturer of the future who is not in a position to enlist as required the services of a competent designer—that is, one capable of producing satisfactory designs by pen-and-paper work only—will, therefore, be at a great disadvantage as compared with competitors who have such assistance available. The courses of lectures at the Imperial College have been decided upon for the immediate purpose of assisting manufacturers in the production of optical munitions of war, but at the same time they will give to those manufacturers an opportunity of furthering the technical education of such of their employees as are, or will be, responsible for the scientific direction of their work in matters of optical design, and thus ensure, so far as possible, favourable conditions for entering into that keen commercial struggle which must inevitably follow the attainment of peace. The lectures will appeal also to those who, having the necessary mathematical knowledge, are anxious to learn the theory and practice of optical designing. Intending students should apply to the Director, Technical Optics Department, Imperial College, South Kensington, London, S.W.7.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 20.—Dr. Alfred Harker, president, in the chair.—Dr. A. **Holmes**: The Pre-Cambrian and associated rocks of the district of Mozambique. Beyond the coastal and volcanic beds of Mozambique (described in a previous contribution, Abs. Proc. Geol. Soc., 1916, No. 994, p. 72) the country assumes the form of a gently undulating plateau, gradually rising towards the west and diversified by innumerable *inselberg* peaks and abruptly rising clusters of hills. The dominant rock throughout is a grey biotite-gneiss. Interfoliated with this are occasional lenticular masses of hornblende-gneiss and amphibolite, and within these smaller bands of crystalline limestone are sometimes preserved. Schists—referable to arenaceous sediments—are found only near the coast, where they are interbanded with gneisses; and, as the latter are mainly of igneous origin, they are thought to be intrusive into, and therefore younger than, the schists. The succession of rocks in eight of the better-known districts is described, and a general classification based on the details is given. The correlations of certain groups of rocks with the Lower and Middle Pre-Cambrian of other regions are based on the determination of lead-uranium ratios of zircons derived from the gneisses and granulitic granites respectively, the zircons having been obtained by crushing and panning the rocks in the field. The gneisses give a ratio of 0·21, comparable with a ratio of 0·24 obtained for Canadian zircons of Laurentian age. The granulitic granites give ratios of 0·14 to 0·17, comparable with those of radio-active minerals of late Archæan—that is, late Middle Pre-Cambrian—age in Scandinavia (Moss 0·12 to 0·15, Arendal 0·16 to 0·18, and Ytterby 0·15 to 0·17), Canada (Villeneuve, Quebec, 0·17), and India (Singar 0·14). The rocks are described in detail, with tables giving the quantitative mineral composition and the specific gravities and radium contents.—L. **Richardson**: The inferior oolite and contiguous deposits of the Crewkerne district (Somerset). A detailed description is given of the inferior oolite of the Crewkerne district.

EDINBURGH.

Royal Society, July 9.—Dr. J. Horne, president, in the chair.—Prof. A. **Robinson**: The origin, rupture, and closure of ovarian follicles. In the ferrets and polecats there are two distinct growth periods: (1) a period of relatively slow growth extending over several weeks; (2) a period of rapid growth lasting from twenty to forty-eight hours. During the first period the cavity of the follicle forms, and is filled as it forms, with a viscid tenacious "primary" fluid, which gradually becomes membranous at its periphery, where it is intimately connected with the follicular epithelium. During the second period a much less viscid "secondary" fluid is quickly formed amidst the epithelium of the ovarian cumulus, which is simultaneously disintegrated and dispersed. Thereafter the secondary fluid forces its way, between the membranous periphery of the primary fluid and the follicular epithelium, to the apex of the follicle. Under increasing pressure the follicle ruptures, and the ovum, with its corona of follicular epithelium, the disintegrated cumulus epithelium, the whole of the secondary fluid, and part of the primary fluid are evacuated and pass into the oviduct. The remainder of the primary fluid fills the remnant of the cavity of the follicle and plugs the orifice through which the contents escaped. So soon as the orifice is plugged distension of the follicle recommences, and fluid again accumulates in its interior. Simultaneously the orifice contracts, the plug shrinks, and in from thirty to forty-eight hours the orifice is completely closed, and the follicle again fully distended. The formation of the secondary fluid depends upon insemination. The follicular epithelium becomes vascularised before the rupture takes place, but there is no effusion of blood when this occurs.—Prof. D. **Waterston**: Development of the heart in man. Reconstructions of the hearts of embryos at different stages of development were exhibited and their indications discussed. They showed clearly the profound changes which take place in the structure of the heart, changes which occur as the heart is carrying on its functions. Another point dealt with was the mechanism of the subdivision of the heart into its various chambers and the formation of the valves of the heart.—Prof. E. T. **Whittaker**: Compound determinants. A general method of reducing compound determinants to simple determinants.—Prof. W. H. **Metzler**: Vanishing aggregates. This paper gave a generalisation of a theorem due to Sir Thomas Muir.—Dr. J. M. **Thompson**: A further contribution to our knowledge of *Platyzoma microphyllum*, R. Br. An analysis was given of the spore numbers in the various sporangial types, and it was shown that the small and large sporangia and spores already described for Platyzoma are well-defined generic features. The typical spore number for a small sporangium is 32, while that for a large sporangium is 16. The facts available, though insufficient to show the true nature of the various spore types, strengthen rather than weaken a belief in the heterosporous nature of Platyzoma. The plant is then probably an up-grade fern in which segregation of the microsporangia and megasporangia is not yet complete, and in which the megaspores do not declare their female character until they are shed. Should, however, the sporangial development and spore germination prove the plant to be homosporous, its anomalous structure and unique position among living Pteridophytes will be accentuated.

