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Cotton-Breeding, Plant Physiology and Agriculture.

KNOWLEDGE of the cotton crop presents a curious antithesis to that of wheat. The effects of environment are better analysed and understood for cotton than for most crops, but whereas the genetic study of wheat is classical, that of cotton is fragmentary. About cotton we have practically no "useless" genetical information, such as may suddenly turn out to hold the key to commercial difficulties, and a recognition of this ignorance has been a factor in founding the new Empire Cotton Experiment Station in Trinidad. So far, this lack of knowledge has mattered less than it might have done, because Nature provides the cotton - breeder with ample occupation in merely isolating pure lines from the complex population which arises from the small amount of natural crossing in cotton. Thus, almost no successful application of synthetic genetics has been made to cotton, except by Leake.

A further complication of cotton-breeding (and a further justification of the Trinidad scheme) lies in its inability to be a self-contained science. The cotton-breeder has one foot in the physiologist's camp so long as he deals with the inheritance of dimensional characters ; and while cotton is grown as a paying crop for spinning purposes, its dimensional characters take practical precedence of all others. This may or may not be the right attitude, but at least we may be sure that the dimensions—if inherited at all as such—are not inherited in isolation. The writer had some glimmering of this when, in the dawn of Mendelism, he started to record every recordable characteristic in one hybrid cotton ; his simultaneous observation that there were about two dozen chromosomes was damping to enthusiasm, even in those pre-Morgan days, and the study of dimensions led him by insidious paths into physiology. There is, of course, no antagonism between genetics and physiology in cotton ; rather they are much too intimate, so that their disentanglement is quite difficult.

Some illustrations of this intimacy are provided by the report from the Bombay Presidency of the second annual Conference of Plant Breeders held at Surat last spring. The very first group of papers not only dived into physiology, but came out on the other side, with a discussion on the probable error of field experiments, an omnibus subject if considered for what it really contains, but yet an end in itself for the economic side of agriculture. The reputed instability of certain improved varieties when grown by farmers was next discussed ; and, though traced to the obliteration of small superiorities by local conditions, it led to a recommendation that "adaptability to a large range of conditions should be the ideal in breeding improved races." It is more than doubtful whether this ideal can be realised. Most species which adapt themselves to a wide range of conditions are complexes of elementary species, between which natural selection takes place on establishment in any fixed environment. When such elementary species, or similarly pure lines of cotton, are tested for various environments, they have been found by the writer to exhibit most decided local preferences; in one pair of Egyptian strains the long staple became short in the Sudan while the short became long; in another pair the yields crossed over when moved from Cairo to the cooler sea-board. Indeed, it seemed that if flexibility were wanted very badly, without abandoning the control of production-quality which pure lines give, then it would be necessary to issue blended seed containing more than one pure line. The suggestion may seem absurd; but with cotton it is in any case essential to have a seed-renewal system, so that after the lapse of some three years, when the blended strains have intercrossed to a serious extent, the bulk seed supply would be due for renewal from the pure stocks. It may be possible with some plants to eat one's cake and still possess it intact, but with cotton at least there seems to be a choice between putting stable pure lines into their appropriate environment or continuing to endure the inconvenience of unstable but plastic commercial "varieties."

A discussion on the possibility of standardising testing methods for different crops was held at Poona but does not seem to have been very helpful, as abridged in the report now before us. Testing as testing is a rather futile process, whether of crop yield, yarn elasticity or metal hardness; it can aim only at establishing comparable facts, which are incidentally and inevitably numerical. There is no test result known to the writer, in agriculture or textiles or engineering, for which he would not be glad to substitute an understanding of why the result was obtained. Without such understanding, even if imperfect, some of the factors implicit in the test method will escape control, and the comparability of the facts established will thereby be invalidated. More analytical, and much more physiological, was an account by Mr. M. L. Patel of the competitive effects of adjacent plants in the crowd of a field crop, and the differences from one strain to another in this respect.

Genetics as such does not appear until half-way through the Conference, with a note on natural crossing, also by Mr. Patel. The desirability of mass selection was then seriously questioned, though apparently without reaching the only definite conclusion possible, namely, that while mass selection is the first thing to do, it is also the worst thing to do, and is simply a stop-gap expedient. We would like to hear more of the figures on which the next discussion was based, namely, "Acclimatisation and the Adaptation of Newly Imported Seeds." Few topics have been more thoroughly disintegrated than this by mere convictions, and any facts are of value. The Conference did not commit itself in its conclusion, which wags a reactionary tail; it considered that "acclimatisation was a fact and that it might be (1) selection by climate of like individuals from an obvious mixture, and (2) selection by climate of a physiologically suitable race from a variety apparently pure for all external characters, or the gradual adjustment of some individuals of a variety to a new environment, and that it is desirable to consider each case on its own merits."

It is clear that the plant breeders of the Bombay Presidency do not lack material for investigation, nor are they geneticists only. So far as can be judged from a brief report, it would seem that a useful service could be rendered to his fellows by some one who would dissect the complex story of plant-breeding into unit assertions—even if they were wrong—and definitions. To have two main meanings and several subsidiary ones, some mutually contradictory, for a single word like "acclimatisation," does not facilitate discussion with fellow-workers, or afford explanation to the outsider.

W. L. B.

Science at Oxford.

Early Science in Oxford. By R. T. Gunther. Vol. 3. Part I.: The Biological Sciences; Part II.: The Biological Collections. Pp. xii + 564 + 64 plates. (Oxford: The Author, Magdalen College, 1925.) 42*s.* net.

THIS splendidly produced and entertaining volume is the third of a series which Mr. Gunther has devoted to an account of the historic remains of scientific Oxford. They stand as a permanent memorial of the subject of which they treat. Like its predecessors, this volume is in the form of a catalogue, in which each heading is provided with a short introduction. It differs from the generality of catalogues in being extremely readable, and in the capacity that its author exhibits to lead the reader from point to point. Mr. Gunther is to be heartily congratulated on an achievement involving a most unusual combination of persistence, scientific knowledge in many departments, self-devotion, and literary skill and charm.

The history of science has two aspects, complementary one to the other. It may be treated from the point of view of the development of scientific ideas, the historian tracing these ideas in reference to one another and to the cognate thought of the successive ages. This is the philosophical or psychological approach. The exponents of this method usually pay but scant attention to the "false starts" in science, they ignore almost entirely the by-paths of the subject, and are more interested in methods and results than they are in the men who use one or attain the other. On the other hand, the subject may be treated from the point of view of biography or of local history. This is the antiquarian or archæological method. In the ultimate analysis it is philosophically indefensible, since the scientific process, of its very nature, demands that the search for truth must be carried on without prejudice to persons, and that truth, when found, must be taken for what it is, without regard to its origin. Science is the great leveller. Should she bow the knee to any idol, whether of the tribe, the cave, the market-place, or the theatre, she loses her divine right. But the antiquarian method is nevertheless very useful in another sense. By it alone can we learn of the social and intellectual environment in which science yields effective fruit, and —what is no less important—by it we can learn of some of those insidious factors that render science sterile. This knowledge is of evident practical application.

Mr. Gunther is an eminent exponent of the antiquarian method of scientific history. The value and interest of his results are undeniable. They have been justly greeted in his own University as containing a hitherto unwritten chapter in its long and varied history. Mr. Gunther is a genial and optimistic writer, a very loyal son of his *alma mater*, an admirable *raconteur* with a good eye and ear for the bizarre and ridiculous, which, however, never permit an interference with his enthusiasm for what is high and great. Nevertheless, reflection on the results of his work does not summon up thoughts that are consoling or cheering.

After enjoying these volumes, the contemplative reader will naturally ponder the end of all the endeavour that is there related. Since the Revival of Learning, four hundred years ago, a great University has been equipped with great endowments assigned to scientific ends. What have been the results? Let us discount the "amateur" who has ever borne an honoured place in British learning, but whose debt to his university has ended with his literary training. Let us put him aside and make a proper balance sheet: on one hand the endowments for scientific instruction, on the other the scientific achievements of those who have held, in this great and ancient University, the offices for the imparting of that instruction. Mr. Gunther rightly ends his book with a "Table of Succession of the Scientific Professors." It is the summary of the whole book, and is mournful reading. On the credit side a few really great scientific names will be discerned, among them several of the founders of the Royal Society. But apart from the last generation or two, and excluding this limited number of brilliant exceptions, the succession is one of scientific nonentities, mostly men who do not take even a secondary place in the annals of science.

These fine volumes of careful studies thus bring out a fact that all interested in national education should take to heart. It is that the best manner of obtaining scientific results can by no means be easily determined. A very complex psychological question is involved. Pious founders in the past and in the present have often thought that they could obtain good results by mere monetary gifts to some particular department of learning. Men with affectionate memories of this school or that college seek to link the glory of an ancient foundation with that pure search for knowledge that can never be the property of a class or institution. These volumes show how much of this seed, thus strewn with careless and generous, if ignorant enthusiasm, has fallen and will fall on sterile ground.

The fact is that the production of an effective scientific atmosphere depends in the end on neither endowments nor institutions nor even good will, but on the intellectual outlook of society as a whole. The lesson is to help to create that outlook and the rest will follow naturally. The arrogant aloofness of the classical spirit of Oxford for centuries separated it from many of the movements that stirred the pulses of the people of England, and among them was the great scientific movement, the most important intellectual event of the last eighteen hundred years. Shame it is on our humanity and to the memories of its creators, the great minds of Greece and Rome, to call such a spirit "humanism"! The price—and it is a heavy one—has been most surely paid for being the home of lost causes. That phrase must not be lightly glossed as a mere joke or epigram. It is a diagnosis of a grave and deeply seated spiritual malady. From it Mr. Gunther's University emerged into convalescence only in quite modern times. His volumes will be read by posterity, but we believe that they will be read for the account that they contain of the course and symptoms of a very deadly disease.

The Technology of Glass.

A Text-book of Glass Technology. By F. W. Hodkin and A. Cousen. Pp. xxiii + 551. (London, Bombay and Sydney: Constable and Co., Ltd., 1925.) 42*s.* net.

FOR several years the glass industry of Great Britain has suffered from the lack of an up-to-date and authoritative text-book upon the technology of glass, but the deficiency has now been made good by

Messrs. F. W. Hodkin and A. Cousen. All interested in glass will welcome the recently published compilation of these two authors, and the industry owes them a debt of gratitude for such a masterly exposition of their subject, which covers the whole field of glass manufacture. Acting with admirable forethought, they have not stressed any one side of this manufacture above another, and throughout the work they have adhered to their determination as stated in the preface: to attempt no encyclopædic survey, but to allow the book to take the simpler form of a general introduction to the study of glass technology. In this they are to be commended, because the book becomes as valuable to the beginner as to the expert. The latter may indulge his desire for more detailed knowledge by reference to original papers and to books specified in a well-arranged bibliography and in copious footnotes, whilst the beginner will find each chapter easy to assimilate, there being no extraneous matter to confuse him.

The general arrangement of the volume will meet with approval, and it shows the stamp not only of experienced teachers but also of men who have a wide practical knowledge as well. Commencing with a chapter upon the historical development of the glass industry, the work naturally divides itself into sections upon physical properties, raw materials, fuels, refractory materials, furnaces and glass-making processes. No matter of importance is neglected, and each chapter is a mine of information upon the subject with which it deals. To those whose knowledge of chemistry is limited, Chap. ii. dealing with the basis of glass technology will be found helpful, as it indicates in a simple manner how glass is produced from raw materials. Chaps. iii., iv., v. and vi. upon the physical properties of glass, whilst of interest generally, are of particular import to those in whose domain lie the devising of new glasses and the improving of old. The question of thermal endurance is rightly stressed as this property is so important in every type of glass. The various factors which determine this endurance are also fully discussed. In this connexion, it would have increased the value of Table xv. to have included with the compositions of the glasses shown, the thermal endurance values calculated from the Winkelmann and Schott relation. However, the reader will find pleasant exercise in supplying the values for himself, using the various tables provided, which deal with density, tensile and crushing strength, elasticity, hardness, specific heat, expansion and the like. It may be said regarding these tables that one deprecates the omission of the values of Winkelmann and Schott for the elasticity factors of the various constituents of glass (see *Ann. d. Phys. u. Chem.*, 1894, p. 711, and 1897, p. 122).

One of the most valuable chapters in the book (Chap. vi.) deals with the question of the durability of glass, and it provides a very thorough survey of the knowledge accumulated upon this important subject. A more detailed account of the apparatus used in testing for durability, together with diagrams of such apparatus, would not have been out of place and would have been found useful by manufacturers desiring to apply durability tests to their ware. In comparing the effect of sodium oxide and potassium oxide upon durability, "Peddle's generalisation" might well have been included, namely:

"In alkali—RO—silica glasses where RO is the oxide of calcium, barium, strontium, magnesium, zinc or lead, when the total alkali present is less than 20 per cent., a glass containing both alkaline oxides will be less soluble and more durable than the glass containing the same amount of alkali as sodium oxide or potassium oxide alone. This is true whatever amount of silica or RO is contained in the glass."

The raw materials of the glass industry are dealt with in Chaps. vii.-xii. The account given will be found full and up-to-date, in particular the pages dealing with the treatment of sands and the storage and mixing of batches. A special feature of this section is the tabulating of more than 100 batches for glass-melting, the mixtures given ranging over most of the best known types. To those who find difficulty in the calculation of batches for glass, Chap. xi. will appeal with especial force because the whole question of such calculations is treated in a very comprehensive manner. Purists will quarrel with the authors when they write "$\frac{1}{2}K_2O$," etc., thereby implying the "half molecule of a compound," but the expression may perhaps be tolerated in this chapter as it simplifies calculation considerably.

The authors deal with combustion and the evaluation of fuels in a very lucid manner, all the data being well marshalled and easy to assimilate. Chapter xiv., upon combustion, is rendered all the more valuable by the inclusion of typical calculations, and these are treated in a fashion which commands admiration. Throughout the volume, indeed, one cannot help being impressed by the facile manner in which calculations are worked out. In view of the increasing recognition of the value of temperature control in all glass-working processes, Chap. xvii., upon pyrometry, will arouse interest, and in it will be found a full account of the various devices for registering temperature in a glass works.

The sections of the work that will appeal most to actual manufacturers are those upon producers, refractories and furnaces. Chap. xix., dealing with producers, has only to be read to be appreciated, for it is a veritable storehouse of information. Pride of place among the four chapters (xx.-xxiii.) upon refractory materials must be given to that which describes the manufacture of glasshouse pots and blocks, because of the series of fourteen photographs illustrating the production of a pot. Seven chapters in all (xxiv.-xxx.) are devoted to furnaces, and we have nothing but praise for the manner of treatment. Numerous diagrams and photographs enhance the value of these chapters, which deal in sufficient detail with many types of furnaces, lehrs, and so on, without being at all verbose, whilst the discussion is without bias. The principles of regeneration and recuperation receive full attention, and the respective merits and demerits of the two systems are emphasised.

The volume ends with nine chapters upon glass-making processes. This section will be of especial interest to the general reader as it serves to indicate the huge strides that have been taken during the present century in the manipulation of glass by machinery. The most modern processes are ably dealt with and a wealth of photographs and of diagrams is included. In this connexion it may be said that the whole book is admirably illustrated by more than 250 figures, many of them being full page in size.

The indexing will be found comprehensive, sections being devoted to name index and subject index, whilst a word of praise is due to the proof-reading, which has been very thorough. Very few errors will be met with in the text, and those of small importance.

Economy and Efficiency in House-Heating.

House Heating: a General Discussion of the Relative Merits of Coal, Coke, Gas, Electricity, etc., as alternative means of providing for Domestic Heating, Cooking and Hot Water Requirements, with Special Reference to Economy and Efficiency. By Dr. Margaret Fishenden. Pp. 296. (London: H. F. and G. Witherby, 1925.) 25*s*. net.

DR. FISHENDEN has provided one of the most interesting books that has ever been written on a most important branch of domestic science. Her work has been known for a considerable time to all those who are specially interested in the performances of domestic heating appliances, through valuable reports which have been issued from time to time by the Department of Scientific and Industrial Research. The contents of these reports have now been collected and expanded so as to give greater continuity and comprehensiveness of treatment, with the addition of critical historical matter, and a wide public owes a debt of gratitude to Dr. Fishenden for having undertaken the task, and having carried it through so well.

The book begins with a preliminary consideration of fuels available, their composition, and the methods of production of such artificial fuels as town gas and coke. A brief summary of the position of electricity as a heating agent, and of the reports of the Electricity Commissioners in relation to power supply, terminates with the judgment: "At present, however, even the fact that most electric heaters give efficiencies of practically 100 per cent. theoretical, is not enough to counterbalance the low thermal efficiency and high cost of production."

Dr. Fishenden goes on to treat of the development of the modern sitting-room grate, and justice is done to Count Rumford, who was advocating at the end of the eighteenth century ideas applied in the modern fireplace, and to Dr. Pridgin Teale of Leeds, who enunciated detailed rules for the construction of fire grates, some of which are so generally adopted in the design of modern fireplaces that the author sets them out in full.

Then we begin to see the kind of thing that Dr. Fishenden has herself been doing in a paragraph headed "Fluctuations in the Rate of Burning of Coal Fires," accompanied by a number of diagrams indicating the variations in the intensity of radiation emitted from fires fed with coal, slack, and coke, stoked in different ways. A study of the distribution of radiation from open fires was carried out on the general plan adopted in the "Leeds" tests, described in the first and second Reports of the Joint Gas Heating Research Committee of the University of Leeds and the Institution of Gas Engineers. This chapter is very comprehensive. It is appreciative as regards the method employed by Prof. Boys in successfully burning gas coke on a flat firebrick hearth with an overhanging firebrick back, and the reverse of appreciative in dealing with the effect, or rather non-effect, of patent preparations on the efficiency of coal fires. The importance of providing draught regulation with coal fires is insisted upon, and the common error in the older open fireplace of drawing far too much air through the room is emphasised. The opportunity in installing a gas fire of realising a more efficient and economic arrangement in this respect is made very obvious. A corresponding treatment is then given to the development of the kitchen range, the survival of which is attributed to the fact that it can meet so many different requirements, although it functions so uneconomically with respect to any one of them. Dr. Fishenden's conclusion is: "It is probable that the independent boiler with open fire, with or without the addition of an oven, will gradually rise to a considerable degree of popularity, gas being used for cooking when no oven is included in the range."

The chapter on "The Development of Gas for Heating Purposes" is also very well done, and stress is rightly laid upon the ventilating effects of gas fires. In the discussion of room heating it is too often forgotten that the fire and the flue into which it works are serving a double purpose, and that from the hygienic standard the ventilation is at least as important as the heating. Merely to warm the air in a room is insufficient, and in this lies the weakness of so-called "radiators" (which are mainly convectors), whether heated by steam or gas, and of nearly all the electric heaters.

An interesting chapter follows upon the use of gas for cooking purposes, in which the "Standard Gas Cooker" proposals of the Standardisation Committee of the National Gas Council are detailed, and the new gas cooker of Messrs. Radiation, Ltd., with its semi-automatic controlling device, are both described along with more specialised devices, such as the Radiophragm heating introduced by Prof. Bone specially for toasting or grilling operations.

As regards the efficiencies obtainable in gas heating and cooking appliances, the results of the Gas Investigation Committee of the Institution of Gas Engineers and the University of Leeds in Britain, and those of the Bureau of Standards in the United States, are widely quoted.

Electricity for heating, cooking, etc., is given a chapter to itself, Dr. Fishenden pointing out that "modern electrical cookers, like electrical heaters in general, can be considered to owe their origin to the discovery of nickel-chromium high resistance wires," which stand long contact with air at high temperatures. Various types are discussed, and then in another short, but interesting, chapter the position of central heating by various methods is indicated and briefly discussed.

In many ways the most important and useful chapter of all is that which brings the book to a close, but it is not easily summarised. It is to be hoped, however, that this impartial and well-informed summary by a competent authority, who has given special attention to the subject, will be widely read, even by those who have not the time or perhaps the inclination to read the more detailed considerations of the preceding chapters. It is a statement and an expression of reasoned opinion which comes at a time when it is very much wanted, in the first place, because a combination of circumstances is persuading or compelling householders to find out what are the most economical, cleanly, and healthy methods applicable for carrying out the heating operations required in their homes, and secondly, because without such information it is only too likely that catch-words may take the place of principles in forming public opinion and inducing legislative action.

The reviewer does not mean that he would necessarily endorse in detail all the statements and conclusions made in this chapter, but he does regard it as an excellent attempt at summarising a very complicated matter. Dr. Fishenden begins by taking the costs of different fuels which would be sufficient, if completely burned, to produce one therm (or 100,000 B.Th.U.), and then, with reasonable assumptions as to comparative efficiencies, points out that "with coal at 50*s*. per ton, gas at 10*d*. per therm and electricity at 1*d*. per Board of Trade unit, an up-to-date open gas fire would cost about two and a half times as much as an open coal fire, whilst an electric heater would cost about five and a half times as much. But it must be clearly understood that in this comparison equivalent heating values during continuous running have been the basis, and no allowance has been made for the saving in labour effected by the use of gas or electricity as compared with coal." For intermittent use, of course, the conditions become much more favourable for the more easily controlled methods of heating. "In practice, owing to the fact that coal fires cost an appreciable amount to light, and involve a great deal of work in the carrying of coal, cleaning of grates, etc., gas fires for such periodic heating would generally prove to be decidedly cheaper than coal fires. And even electric heaters, on the relative costs which have been taken, would sometimes, by their convenience and adaptability, repay for the higher cost of the units used."

One of the most useful portions of this chapter is that in which the author considers in turn heating appliances for large and small houses and for cottages, discriminating wisely between the requirements of one and another. Her final sentence is: "For almost every purpose which raw coal at present fulfils, smokeless domestic cokes would prove a satisfactory substitute, and used in conjunction with gas or electricity would enable all domestic heating, cooking, and hot water requirements to be carried out economically, with a complete absence of black smoke production."

One criticism the reviewer must make. This book is very well printed, and the diagrams are numerous and clear, but it is surely a book for which a large circulation should be sought, and the price asked will scarcely allow of that object being attained. JOHN W. COBB.

The Morphology of Crustacea.

Studies on Arthropoda, II. By Dr. H. J. Hansen. (Published at the expense of the Rask-Ørsted Fund.) Pp. 176 + 8 plates. (Copenhagen and Berlin: Gyldendalske Boghandel; London: Constable and Co., Ltd., 1925.) 15*s*. net.

SO long ago as 1893, Dr. H. J. Hansen published in the *Zoologischer Anzeiger* a preliminary paper on the morphology of the limbs and mouth-parts in crustaceans and insects. Many of the views adumbrated in that paper have since been adopted and developed by others, and some of them have been further illustrated by the author himself in the course of systematic papers dealing with the varied groups of arthropods which he has studied. Now, after more than thirty years, we have the first part of the connected exposition of his morphological views, for which the earlier paper was to prepare the way. In this memoir, only the Crustacea are dealt with, the remaining divisions of the Arthropoda being reserved for a future part.