PARIS.

Academy of Sciences, July 2.—M. A. d'Arsonval in the chair.—J. **Boussinesq**: The limiting equilibrium of a sandy mass.—A. **Gautier** and P. **Clausmann**: A new method of destruction of tissues for the estimation of arsenic and other mineral matter. The method in current use requires large quantities of nitric and sulphuric acids of a high degree of purity; the new method now proposed is free from this disadvantage. By drying and heating to 300° C. the material to be examined is brought into a condition in which it can be powdered, and this is mixed with 2 to 3 per cent. of its weight of quicklime and a little water added. The mixture is burnt off in the muffle at a low red-heat. The ash is powdered, taken up with water, and a few drops of sulphuric acid added, filtered and evaporated until fumes of acid are given off. After dilution this can be transferred to the Marsh apparatus and the arsenic estimated in the usual manner. The whole examination can be carried through in a day, as against three days' work by the older method. The results of tests proving the accuracy of the process are given.—G. **Gouy**: The effects of molecular shock on the spectra of gases.—M. **Akimoff**: Fourier-Bessel transcendentals with several variables.—Ed. **Chauvenet**: The acid sulphate of zirconyl.—F. **Dienert** and F. **Wandenbulke**: The estimation of free chlorine in solutions of hypochlorites. The addition of a large excess of ammonium salt to the hypochlorite solution, followed by potassium iodide, prevents the formation of iodate and allows the direct estimation of chlorine in alkaline solution by arsenious acid.—(The late) A. **Cochain**: A new manner of understanding the deformation of the earth's crust.—R. **Dubois**: Remarks on the recent researches of M. Newton Harvey on biophotogenesis.—Mme. Marie **Phisalix** and F. **Caius**: The poisonous properties of the parotidian secretion in species of snakes belonging to the Boideæ and the Uropeltideæ.—W. **Kopaczewski**: Researches on the serum of *Muraena Helena*. The physiological action of the serum. The normal serum possesses very marked hæmolytic properties; these are lost after heating to 56° C. for fifteen minutes. The bacteriolytic properties are not so marked. The serum was devoid of agglutinating or precipitating properties.—F. **Mesnil** and E. **Roubaud**: The sensibility of the chimpanzee to human paludism.—H. **Stassano**: The sterilisation of liquids in thin layers by heat.

BOOKS RECEIVED.

The Public School System in Relation to the Coming Conflict for National Supremacy. By V. S. Bryant. Pp. xviii+78. (London: Longmans and Co.) 1*s*. 6*d*. net.

Report of the Commissioner of Education for the Year ended June 30, 1916. 2 vols. (Washington: Government Printing Office.)

Industry, Science, and Education. By Principal E. H. Griffiths. Pp. 70. (Cardiff: Roberts and Co.) 1*s*.

Index of Spectra. By Dr. W. M. Watts. Appendix x. (London: W. Wesley and Son.)

Memoirs of the Geological Survey. Scotland. The Economic Geology of the Central Coalfield of Scotland. Area viii., East Kilbride and Quarter. By R. G. Carruthers and C. H. Durham. Pp. iv+55+map and table of vertical sections. (Edinburgh: H.M.S.O.) 2*s*. net.

The Annual of the British School at Athens. No. xxi. Sessions 1914–1915; 1915–1916. Pp. viii+238+plates xv. (London: Macmillan and Co., Ltd.) 21*s*. net.

Correction Tables for Thermodynamic Efficiency. Calculated by C. H. Naylor. Pp. 59. (London: E. Arnold.) 5*s*. net.

Heat Drop Tables: Absolute Pressure. Calculated by H. Moss, from the Formulæ and Steam Tables of Prof. H. L. Callendar. Pp. 63. (London: E. Arnold.) 5*s*. net.

Continuity, or From Electrons to Infinity. By Dr. P. S. G. Dubash. Pp. 60. (Blackburn: G. Toulmin and Sons, Ltd.) 1*s*. 6*d*.

Chemistry in the Service of Man. By Prof. A. Findlay. Second edition. Pp. xv+272. (London: Longmans and Co.) 6*s*. net.

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