So far as it is not purely descriptive, Dr. Hansen's point of view may be said to be that of an idealistic morphology. He abjures phylogenetic speculation, and has nothing to say as to the structure of hypothetical ancestral forms. This was also the point of view of the great protagonist of Darwinism, whose centenary we have recently been celebrating. It was Huxley's opinion that "morphological generalisations . . . will remain true, so far as they are true at all, even if it should be proved that every animal species has come into existence by itself and without reference to any other." It may perhaps be doubted, however, whether even Huxley was able to keep his morphology quite untainted by evolutionary speculation. Try as we may, we cannot look at things with the eyes of the pre-Darwinians, but it is right that we should be reminded how much in our phylogenies is sheer guesswork and how little justified is the confident dogmatism of "Haeckelismus."

Dr. Hansen describes in great detail, and illustrates in a series of finely engraved plates, the chitinous exoskeleton of the mouth-parts and limbs in the main subdivisions of the class Crustacea. He brings much additional evidence in favour of the view, now accepted by many authorities, that the sympod (protopodite of Huxley) is typically composed of three, instead of two segments. In the thoracic legs of Decapoda he finds that an additional segment, first observed by Coutière and here termed "præischium," is often indicated, and he bases on this a new scheme of comparison of the segmentation of the legs in the various orders of the Malacostraca. In this scheme the position of the "knee," or main flexure of the limb, is assumed to remain constant throughout the sub-class. On this point it is perhaps permissible to doubt whether the evidence is quite conclusive.

Dr. Hansen has no doubt that the trilobites should be regarded as Crustacea, rejecting, probably with justice, the arguments against this view drawn from the absence of a shell-fold and the sessile condition of the eyes. He thinks it impossible that the limbs can have been articulated, in the way described by Raymond and Walcott, to downgrowths of the dorsal skeleton, and, indeed, such a mode of articulation would be without parallel among recent arthropods.

In dealing with the Cirripedia, the interesting suggestion is put forward that the so-called "mandibles" of the adult may be the maxillulæ, the mandibles being lost in the course of development. This point might well engage the attention of embryologists.

Great importance is attached to Geoffrey Smith's description of a biramous mandibular palp in Paranaspides as giving the clue to the interpretation of the palp in other Malacostraca. No subsequent observer, however, has been able to see a trace of the biramous condition in Paranaspides, and there can be little doubt that Geoffrey Smith was misled on this point.

Many other points of general morphological interest are discussed in the course of this memoir, which deserves the close attention of all students of the Arthropoda.

W. T. C.

Education of Chimpanzees.

The Mentality of Apes. By Prof. Wolfgang Köhler. Translated from the second revised edition by Ella Winter. (International Library of Psychology, Philosophy and Scientific Method.) Pp. viii + 342. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1925.) 16*s.* net.

PROF. KÖHLER'S book marks a distinct advance in comparative psychology, for he was able to study his chimpanzees in very favourable conditions of health and housing in Teneriffe. He also realised that these apes are characteristically social creatures and must be studied in companionship with their fellows. A chimpanzee is intellectually and emotionally bewildered if it is kept in solitary confinement. "It is hardly an exaggeration to say that a chimpanzee kept in solitude is not a real chimpanzee at all." Prof. Köhler's experiments were also marked by their critical carefulness. No emphasis is laid on single incidents; the crucial experiments were repeated many times. Generous descriptions were for the most part rejected.

The book gives abundant evidence of genuine intelligence or power of perceptual inference. Thus a chimpanzee will pile one box on the top of another to the number of four, in order to reach a banana fastened to the roof of the cage. In the course of a forenoon a clever chimpanzee discovered how to fit a short bamboo rod into the end of a longer and broader one, so that it was able to reach a prize lying beyond the bars. Even more striking was the prolonged biting at an unsuitable piece of wood so that it could be fitted into the bamboo rod, thus making a double stick. The apes often showed very precise observation, for example, of the spot on raked and featureless ground where they had seen some treasure buried. They recognised their teacher or a companion after prolonged absence, though on the whole, out of sight is out of mind to a chimpanzee. A conspicuous feature was the restless inquisitiveness; it often seemed as if they liked trying for trying's sake. They would feed the hens with bread which they themselves were not fond of, and would watch the details of the pecking with great interest—obviously the beginning of chimpanzeeish ornithology. This they would prosecute by luring a hen close to the cage and then suddenly giving it a dig in the ribs with a stick. Very quaint was the appreciation of a hand-mirror and the passage to the use of other things as mirrors, such as pieces of metal or even a pool of rain-water, at which they would stare long and intently, just as if self-consciousness was dawning. Yet in spite of long-continued experiments, the apes never got away from the conviction that there was an elusive "other fellow" through the looking-glass. For him they would lie in wait and at him they would make many a sudden pounce!

The particular limitations of chimpanzees seem to be their poor vocabulary and their slight capacity for working with "images" in the mind. They solved many problems, such as those we have mentioned, but one condition of success is that they must be brought into circumstances where the factors that constitute the solution are all visibly given. They must have all the facts of the case within their visual range. The book seems to us a very valuable one: its net result is to show that chimpanzees are very ingenious within a narrow range.

Our Bookshelf.

The Production and Measurement of Low Pressures. By Dr. F. H. Newman. Pp. 192. (London: Ernest Benn, Ltd., 1925.) 16*s*. net.

IN recent years the advance of physics, especially atomic physics, has required vacua of an ever-increasing perfectness; to this end a series of extremely ingenious methods and pieces of apparatus have been designed, most of which have only been developed after the fundamental principles underlying each of them were fully mastered. At the same time manufacturers have availed themselves of these improved methods, and it is now common practice that methods of exhaust of the most recent type are employed in the production of commercial articles which require to be exhausted to the very highest degree. In order to be able to measure such high vacua, gauges capable of such precise measurements have been developed, and it is, of course, only by advancing such means that the process of exhaust can be improved.

Prof. Newman in his book has given a very good description on both parts of this subject; after a short historical résumé, he has given an excellent account of all modern high vacua exhaust apparatus, which will certainly be of great use to all concerned in such work, and from a large number of tables (some of which possibly might have been better expressed as a curve) has afforded the physicist or the vacuum engineer a sound basis from which he will be able to choose the type of apparatus suitable to his work.

The effect of the size and length of connecting tubes on the rate of exhaust is dealt with and the importance of these factors is shown by a few examples. There is a chapter on "Sorption," giving a good résumé of the most important papers which have been published, after which comes an interesting chapter on "clean up," the process which plays such an important part in the modern methods of lamp and valve manufacture.

The second section of the book deals with the measurement of pressure. Here the different methods are fully described—each one being given space according to its practical uses or for its fundamental importance. A chapter describes the exhaust procedure, in which is emphasised the care which has to be taken in the freeing of the container walls and electrodes from gas. Prof. Newman's short account of making glass to metal joints shows that he is unaware of the ease with which such seals are now carried out on a technical scale even up to a diameter of several inches. As a whole the book is an excellent one and will be welcomed by all who are interested in the subject. R. LE R.

The Indo-Sumerian Seals Deciphered: discovering Sumerians of Indus Valley as Phœnicians, Barats, Goths and Famous Vedic Aryans, 3100–2300 B.C. By Dr. L. A. Waddell. Pp. xxiv+146. (London: Luzac and Co., 1925.) 10*s*. net.

COL. WADDELL, the well-known authority on Tibet, has stepped in where archæologists, as yet, fear to tread. He has produced an interpretation of the remarkable seals which were found, with other relics suggesting an affinity with ancient Sumeria, at Mohenjo Daro and Harappa in the Indus Valley, and illustrated and described by Sir John Marshall, Director of the Archæological Survey of India, in the *Illustrated London News* in September of last year. "Within a day or two of receiving the photographs," says Col. Waddell, "I was able . . . to decipher and read the greater part of the inscriptions on the seals."

According to Col. Waddell's interpretation, the seals provide a record of the rulers of a Sumerian colony in the Valley of the Indus of the third millennium B.C. His system of interpretation is revolutionary and entails a complete revision of the results obtained hitherto in dealing with Mesopotamian records. Detailed discussion of his conclusions would therefore be unprofitable without previous acceptance of the argument by which he justifies his method of attacking the problem. This is based upon theories which have been expounded in part, though not entirely, in a previous publication in which an attempt was made to prove, not only that the Phœnicians were the ancestors of the Britons, Scots and Anglo-Saxons, but also that they were Aryans and the ruling Aryan class of India. The kings of the early Aryan dynasties of India, it was maintained further, had never been in India, but were kings in western Asia and were to be identified with the kings of early Mesopotamia—Sumeria and

Akkad. Col. Waddell regards the seals as confirming his theories; but it must be obvious that an interpretation which is entirely individual depends upon, rather than confirms, a theory which still lacks conclusive demonstration. For it must be stated that Col. Waddell's views, particularly in so far as his etymological arguments are involved, have not met with the acceptance of those most competent to judge. Until the author has brought forward more cogent arguments for the identification of the kings of the Indian lists with those of Mesopotamia—a subject with which it is understood he proposes to deal in a later work—the riddle of the seals remains unsolved.

Aufgaben und Lehrsätze aus der Analysis. Von Prof. G. Pólya und G. Szegö. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, Band 19 and 20.) Erster Band: Reihen, Integralrechnung, Funktionentheorie. Pp. xvi+338. 15 gold marks. Zweiter Band: Funktionentheorie, Nullstellen, Polynome, Determinanten, Zahlentheorie. Pp. x+407. 18 gold marks. (Berlin: Julius Springer, 1925.)

MOST French and German mathematical text-books differ from the English books in one important particular: they contain no examples for solution. The working of problems and examples has long been one of the features of English mathematical teaching. All able mathematical students of a generation ago were expected to gain practice in manipulation by solving hard problems. Wolstenholme's problem book reflects the tendency of the period in which it was compiled, a large proportion of its examples being somewhat artificial in character despite the elegant solutions they admit. Now the tendency is to avoid problems involving hard manipulation, it being considered that familiarity with mathematical subjects can be gained by working easy examples constructed to test a student's knowledge of fundamental principles. The new Wolstenholme still remains to be written.

Meanwhile, Prof. Pólya and Herr Szegö, in the two volumes before us, have brought together some 1500 problems dealing with the subjects of analysis above noted. A large proportion of the questions can be solved at sight; others involve results taken from research papers in the journals, and few readers will see through these without referring to the solutions. The books will be of great value to honours students of pure mathematics in universities, and a lecturer will find innumerable suggestions for examples to set before his classes. W. E. H. B.

Air Ministry: Meteorological Office. British Meteorological and Magnetic Year Book, 1917. Part 5: *Réseau Mondial, 1917.* Monthly and Annual Summaries of Pressure, Temperature, and Precipitation at Land Stations, generally Two for each Ten-degree Square of Latitude and Longitude (M.O., No. 229 *g*, Tables). Pp. xiv+116. (London: H.M. Stationery Office, 1925.) 22*s.* 6*d.* net.

THIS publication deals with the weather results for the whole globe, and similar results are now available for the eight years 1910–1917. The means are compared with normals and the differences are given for each element for each station. The statistics for each additional year add much of real scientific value in the direction of preparing for long-period forecasts. It is now possible to see how excess or defect from the normal in one part of the world influences weather experienced in another part. It is a fairly simple study to ascertain whether the pressure of the air at the earth's surface is practically uniform at different times over the whole globe. All the information refers to land stations, no data over the sea being as yet obtainable. The number of stations utilised is 458, which is an increase of 18 since the previous issue for the year 1916.

The highest mean shade temperature for the year 1917 was 87° F. at Sokoto and 86° F. at Berbera, Somaliland; the lowest mean 6° F. at Verkhoïansk. The absolutely highest shade temperature recorded is 123° F. at Baghdad on July 21 and at Jacobabad on June 11; the absolute lowest temperature was −81° F. at Verkhoïansk on January 19. The heaviest total rainfall for 1917 was 9850 mm. (388 in.) at Cherrapunji; the least 1 mm. at Iquique.

Schlich's Manual of Forestry. By Sir William Schlich. Vol. 3: *Forest Management, including Mensuration and Valuation.* Fifth edition, revised, and the greater part rewritten. Pp. viii+383. (London: Bradbury, Agnew and Co., Ltd., 1925.) 20*s.* net.

IN this fifth edition of vol. 3 of Schlich's "Manual" the number of pages is slightly less than in its predecessor. Room has been found, however, for a considerable mass of new material, and for several new figures, by judicious compression and elimination, so that the work is brought up-to-date with the examination of new ideas and practice in forestry. Those who peruse the several publications devoted to the science of forestry in England and in India are aware that the author has kept in touch with the latest developments, and here he brings to bear his keen faculty for criticism and for the correct appreciation of modern tendencies.

All the features and main divisions of the previous edition are retained and improved. Among the added subjects the British Forestry Commissioner's method of determining the volume of whole woods is described and criticised. Sir William's own graph for indicating the mean forest per cent., first published by him in his pamphlet "Forestry in the United Kingdom" in 1904, is now included, as well as a reference to Mr. W. S. Hiley's indicator graph, and among the modifications of the compartment system, Dr. Eberhard's ingenious system of wedge fellings is discussed. The controversy on the question of the rate and kind of interest to to be adopted in forestry has led to the inclusion of a paragraph explaining why the application of compound interest in forest finance is insisted upon.

The volume is produced in the now familiar, neat, and handy form of the former editions, and should find place on the reference shelves of every scientific forester. C. E. C. F.

A Survey of Physics: a Collection of Lectures and Essays. By Max Planck. Translated by R. Jones and D. H. Williams. Pp. vii+184. (London: Methuen and Co., Ltd., 1925.) 6*s.* net.

MESSRS. Methuen are doing a real service to science by their publication of translations of foreign scientific works, but they are not always fortunate in their choice of books for translation. It might have been thought in a book with so attractive a title and by such an eminent scientific worker they had a real certainty. The book itself, however, somewhat disappointed our, perhaps unduly great, expectations. It is a collection of lectures and addresses, delivered on different occasions and at different times, mainly on the thesis that physics has now reached the stage when the attempt to form a mechanical picture of natural processes, which has engrossed the attention of the great physicists of the past, should be definitely abandoned, and we should satisfy our souls with the subtleties of thermodynamics and the search for an all-embracing formula. The author develops his thesis forcibly and ingeniously though, necessarily from the structure of the book, with some repetition, and the book should prove attractive to those interested in the philosophy of science. To the physicist the most interesting chapter is that in which the author sketches the road by which he arrived at the quantum theory. The translators have not always been happy in their rendering of the original. We, at least, had some little difficulty in recognising in "Thales von Milet" our old friend Thales of Miletus.

Joule and the Study of Energy. By Dr. Alex. Wood. (Classics of Scientific Method.) Pp. viii+88+8 plates. (London: G. Bell and Sons, Ltd., 1925.) 1*s.* 6*d.* net.

THIS excellent little volume could be read not only with profit but also with pleasure by all students of physics from the school-boy stage upward. There is no better way of appreciating the meaning and value of a scientific principle than a study of the ways in which it was evolved, and no better way of gaining a real understanding of scientific method than a study of the work of one of the great pioneers of science. In something under ninety pages, Dr. Wood succeeds in giving a clear and adequate outline of the gradual growth of the conception of energy, and a lucid account of the work of Joule on the mechanical equivalent of heat, illustrated by ample quotations from Joule's papers. At the same time, he finds room for those humanising touches of anecdote and biography which give life and colour to a work of this kind, and the numerous well-chosen illustrations add still further to the interest.

Dr. Wood has a high reputation as a lecturer, and he writes as charmingly as he speaks. Students of physics should certainly read and enjoy the book, but so clear is the exposition that those who, without being students of physics, are interested in scientific thought and method, could read it, we believe, with almost equal pleasure and interest. The editor of the series is to be congratulated on having persuaded Dr. Wood to write this book (we wish he had allowed him to write the general introduction also), and the publishers on producing it in such an attractive form and at so reasonable a price.

Smoke: a Study of Town Air. By Prof. Julius B. Cohen and Dr. Arthur G. Ruston. New enlarged edition. Pp. xii+108+15 plates. (London: Edward Arnold and Co., 1925.) 8*s.* 6*d.* net.

THE second edition of Prof. Cohen's and Dr. Ruston's book on "Smoke" is modelled closely upon the first. It has, however, some important additions on the effect of smoke on vegetation, and a new section has been added—"The Plant as an Index of Smoke Pollution." There is much useful information on the nature, quantity, and effect of soot, based mainly upon Prof. Cohen's own observations made in Leeds and its environs some years ago.

The chapter on "Town Fog" can scarcely be taken as setting forth the latest knowledge on the subject. For example, in describing the initial stages of condensation to form particles of mist or fog, p. 66, the vital distinction between the influence of ordinary dust and of hygroscopic salts is neglected, and ordinary dust is credited with an effect on condensation which it does not possess. Similarly, Aitken's "dust" counter is now known to take cognisance of hygroscopic nuclei only, neglecting ordinary dust. Yet this fact is not brought out when it is compared with the Owens' dust counter; the latter is incorrectly described as a modification of Aitken's, although based on a different principle and counting different particles. Again, the conception of a town fog as formed by condensation on "every little floating particle of dust" is not in accordance with the present state of our knowledge.

There is a little obscurity in the phraseology in plan (p. 27), but, on the whole, the book is a welcome contribution to the study of the air of our cities, the need for purifying which is becoming more apparent as such investigations lay bare the far-reaching ramifications of the smoke evil.

The Ao Naga Tribe of Assam: a Study in Ethnology and Sociology. By Prof. William Carlson Smith. (Published by direction of the Government of Assam.) Pp. xxvii+244+8 plates. (London: Macmillan and Co., Ltd., 1925.) 21*s.* net.

THE Aos, the people studied in this latest addition to the excellent series of monographs published by the Government of Assam, occupy the country lying between the Lhota and Sema Nagas on the south, and the various Naga tribes, collectively known by the Aos as "Miri," in what is mainly independent territory on the north. The Aos are composed of two racial groups, the Mongsen and the Chongli, which Mr. J. H. Hutton in his interesting introductory analysis suggests may have fused comparatively recently, the Mongsen representing a pre-Ao population. The author modestly does not claim for his book that it is any more than an introduction to the study of the people. He has covered a wide field in his account of the culture, social organisation, and religion and magical beliefs of the people, but not in that intensive manner which we have become accustomed to look for in this series. What is, perhaps, the most valuable part of the book, especially from the practical point of view of the future of the people, is the final chapter recording the changes in their culture which have been brought about by contact with outside, and especially European, influences. It is both a guide and a warning.

Nutrition de la plante. 4: *Cycle de l'azote.* Par Marin Molliard. (Encyclopédie scientifique: Bibliothèque de Physiologie et de Pathologie végétales.) Pp. xv+319. (Paris: Gaston Doin, 1925.) 15 francs.

A SUBJECT which has attracted the attention of botanist, chemist, and bacteriologist alike is bound to be unwieldy and its literature difficult to survey in a book of three hundred pages. Especially is this the case when, being part of a scientific encyclopædia, it must presumably be intelligible to those whose general scientific knowledge is only limited. From this point of view, the book is well written, and the author, while necessarily introducing a good deal of text-book matter —as in Chap. i., which deals largely with tests and properties of various nitrogen containing compounds—has yet found space enough to make reference to more than two hundred original papers. These have been well surveyed, and, in most cases, actual experimental numbers are given. The various stages of the cycle are worked out somewhat on monograph lines in Chaps. ii.-v. under the self-explanatory headings of nutrition, digestion, and transformation. The sixth and last chapter is devoted to the *bêtes noires*, or those nitrogen containing bodies which do not find a definite place in the cycle. The conflicting data and opinions of various authors are given, and the reader advisedly left to form his own. A complete bibliography concludes a very readable and useful book. E. R.

The Lilies of Eastern Asia: a Monograph. By Ernest H. Wilson. Pp. xiv+110+17 plates. (London: Dulau and Co., Ltd., 1925.) 25*s.* net.

IT is not often that a writer on plants has the advantage of having had experience of seeing them in their native habitats, of cultivating them, and of studying them from herbarium material. Mr. Wilson is fortunate in having combined these, and shows in his introduction what good use he has made of his opportunities, so as to arrive at an estimate of the value of the various characters for taxonomic purposes. He has made three journeys through those parts of eastern Asia which may be regarded as the headquarters of lilies, and has also studied the material preserved in the chief herbaria of the world. The result has been the production of a volume containing detailed descriptions of the species and varieties, references to literature and synonymy, indication of habitat and notes on their cultivation, together with seventeen plates, of which several are reproductions of photographs taken by the author, of the plants in their native habitats. The book will be of great assistance to students of lilies, and gives references to the scattered literature which has accumulated since the publication in 1880 of Elwes' "Monograph of the Genus Lilium."

C. H. W.

Wireless Valve Transmitters: the Design and Operation of small Power Apparatus. By W. James. Pp. viii + 271 + 8 plates. (London: Iliffe and Sons, Ltd., 1924.) 9*s.* net.

THE aim of the author is to deal in turn with the various parts of a complete radio transmitting equipment so as to enable the amateur to set up and operate his own transmitter. A great deal of interesting and instructive work can be carried out by a "non-radiating" aerial, and certainly this type should be used by the beginner. The circuit arrangements described are either standard practice or of proved practical utility. The author's diagrams make his descriptions easy to follow. Those whose experiments are carried out mainly by trial and error will do well to read this book. Amateurs have recently had many successes to their credit, and they deserve every encouragement. Rigorous mathematicians would not allow some of the proofs given in the book. For example it is stated (p. 7) that the skin effect is greater the larger the cross-section (S), the higher the frequency (f), and the better the permeability (μ). It is less for conductors with a high specific resistance (ρ). "Thus" the skin effect is proportional to $S\mu f/\rho$. It is conceivable that some readers might think that this was a proof.

Choosing your Life Work. By William Rosengarten. Second edition. Pp. xxii+323. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 12*s.* 6*d.* net.

THIS book sets out with the aim of helping a young boy to choose a career. According to the author, psychological tests are so new and uncertain that for practical purposes they are almost as untrustworthy as phrenology and physiognomy. Therefore the youthful aspirant for a career is recommended to analyse himself according to the *questionnaire* appended and then to turn to the various occupations and select according to his fitness. A chapter is devoted to each of the common occupations, and the requirements, emoluments, and drawbacks to each are described. It is distressing to learn that the telegraphist, although he fulfils a very important function, is unlikely to win high financial reward. As a handbook to various trades, the book may be useful; its style is verbose and the information it gives would not have been impaired by judicious compression. The blend of moral "uplift" and commercialism is not attractive to the English reader.

The Dust Hazard in Industry. By Dr. William E. Gibbs. (Chemical Engineering Library: Second Series.) Pp. 168. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

THE subject dealt with in this book is one of great importance. Industrial dust is frequently a source of danger, either to health, or to life and property by causing explosions. Although much valuable information is available, the publications are scattered, and the author has performed a useful service in collecting and arranging the material in a readable form. Particular attention is paid to dust explosions, on which much useful information has been obtained at the Home Office Experimental Station at Eskmeals. American results, of great value, have also been fully considered, and the book is authoritative. Some of the information will be of interest to medical men as well as to chemical engineers. The name of the chief authority on explosions, Prof. H. B. Dixon, does not appear in the book, although many of his results are quoted.

Mechanical Mixing Machinery. By Leonard Carpenter. (Chemical Engineering Library, Second Series.) Pp. 138. (London: Ernest Benn, Ltd., 1925.) 6*s.* net.

ALTHOUGH this book deals with dry mixing, it overlaps in parts the volume on the same subject by Mr. Seymour in the same series. It is not altogether clear why the publishers should have thought it necessary to have had two volumes dealing with the same subject in the same series, but the two books will no doubt appeal to different classes of readers. The treatment is practical, and the book is well illustrated.

Letters to the Editor.

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

The Ionisation Potential of Ionised Manganese.

IN his paper on the manganese spectrum (Phil. Trans. Roy. Soc., vol. 223 A, p. 127) Catalán gives some triplets and multiplets of the spectrum Mn II, and suggests identifications of some of them. I have recently made an attempt to estimate terms from some of these lines; two independent methods agree within the estimated limits of error, and it seems that it is possible thereby to estimate the ionisation potential with an error probably less than half a volt.

Catalán (*loc. cit.*) suggests that the enhanced triplet λλ 2576, 2594, 2606, and multiplet consisting of three triplets near λλ 2428, 2438, 2453 are the first principal and first diffuse triplets of Mn II. Back (*Zeit. f. Phys.*, vol. 15, pp. 238-40) has confirmed the first of these identifications by the Zeeman effect, and has shown that the terms belong to a septet system similar to the Cr I septets (for which see Gieseler and Grotian, *Zeit. f. Phys.*, vol. 22, p. 228), and he agrees with Catalán's identification of the diffuse multiplet.

Further, Catalán states that the lines λλ 2576, 2594, 2606 forming the first principal triplet are the most persistent of the enhanced lines of Mn, so they are probably the "ultimate lines" in Russell's sense (*Astrophys. Journ.*, vol. 61, p. 223), and if so, the septet $1s$ term corresponds to the normal state of the atom.

Now Hund (*Zeit. f. Phys.*, in press) has shown reason to believe that the distribution of electrons in the Cr and Mn^+ atoms in their normal states is the same (5 electrons in 3_3 orbits and 1 in a 4_1 orbit, the inner n_k sub-groups being complete; this is the only case in the iron group in which the normal state of a neutral atom has the same distribution of electrons as the normal state of the ionised atom in the previous place in the periodic table), so the $1s$ terms of the Cr I and Mn II septets are really corresponding terms. Also for Cr I the zero of term value corresponds to the ionisation of the atom by removal of the 4_1 orbit, and if we take a corresponding zero for Mn II it seems likely that quantitative relations between the septet terms of the two spectra can validly be applied.

From the principal triplet alone it is possible to estimate term values in two ways. The quantum defect q for the n_k term, wave number ν, of an atom core charge C being defined by $\nu/R = C^2/(n-q)^2$ as usual, the two estimates are as follows:

(1) For Cr I septets, the s terms belong to a sequence of the Rydberg type, so they can be associated with different orbits of a single series electron, and the concept of a quantum defect is significant; and the first p term (Gieseler and Grotian's 4_2) looks like the first member of a Rydberg sequence. The difference of quantum defect between the first s term and the smallest member of the first p term is 0·46; judging from the behaviour of the similar difference in other spectra, it seems probable that its value for Mn II septets will lie between the limits $0{\cdot}35 \pm 0{\cdot}02$. Using the first principal triplet above mentioned, this gives $1s(4_1) = 119{,}000 \pm 4000$.

(2) The triplet separation for the p term of Cr I fits the Landé formula (see *Zeit. f. Phys.*, vol. 25, p. 48) fairly well, so it may be expected that the relation between the separations for corresponding terms of Cr I and Mn II will be given by this formula. The best way of applying it is through Δq, the difference of quantum defect q between the extreme members of a multiple term. The value of Δq for the 4_2 term of Cr I septets is 0·00584; for the corresponding term of Mn II it would be expected to be about 0·0061. The value of $\Delta\nu$ is known from the separation of the first principal triplet, so the value of the term can be calculated. It leads to a value $1s = 116{,}000$, the limits of error being estimated at ± 5000.

The agreement of the two independent estimates, one from the position of a line of the triplet and the other from triplet separations, is most satisfactory; it seems likely that the $1s$ term of the Mn II septet system lies within the limits $118{,}000 \pm 3000$. The ionisation potential corresponding to the removal of the 4_1 electron is then $14{\cdot}5 \pm 0{\cdot}4$ volts.

It seems possible that similar methods may be of use in providing approximate values of terms of other spectra of ionised atoms, of which only a few lines are known, if suitable lines can be identified.

D. R. HARTREE.

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The Future of the British Patent Office.

PATENT Law is a means to an end, and until the nature of the consideration which the patentee is to bring in in return for his monopoly has been clearly ascertained, it is idle to attempt to lay down what should or should not be the appropriate practice at the Patent Office. Now the object of British Patent Law has varied materially during the last three hundred years.

Coke, for example, is the chief authority for the construction of the Statute of Monopolies and this is his commentary: "The reason wherefore such a privilege is good in law, is because the inventor bringeth to and for the Commonwealth a new manufacture by his invention, cost and charges, and therefore it is reason that he should have a privilege for his reward" (Coke, 3 Inst. 181). Under the Stuart dynasty, the jurisdiction of letters patent was reserved to the Privy Council. This body administered the Statute of James in the sense of Coke's dictum. It insisted that the patentee should make good at the earliest opportunity and was always ready to revoke an unused patent in favour of a second applicant with better credentials; the latter became "the true and first inventor" under the Statute. About 1750, however, its jurisdiction was allowed to lapse, and patentees henceforward were compelled to seek their remedy in the Courts of Law. The latter, being without recent precedents to guide them, interpreted the contract in the letters patent in the light of the specification clause, and in 1778 it became established law that the patent specification was the price of the monopoly.

This doctrine held the field until 1883, when the needle of patent law again began to show signs of instability. The Patents Act of that year contained certain inoperative compulsory licensing clauses, which were afterwards strengthened, but in 1919 the needle once more veered round with a swing to the Statute of Monopolies—the Act of 1919 laying down that "patents for new inventions are granted not only to encourage invention but to secure that new inventions shall, as far as possible, be worked on a commercial scale in the United Kingdom without undue delay, and further providing that a patent shall not be invalidated by the prior sale of the inventors' product if a patent has been applied for within six months of such sale."

Hence there are two basic principles of patent law, (*a*) that patents are granted in consideration of the disclosure of inventions; (*b*) that they are granted for the institution of new industries.

Although both principles may fitly be recognised in a given system of patent law, they cannot be regarded as coequal. For the type of administration appropriate to (*a*) not only differs from, but also is even antagonistic to, that which would naturally be evolved under (*b*). Under (*a*) there must be a highly elaborated machinery for the investigation of novelty, with the result that patents will be granted with relatively narrow claims, and that the capitalist be able to buy inventions cheaply, for patents will possess little restraining power. An official search, no doubt, gives additional security, but the commercially valuable factor in a monopoly is its restraining power. Hence, as a general rule, when security is at its highest the other factor will be "little, or none at all."

Trustworthy evidence of the commercial value of patents is not readily obtainable—for it is against the interest of patent officials, agents and owners alike publicly to depreciate their own services or properties. The following communication, however, was sent to the present writer in 1923 from a well-known scientific writer in Washington. He writes: "I have been wondering for some time whether the world's patent offices are not about to break down under their own weight. Simple arithmetic shows that the possible permutations and combinations of known principles and kinds of matter are so numerous that their task is hopeless unless the definition of invention or originality is radically changed. The U.S. Patent Office is already in a badly demoralised state and far behind with its applications, and its patents have for some years been recognised as worthless in themselves, being essentially only tickets of admission to the courts of law." Corroborative evidence on this point will be found in my letter to NATURE, Nov. 11, 1922, p. 633. These are inside views of the effect of a universal search upon the selling value of patents.

The writer of the articles in NATURE of July 25 and August 1 proposes a search through the 1759 periodicals taken in the Patent Office Library. But what about the 24,028 registered in the recently published "World List of Scientific Periodicals"? His search is to be limited to suit the convenience and capacities of the examining staff. Section 41 (1) of the Patents and Designs Act 1907 established the principle that "what we don't know isn't knowledge" in order to round off the official 50-year search (see my letter as above). When I pointed this clause out to a legal authority, he said it was "damned nonsense"—but it is proposed in the articles referred to above to extend the principle.

The remedy is obvious. An administrative search for novelty has long been an economic absurdity. The direction in which reform should be sought, if the object of our patent law is to stimulate the growth of British industries, is in the relief of the patentee from the unduly high legal standard of novelty. Sir John Dewrance in his presidential address before the Institution of Mechanical Engineers in 1923 supports this contention. He writes: "It has always seemed to me to be unfair that documents should be evidence of anticipation: evidence should be of prior use." This relief can, of course, be granted to the patentee only upon proof of commercial working.

Hence official search for novelty should be restricted to secure that concurrent British patents are not granted with overlapping claims. With a simplified procedure and broader claims, which can be substantiated so soon as the patented process has been reduced to practice, capital will once more flow into native industries.

Underlying the case presented in NATURE is the thesis that the public requires to be protected against the inventor. My case is that the inventor should be wooed and if possible won to come over and help us, and for this purpose I would make the law clear and consistent and the official practice cheap and expeditious.

E. WYNDHAM HULME.

A Radio Method of Estimating the Height of the Conducting Layer.

IN a recent note we have outlined a method of estimating the height of the conducting layer by means of radio waves (M. A. Tuve and G. Breit, *Terr. Mag.*, vol. 30 (1925), pp. 15-16). Through the co-operation of the U.S. Naval Research Laboratory, Bellevue, Anacostia, D.C., we have obtained definite indications of reflections such as would take place from the layer and some estimates of its height. The method used consists in sending out interrupted high frequency wave-trains and observing the wave-form of the received signal. Each wave-train received manifests itself as a temporary rise in the detector current of the receiving set. One particular wave-train at the transmitter gives rise to two received wave-trains at the receiver if a single reflection takes place. One of these trains travels over the ground and the other by way of the layer. Thus the detector current is forced to rise at two different times by the same wave-train from the transmitter and an oscillogram of the detector current shows two humps generally of unequal size.

The transmitter was operated with a 500-cycle plate current supply so that a wave-train of 71·3 metres wave-length was emitted during a part of each positive half of the cycle. A succession of single humps is thus emitted. (We have made sure of this by observing the wave form at the same time at the transmitting and the receiving stations.) The receiving station was located 7 miles away from the transmitter in a general direction north, the Potomac River and the City of Washington being between the two stations. We have observed the received wave-form visually and photographically. Double and triple humps were observed on some days, though practically single humps were observed on others. Marked variations in the relative position and amplitude of the humps were observed during 10-minute observation periods. The retardation of the secondary humps with respect to the primary is of the order of 1/1700 second, which corresponds to a retardation over a length of roughly 110 miles and a distance of the layer of the order of 50 miles. Other humps correspond to 100 miles. The origin of triple humps is not clear. The possibilities of a wavy surface in the layer and successive reflections suggest themselves.

Experiments on other wave-lengths with different receivers and transmitters and in different locations seem valuable. We are hoping that such experiments will be performed by others as well as ourselves. Some experiments at 600 metres were performed in co-operation with the Radio Corporation of America, the distances between the two stations being about 150 and 100 miles. No definite indication of the presence of the layer was found in these cases.

G. BREIT.
M. A. TUVE.

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Science and Intellectual Freedom.

IN the issue of NATURE for July 18, p. 103, it is stated: "Our sole object in taking up the subject of the prohibition of the teaching of evolution in certain States of the United States, and in inviting opinions upon this action from a number of leading authorities, has been to afford support to our colleagues fighting for scientific truth and progress against dogma and stagnation. We trust that the additional messages subjoined will give them the strength and courage they need to secure for them the position of intellectual freedom established in Great Britain many years ago, and existing unchallenged to-day."

It is possible to appreciate the good intentions of this patronage without admitting its need. Not intending to bite the hand that feeds us, I still venture to express a doubt as to whether the strength and courage of American men of science in their efforts to attain the intellectual freedom established in Great Britain will be greatly forwarded by the series of little articles published in NATURE and by the editorial comments.

Tennessee is the only State concerned, and it does not forbid the teaching of evolution, but only the teaching in tax-supported institutions of the derivation of man from a lower order of animals. The law is unfortunate, and is opposed by general public sentiment as well as by men of science. It should, however, be remembered that Tennessee also forbids the reading of the Bible in its public schools; it does not expect them to teach that the evolution of man is not true. The control of teaching by legislation is unwise, but no sensible teacher would want to lead children to question the religious convictions of their parents. Intellectual freedom is also interfered with when a premier prescribes that the children of a nation must study Latin, thus leaving no time for the study of science.

There is a larger proportion of "Fundamentalists" in every European nation than in the United States, and also a larger proportion of educated people who profess, without believing, the thirty-nine articles and other inherited creeds. Sir Joseph Larmor, the distinguished man of science who represented the University of Cambridge in Parliament, made it one of his chief pleas when he was first a candidate that he would support the maintenance of the control of the Church of England over tax-supported schools. It is not surprising if a majority of the rural population of Tennessee hold the creed that Mr. Gladstone defended and that Lord Balfour exploits in more sophisticated fashion. They would scarcely follow the vagaries of Sir Oliver Lodge. The only scientific man here who manifests an interest in such things was sent to us from the University of Oxford. But perhaps it is undesirable to make international comparisons.

J. MCKEEN CATTELL.

New York, July 30.

On the Spectra of Neon and Argon in the Extreme Ultra-violet.

AT the April meeting of the American Physical Society (see *Physical Review*, 25, 886, 1925) we reported the existence of a very strong pair of lines in the spectrum of neon at λλ 743·78 and 735·95, together with some ten other lines, all combinations with a fundamental $1p$ term in this spectrum. We are glad to see that G. Hertz (*Die Naturwissenschaften*, May 29) has independently found the same strong pair, and that their position agrees satisfactorily with our measures and with that obtained by him from resonance potential observations.

It is perhaps worth while to note that the spectrum of argon contains a similar pair, at λλ 1048·28 and 1066·73 (±0·2), together with a number of other lines of shorter wave-length, which are probably components of a like pattern. The strong pair fits exactly the resonance potential, 11·5 volts, found by Hertz. Another observed pair corresponds to his value of 14·0 volts. His third resonance potential, 13·0, seems not to correspond to any emission line, but the presence of unidentified impurity lines in our spectra makes it necessary to take further observations before giving final data.

The complete argon spectrum is probably like that of neon. The strong lines are therefore combinations of a fundamental $1p$ term with terms $1s_2$ and $1s_4$. The latter combine with other terms, as yet unknown, to produce several lines which are listed in tables of constant wave-number differences (*e.g.* Kayser, "Handbuch," 7, p. 26, where two of the columns refer to such combinations). More observations on the spectrum of argon are, however, needed before the structure of the spectrum can be worked out.

In neon a curious fact has been noted. The line at λ735 is normally stronger than that at λ743; it is in fact the strongest line in the whole spectrum. When, however, a small quantity of neon is present as an impurity in helium, the relative intensities of the lines of this pair reverse, λ735 becoming the weaker of the two. Our observations make it seem unlikely that this could be due to the presence of a sharp-edged absorption band in our helium. One would therefore suppose that collisions between atoms of neon and of helium render the peculiar atomic state yielding the line λ735 less probable than is the case when the neon is alone. Argon as an impurity in neon shows no such effect.

THEODORE LYMAN.
F. A. SAUNDERS.

Jefferson Physical Laboratory,
Harvard University, July 25.

Lunar Periodicity in Obelia.

IN Proc. Roy. Soc., vol. 95, 1923, Mr. H. M. Fox directed attention to a number of cases of "Lunar Periodicity in Reproduction" in marine organisms. To these may be added the hydroid *Obelia geniculata*. At first sight the periodicity is masked by the irregular breeding of colonies which are wave-worn or much eaten down by nudibranchs, but if attention is confined to healthy and perfect colonies, the lunar periodicity seems quite definite. During 1924 several colonies on the piers were located and watched; the best result was from a colony on Laminaria on Millport old pier, which was giving off medusæ during the ten-day periods beginning with the third week of the moon in July, August and September, and not at other times. Other colonies gave definite results in two consecutive months, but were then attacked by nudibranchs or lost.

More recently, twelve colonies at Keppel were examined on July 28 (first moon quarter)—none of them had gonothecæ, one colony had minute axillary buds beginning to form gonothecæ; on August 5 (full moon August 4)—of fifteen colonies examined, eight were worn, frayed or eaten, the remaining seven were healthy and ripe, including small colonies of only five or six branches, probably three weeks old.

Miss S. M. Marshall has confirmed these observations by noting occasional abundance of Obelia medusæ in the plankton about the third quarter of the moon. Colonies which have been much eaten by nudibranchs may, if abundant food be present, recover rapidly and reproduce at any time; to which is probably due the fact that this case of lunar periodicity has escaped observation.

RICHARD ELMHIRST.

Marine Biological Station,
Millport.

Magneton Numbers of Iron in some Complex Salts.

DR. L. C. JACKSON'S letter in NATURE of June 27, p. 981, points out the fact that an iron atom, known definitely to be ferrous, can have at least four distinct magnetic moments; namely, 26, 26·5, 27, and 27·5 when expressed in the magneton of Weiss. The purpose of this note is to present preliminary data tending to show that the magneton numbers for ferrous iron are not limited to 26-27·5, but can be 0 and 10 as well. Likewise, a ferric iron atom can have a magnetic moment corresponding to 0 and 10 magnetons in addition to the 29 magnetons usually obtained from measurements on simple paramagnetic salts. An example is included of an iron compound, the carbonyl, in which the iron certainly plays the part of a diamagnetic element.

The data appear in the table below. The mass susceptibilities for potassium ferricyanide, potassium ferrocyanide, and iron carbonyl are taken from a paper by Oxley (Proc. Camb. Phil. Soc., 1910–12, 16, 102), whose values have been recalculated since the susceptibility, k, of the reference substance, water, is now considered to be $-7·19 \times 10^{-7}$ rather than $-7·5 \times 10^{-7}$. The other complex salts are formed by the substitution of the radicals NH_3, NO_2, etc., for one of the CN groups in either the ferricyanide or the ferrocyanide of sodium. One of them is the well-known sodium nitroprusside. The other seven were prepared by Dr. Baudisch of this Institute, who followed, in general, the methods described by Hofmann (*Annalen der Chemie*, 1900, 312, 1).

The net susceptibilities pertaining to the gram atom of iron were obtained by allowing for the diamagnetic moment due to the atoms other than iron. For this purpose use was made of the diamagnetic constants listed by Pascal (*Revue générale des Sciences*, July 15, 1923). Since my measurements were made on the salts in the solid state, the Weiss formula for the magneton number

$$N = \frac{\sqrt{3RTK_i}}{1123·5}$$

is not directly applicable. But Weiss (*Jour. d. Phys.*, 1911, 1, 965, 5th ser.) has already calculated that iron in potassium ferricyanide has 10·41 magnetons by making use of Pascal's measurements on this salt in a dilute solution (*Ann. Chim. Phys.*, 1909, 16, 531, 8th ser.). Weiss's value, 10·41, becomes 10·2 when revised on account of the newer susceptibility, $k = -7·19 \times 10^{-7}$, assigned to the water used as a standard. 10·2 was therefore adopted as the correct magneton number for potassium ferricyanide, and all of the others were calculated by taking the magneton number to be proportional to the square root of the net susceptibility.

We note at once that the magneton numbers group themselves around ten and, very probably, zero. There is no doubt as to the ferric salts, provided that we accept the value of 10 magnetons for potassium ferricyanide. The fact that the ferrous diamagnetic salts give magneton numbers up to 1·5 may be due to the presence of small amounts of paramagnetic impurities or to uncertainties about the diamagnetic constants used in calculating the net susceptibilities. Both of these factors are important in dealing with diamagnetic substances. According to the table, the last ferrous salt, $Na_3Fe(CN)_5OH_2 + H_2O$, does not yield 10 magnetons. 6·6 is the highest value yet observed. The salt is difficult to prepare and becomes more and more paramagnetic on repeated recrystallisation. At first it seemed to approach 5 Weiss magnetons, or one of Bohr's, as a limit. Since it passed 5 magnetons its upper limit is now believed to be 10. At any rate the magneton number of the iron in this salt is known to be greater than 6·6.

Iron.	Complex Salt (solid state).	Susceptibility, $\frac{K \times 10^7}{\text{gm.}}$	Susceptibility, $\frac{K_m \times 10^7}{\text{gm. mol.}}$	Net Susceptibility of Iron $\frac{K_i \times 10^7}{\text{gm. atom}}$	Magneton Number. Observed. Weiss.	Magneton Number. Probable Real Value. Weiss.	Magneton Number. Probable Real Value. Bohr.
Ferric	$K_3Fe(CN)_6$	+90·0	+29610	+30800	10·2	10	2
	$Na_2Fe(CN)_5NH_3+H_2O$	+95·3	+25500	+26500	9·5	10	2
	$Na_3Fe(CN)_5NO_2$	+87·3	+26300	+27170	9·6	10	2
	$Na_2Fe(CN)_5OH_2+H_2O$	+104	+27900	+28880	9·8	10	2
	$Na_2Fe(CN)_5NO+2H_2O$	−3·497	−1042	−43	—	0	0
Ferrous	$K_4Fe(CN)_6+3H_2O$	−4·07	−1720	+54	0·43	0	0
	$Na_3Fe(CN)_5NH_3+6H_2O$	−2·77	−1052	+680	1·5	0	0
	$Na_4Fe(CN)_5NO_2+H_2O$	−1·49	−508	+582	1·4	0	0
	$Na_5Fe(CN)_5SO_3+2H_2O$	−3·31	−1380	+99	0·58	0	0
	$Na_3Fe(CN)_5OH_2+H_2O$	+41·2	+12000	+13070	6·6	10	2
—	$Fe(CO)_5$ (liquid)	−3·84	−752	−540	—	—	—

Still more interesting than this grouping of magneton numbers about zero and ten is the appearance of two inversions. Iron in most of the ferric salts has 10 magnetons, but in at least one ferric salt it has none. Similarly, the ferrous salts usually contain no magnetons, but in one of them we find at least 6·6 and very probably 10. We see then that the magnetic moment of iron is extremely variable, and that it is not uniquely defined by a statement of its valence.

Gerlach (*Ann. der Phys.*, 1925, 76, 163) has recently observed that iron in the vapour state has no magnetic moment. This suggests that its paramagnetic properties in a salt, either solid or dissolved, are due entirely to the distortion of its electron system by the neighbouring atoms with which it is combined, or by the water molecules surrounding the ion. Altogether there seem to be at least seven principal states in which the iron may exist on account of these external forces of a chemical nature. Putting it in another way, there are at least seven main configurations of the electron system known to us as the iron atom. They are ferric iron, giving 0, 10, and 29 magnetons; ferrous iron giving

0, 10, and the group of 26 to 27·5 magnetons; and then there is the iron which is nearly as diamagnetic as Pascal (*Revue générale des Sciences*, July 15, 1923) has found bismuth to be in its compounds.

LARS A. WELO.

Rockefeller Institute for Medical Research,
New York, July 23.

MR. WELO'S interesting letter directs attention to the fact that the iron atoms in various complex cyanides possess quite different magnetic properties from the iron atoms in simple ferrous or ferric salts. The existence of iron atoms which are either paramagnetic, but have a moment considerably smaller than that found in the simple salts, or even diamagnetic (zero magnetic moment) finds a parallel in the observation of Pascal that oxygen may function in organic compounds as a paramagnetic element with the "usual" moment, as paramagnetic with a lesser moment and also as diamagnetic.

The susceptibilities of a large number of complex co-ordination compounds of cobalt and nickel are known. It would be of considerable interest to carry out similar calculations to Mr. Welo's with these data also. Cobalt and nickel atoms with zero magnetic moment may be expected, but the interesting point would be the determination whether these elements exist in modifications analogous to Mr. Welo's iron with 10 magnetons.

It may be of interest to mention the non-magnetic films of nickel which have recently been described. Their existence has been ascribed elsewhere to a rearrangement in the electron configuration similar to that suggested by me in the letter referred to by Mr. Welo. By this rearrangement the electron configuration of the nickel atom becomes completely symmetrical and hence the atom possesses no magnetic moment.

A further study of data such as are given by Mr. Welo and those derived from the simple salts of the magnetic elements is likely to be of considerable interest in giving some evidence of the deformations or rearrangements of the electron orbits of an atom in a solid compound. The magnetic properties of the free undeformed atom may be inferred from spectroscopic data.

Two further points may be mentioned in connexion with Mr. Welo's letter. First, his method of calculation of the magneton numbers implicitly assumes that the various substances obey Curie's law $KT=C$. In general, however, paramagnetic substances obey the more general law, $K(T+\Delta)=C$, so that a single measurement at one temperature is not sufficient for the determination of the Curie constant C, from which the magneton numbers are calculated according to Weiss. Mr. Welo's numbers may, therefore, need a correction on this account. Further, it is scarcely permissible to calculate the Bohr magneton numbers merely by dividing the corresponding Weiss numbers by 5 since, though the Bohr magneton is essentially a quantum unit, no account is then taken of the spatial quantisation factor.

Secondly, it seems that there is a slight misunderstanding of the purpose of my letter already referred to. It is perfectly reasonable to expect that iron atoms in quite different modes of combination should possess different magnetic properties, but in the letter attention was directed to the fact that iron atoms in ferrous compounds may exist in different magnetic states in one and the same compound. Thus the four values of the magneton number there mentioned were obtained from observations on ferrous ammonium sulphate.

L. C. JACKSON.

The Band Spectra associated with Carbon.

HAVING read with great interest the two communications by Prof. Raymond T. Birge, published in NATURE of August 1, p. 170, and August 8, p. 207, I should like to direct attention to the fact that I gave in 1924 the description and wave-lengths of the band spectrum described a year later by Dr. R. C. Johnson as "A New Band System" in Proc. Roy. Soc. A, 108, 349, June 1925, and called "the new Johnson group" by Prof. Birge (NATURE, August 8, p. 207).

My first publication concerning these new bands appeared in *Comptes rendus*, 178, May 5, 1924, p. 1525, under the heading "Sur les spectres de la décharge thermionique dans l'oxyde de carbone. *Nouveau spectre de bandes*" (italics mine here). It was also published with a photographic reproduction of the bands in *L'Astronomie*, 38, Nov. 1924, 444, Fig. 236.

The thermoelectronic bulb filled with pure carbon monoxide at a pressure of about half a millimetre gives with intensity only the three double-double headed bands at λ4236, 3978, 3730, while the helium mixture of Dr. Johnson gives three additional bands. So far as I can judge with such a limited number of bands, it appears that the distribution of the intensities seems a high-temperature distribution with thermoelectronic bombardment, while it would be a low-temperature distribution in a helium mixture. Prof. Birge has rightly made the same remark for the comet-tail bands (NATURE, August 1, p. 171).

Since the publication of my above-mentioned papers, I have obtained the three bands with a great dispersion, and I will give later the analysis of their fine structure.

F. BALDET.

Observatoire de Meudon, August 12.

The Transport of Organic Foodstuffs in Plants.

FROM the ringing experiments of early times, it has reasonably been inferred that foodstuffs are translocated downwards by the phloem. But to complete the evidence it would be necessary to prove directly that the tissues external to the wood can translocate foodstuffs by themselves. Adequate experimental evidence for this has never been produced, and recently it has been maintained that downwards as well as upwards the foodstuffs must be translocated by the wood. (Dixon, H. H., and Ball, N. G., NATURE, February 23, 1922, vol. 109, p. 236.)

Evidence for translocation by the rind I have, however, now been able to obtain by rooting shoots of *Salix fragilis* in tap-water, and peeling off from below upwards strips of rind from 4 to 8 cm. long, each carrying a root. The strips remained connected with the shoots above. The roots on these strips grew at rates up to a centimetre a day, and nearly as fast as similar roots on intact parts of the same shoots. They continued to grow indefinitely. The foodstuffs for their growth must have been translocated from the shoot, for roots on short, completely isolated strips of rind grew only for a few millimetres and then stopped, showing that the local supply was insufficient. Since new wood did not begin to be regenerated for from four to eight days, the foodstuffs must have been translocated by the rind alone.

It should be mentioned that before the roots on the strips of rind could be got to grow, it was found necessary either to prevent the water surrounding the roots from touching the inner surfaces of the strips, or to keep this water sterile with one part in 120,000 of thymol.

It is hoped to continue the experiments next spring.

R. SNOW.

Magdalen College, Oxford.

The New Ideas in Meteorology.[1]

By Dr. G. C. SIMPSON, F.R.S.

THE first quarter of the twentieth century will always be remarkable for the great advances made in science. In our own particular branch the advance has probably been the most startling and has appealed very strongly to the popular imagination. In mathematics we have had a little-known and even less-understood branch of pure mathematics applied to physical problems with results which have revolutionised our whole conception of the universe in which we live. In astronomy we have had described to us an evolution of the heavenly bodies as real and as dominating as the evolution which the previous century revealed in the animal kingdom. In physics the progress made has been most remarkable. At the beginning of the century, it is true, we had been introduced to the electron, to Röntgen rays, and to radioactivity; Planck was also writing on the laws of radiation; but no one realised the powerful tools which these phenomena were going to put into the hands of physicists. These tools have, however, been used, and not least by our own countrymen, to dig deep into Nature's secrets, even into the atom itself, so that now we are able to visualise the component parts of an atom, which itself is a structure far removed from our powers of perception.

Meteorology, although a child of applied mathematics and physics, has scarcely been touched by the epoch-making discoveries in the house of its parents. The quantum has found no place in our theories of the mechanism of the atmosphere; a knowledge of the structure of the atom has not helped us to understand the physics of the air as we deal with it in meteorology; the relationship between mass and charge, the invariability of the velocity of light, four-dimensional space and all the other new conceptions which have been responsible for the advance of physics, have been of no help to meteorologists in their especial branch of science.

The whole attention of physicists has been so dominated by these new ideas, and the vistas of unexplored country which they have opened out are so vast, that it is no wonder that physicists have had no interest in a domain in which their new tools could not be employed. The consequence has been that meteorology has had little help from physicists and mathematicians as such, and has had to depend, at least in Britain, on the relatively small band of meteorologists in Government employ. Let me say, however, that we are grateful for the help which we have received from physicists, especially from those who were brought into contact with meteorology during the War. In spite of the fact that meteorology has not been able to make use of the recent discoveries in pure physics, there has been in the last twenty-five years as fundamental a revolution in our ideas of the atmosphere as has taken place in our ideas of electricity and matter. Unless I am very much mistaken, however, these fundamental changes in our conception of the atmosphere, both as a whole and in its parts, are little known outside the small band of professional meteorologists. I therefore welcome this opportunity of bringing them before the members of Section A of the British Association.

[1] From the presidential address delivered at Southampton on August 28, before Section A (Mathematical and Physical Science) of the British Association.

THE THERMAL STRATIFICATION OF THE ATMOSPHERE.

The fact that the temperature of the air decreases as we ascend in the atmosphere has been known from time immemorial, but our real knowledge of the temperature of the free air dates only from 1898, when Teisserenc de Bort introduced his *ballons-sondes*, which carried self-recording instruments to heights in the atmosphere up to that time never attained and from which no information was then available.

The initial success of Teisserenc de Bort in his epoch-making discovery of the stratosphere attracted great attention to his investigations. His methods were introduced into other countries, and an intense investigation of the upper atmosphere, with an International Commission to guide and encourage it, was inaugurated. In Britain, Mr. W. H. Dines did Trojan service in the cause, and his observations and deductions are outstanding in the mass of data accumulated in many parts of the world. Naturally the conditions over Europe and North America were investigated in the greatest detail, but every opportunity has been taken by metcorologists to obtain upper-air data from all parts of the world. In addition to the regular observations undertaken in most countries having an organised meteorological service, expeditions have gone out specially to investigate the upper atmosphere over the oceans and over tropical Africa, and nearly all recent polar expeditions have included this investigation amongst their scientific activities.

There are, of course, large tracts of the earth's surface above which no observations have yet been made, but some, if only a few, observations have been made in all meteorologically important areas, including both polar regions. It is on the results of these observations that we base our conception of the thermal structure of the atmosphere, and meteorologists have attempted from them to generalise the conditions in all parts of the world. The most important generalisation of this kind has been made by Sir Napier Shaw and published in the form of diagrams in his book, "The Air and its Ways."

Probably every one here is familiar with the main results of these investigations. The atmosphere, which itself is an extremely thin film of air, is composed of two shells surrounding the earth. In the lower of these shells, called the troposphere, the temperature decreases as one rises in the atmosphere, and the air is warmer over the equator than over the poles at corresponding heights. In the upper shell, called the stratosphere, the temperature conditions are entirely different. There is little or no change in temperature with height, and the horizontal change of temperature is reversed, the temperature at the same height in the stratosphere decreasing as one passes from the poles to the equator. At the earth's surface the mean annual temperature near the equator is 27° C., and at the poles –23° C.; *i.e.* the equator is 50° C. warmer than the poles. At twenty kilometres above the surface the temperature over the equator is –80° C., and over the poles –30° C.; that is, the temperature difference between the equator and the poles is the same in amount at the surface and at a height of twenty kilometres, but in the former case it is the equator which is the warmer, while in the latter it is the polar regions—a truly remarkable reversal.

The surface of separation between the two shells, called by Sir Napier Shaw the "tropopause," is extremely sharp. There is no region of transition. The stratosphere sits on the troposphere like a layer of oil on a layer of water. The boundary is, however, not horizontal, and therefore not exactly concentric with the earth's surface, being higher at the equator than at the pole. In other words, the lower atmospheric shell, the troposphere, is thicker at the equator than at the poles. At the equator it is nearly twenty kilometres thick, while at the poles it thins down to a layer less than six kilometres thick in the summer and less than four in the winter.

I have already said that in the troposphere the temperature decreases as one ascends. The magnitude of this decrease varies from place to place and from time to time, but one remarkable result has come out of the investigation, and that is that the average decrease is practically the same in all parts of the world. Near the ground the conditions are complicated; here the rate of decrease is largely affected by such factors as the kind of surface, whether land or water, the time of day and the time of year. If we omit for this reason the two lower kilometres of the atmosphere, we are able to state that the rate of decrease of temperature with height, to which I shall refer as the "lapse rate," is the same in all parts of the world, from the equator to the poles. The lapse rate is not the same at all heights, but increases regularly as one ascends. Between two and four kilometres above sea-level the rate of decrease is 5·6° C. for each kilometre of ascent; the rate is greater at greater heights, until towards the top of the troposphere, say between six and eight kilometres, the rate is 7·1° C. per kilometre.

The importance of these results lies in the bearing they have on the possibility of vertical motion in the atmosphere. Whether air will rise or fall as the result of differences of temperature depends not only on an initial difference of temperature but also on the lapse rate in the surrounding atmosphere. When dry air rises its temperature falls on account of adiabatic expansion 10° C. for each kilometre of ascent. From the observed values of the lapse rate given above, it will be seen that if a mass of air is as much as 10° C. warmer than its surroundings it cannot rise much more than two kilometres before it has no buoyancy left. The question of ascending and descending air is, however, very complicated on account of the condensation of the water vapour carried with it. The vertical motion of the atmosphere cannot be determined simply from consideration of the lapse rate of temperature in the atmosphere. We have also to take into account the pressure and vapour content of the moving air. This can best be done by considerations of entropy.

Sir Napier Shaw has prepared diagrams showing the entropy throughout the normal atmosphere. These show surfaces of constant entropy which are nearly horizontal, but they slope upwards from the equator to the poles, especially in the lower layers. If these surfaces could be made visible, we should see a series of layers lying one above the other like the strata in a geological specimen of stratified rock.

In all movements of the air in which heat is neither added nor extracted—for example, by condensation or radiation—it must travel along an isentropic surface. Even if condensation takes place, the amount of heat added is usually so small that the air can only move to a neighbouring isentropic surface slightly higher in the atmosphere. These isentropic surfaces act like physical restraints to the air, tending to prevent its moving in any but an almost horizontal direction. The effect is almost exactly as though the atmosphere were definitely stratified in nearly horizontal planes, so that all motion of the air must take place along the strata in which it started.

This is what I mean by the thermal stratification of the atmosphere, and it is a new idea in meteorology, for it rules out ascending and descending currents as a direct consequence of the normal temperature distribution in the atmosphere. That ascending currents do occur and play a large part in atmospheric processes is, however, a matter of both observation and inference. We can actually see them taking place whenever we observe well-developed cumulus clouds, and we infer them from the large amounts of precipitation which we measure, for appreciable precipitation can only be accounted for on the assumption that air is rising in the atmosphere and cooling by adiabatic expansion. These ascending currents are possible in the stratified atmosphere only if the air taking part in them receives sufficient heat on its ascent to raise its entropy at least to that of the surrounding atmosphere at each level. Heat is supplied by condensation of water vapour, but normally air does not hold sufficient water vapour, even when saturated, to supply the requisite heat, and so cannot pierce the normal stratification. It sometimes happens, however, that the stratification is less pronounced than at other times. The greater the lapse rate the less the stratification, and by increasing the lapse rate sufficiently the stratification can be reduced to such an extent that there is sufficient water vapour to supply the heat required. When this occurs the atmosphere becomes unstable to saturated air and ascending currents take place, generally with considerable violence.

Such conditions give rise to thunder-storms, which occur, as is well known, only when the lapse rate has been abnormally increased, generally by the heating of the surface layers faster than the layers higher in the atmosphere. Also in equatorial regions over the ocean, where the air is very hot and also very humid, there may be sufficient water vapour in the air for it to rise through the normal stratification. This is the origin of the squalls and heavy rain in the Doldrums. From this it will be seen that the ascent of air through its environment is not a normal phenomenon, but does occasionally occur in special circumstances.

The descent of air is an entirely different matter, for there is no process which extracts heat from a descending current equivalent to the process of condensation which supplies heat to an ascending current. Yet air cannot descend through the stratification without the necessary heat being extracted. On the other hand, we do know that air descends, for the air which goes up in the ascending currents, or rather an equivalent amount, must come down somewhere. The solution of the problem is that air practically never descends through its environment, but comes down by the gradual subsidence of a whole column. This is generally brought about by the air at the bottom of the column spreading under the surrounding air and so lowering the air above in a way to be described in greater detail later.

If now we consider the undisturbed atmosphere in different parts of the world, we find that each has its own stratification, which is mainly determined by the local radiation. At the equator the stratification is not so close as at the poles, and equivalent strata are higher in the atmosphere the farther we move from the equator. If a large mass of air is transported as a whole without gain or loss of heat, no change in entropy occurs, and therefore it retains its original stratification. It is therefore clear that if masses of polar and tropical air are brought together the strata will not fit. The process is something like removing two geological specimens from different parts of a stratified rock and then placing them side by side. We can recognise the surface where the two masses meet by the discontinuity in the strata; in geology such a surface of discontinuity is called a fault. We shall consider later the consequence of bringing together masses of air of different origin in this way, and it will be shown that they interact like separate fluids, but throughout the resulting motion they retain their stratification, although this stratification becomes modified and distorted.

This idea of the stratification of the atmosphere which has caused us to recognise that ascending and descending currents are relatively rare occurrences raises new problems as to how the solar energy is converted into the kinetic energy of winds. This leads me to the second subject of this address.

THE MECHANISM OF THE ATMOSPHERIC HEAT ENGINE.

Brunt has calculated from considerations of wind and atmospheric friction that 25×10^{11} kilowatts of energy are required to maintain the motion of the atmosphere. It is generally agreed that this energy is derived from the solar radiation which falls on the earth, the atmosphere itself acting as a gigantic heat engine to convert the solar energy into the kinetic energy of the winds. How the atmospheric heat engine works is the problem which we are now to discuss.

Until quite recently this problem seemed to present no difficulty. All atmospheric motion was referred in one form or another to the ascent of warm air through cold air and the descent of cold air through warm air. The so-called general circulation of the atmosphere was considered to be the direct consequence of the ascent of warm air at the equator and the descent of cold air at the poles, there being a permanent circulation from the equator to the poles in the upper atmosphere, with a return flow in the surface or middle layers. Similarly cyclones were considered to form in regions where the air is warmer than the surrounding air, with a consequent upward motion of the warm air through its colder environment. The anticyclone, on the other hand, was considered to be a region of cold descending air. Thus cyclone and anticylcone were regions of ascent of warm and descent of cold air respectively.

I have already shown, however, that the thermal stratification of the atmosphere, except in the Doldrums and occasionally in other regions, is prohibitive of such ascending and descending currents. Further, observations have shown that there is no direct flow of air from the equator to the poles in the upper atmosphere, and measurements of temperature in cyclones and anticyclones have shown that the former are not warm and the latter are not cold.

Although the old ideas were wrong in detail, they were, of course, right in principle, for the potential energy inherent in masses of air at different temperatures must be the origin of the kinetic energy of the winds, the difference in temperature between the equator and the poles being responsible for the general circulation of the atmosphere, and the difference in temperature between neighbouring masses of air for the energy of cyclones and anticyclones. The only question is, how does the transfer from potential to kinetic energy take place?

The solution of the problem was given by Margules in a series of papers, commencing in 1903, in which he investigated the energy developed in storms. Margules' work leads to an entirely new idea as to the method by which solar energy is converted into the kinetic energy of atmospheric motion. Instead of warm air rising vertically like the warm gases in a chimney, drawing air in at the bottom and delivering it at the top, we see two bodies of air, one warm and the other cold, brought side by side, then the cold mass slowly subsiding and pushing its way as a wedge of cold air under the warm air, which is partly raised and partly drawn in above to replace the cold subsiding air. In the process the centre of gravity of the whole moving mass is gradually lowered, so providing the energy for the motion which we recognise as winds.

The essential difference between the new and the old idea is that the two masses of air, in which the difference of temperature is the cause of the motion, never mix. We start with the two bodies of air side by side, with a surface of sharp discontinuity between them. In each body there is a different stratification of isentropic surfaces. In the warm body of air the corresponding isentropic layers are all lower than in the cold body of air. As the cold mass subsides its isentropic layers are lowered, while as the warm air is raised its isentropic layers are raised with it; but the surface of discontinuity between them, which I have previously likened to a geological fault, is a sliding surface, and no air crosses it. The sliding motion does not cease until either the corresponding isentropic layers on the two sides have joined up across the surface, which then ceases to be a surface of discontinuity, or until all the warm air has been raised above the cold air and the surface of discontinuity becomes a horizontal plane. The two masses are then in equilibrium without any mixing having taken place.

SURFACES OF DISCONTINUITY.

The process which I have just described would take place very rapidly on a stationary earth, and in a short time the surface of discontinuity would disappear in the manner described or appear as a horizontal surface with all the cold air underneath and all the warm air above. But in the atmosphere we find inclined surfaces of discontinuity persisting for days together, and others which are apparently permanent. This arises from the effect of the rotation of the earth, which we have so far neglected, but which introduces new forces when air is in motion.

A mathematical investigation of the conditions governing the air motion at surfaces of discontinuity has shown that, on a rotating earth, the tendency of cold air to pass under warm air can be completely counterbalanced by forces due to the earth's rotation if the air on the two sides of the surface has suitable relative velocities.

We owe the mathematical investigation of this problem chiefly to Helmholtz, Margules, V. Bjerknes, and Exner.

Two bodies of air at different temperatures will remain in equilibrium side by side if suitable motion parallel to the boundary is given to the air on each side. The angle which the surface of discontinuity makes with the horizontal depends on three factors, namely, the latitude and the difference in temperature and relative motion of the warm and cold currents. Given steady motion, these three factors adjust themselves in a perfectly definite way, with the cold air lying as a rule in the acute angle which the boundary makes with the horizon.

V. Bjerknes considers that there are three great permanent surfaces of discontinuity of this kind in the atmosphere, and that the slope of the surface in each is in accordance with the discontinuities of the wind and density observed on the two sides. Taking these in turn, the first is the great surface of discontinuity between the troposphere and the stratosphere. The second surface of discontinuity is between the trade winds and the anti-trade winds above them. Bjerknes' third surface of discontinuity, which has received the name of the "polar front," is a very important one in modern meteorological theory. On the whole there is very little air motion in polar regions, and the cap of air over each pole is losing heat by radiation and so tending to subside and flow away from the pole. As the air from the polar cap flows radially outwards it is deflected to the west on account of the earth's rotation. On the other hand, in middle latitudes, from near latitude 30° to the polar circle, the air is moving in an almost unbroken stream from west to east. Relative to the air in the polar cap this air is very warm. We therefore have a cold cap of westerly-moving air embedded in a warmer mass of air moving towards the east, and between the two there must be a pronounced surface of discontinuity. In such conditions the surface should slope upwards toward the pole. V. Bjerknes considers that there are such surfaces of discontinuity associated with each pole and that they are very stable. These "polar fronts" play a large part, as we shall see later, in Bjerknes' theory of the formation of cyclones.

But these are not the only surfaces of discontinuity which play a very real part in the physics of the atmosphere. While the three surfaces just described are of a more or less permanent nature, we now recognise a constant succession of temporary surfaces of discontinuity which form and pass away in our own latitudes. Their presence is revealed in many ways. On the synoptic charts lines can be drawn which divide regions in which the conditions at the surface as regards temperature, humidity, and wind velocities are entirely different. These lines are simply the intersection at the earth's surface of the surface of discontinuity between two bodies of air.

THE ORIGIN AND STRUCTURE OF CYCLONES.

The old idea of a cyclone was tersely expressed by Sir Oliver Lodge, in a letter to the *Times* last year, as follows: "A cylindrical vortex with its axis nearly vertical, rolling along at a rate conjecturally dependent partly on the tilt, and with an axial uprush of air to fill up a central depression, which depression, nevertheless, was maintained and might be intensified by the whirl, the energy being derived from the condensation of vapour." If this were the true mechanism of a cyclone we should expect to find considerable symmetry around the axis. The air would move in a continuous stream circulating around the centre but always approaching it; in other words, the stream lines would be continuous spirals. There would also be little difference of temperature in the different parts of the cyclone, for the same air current would pass successively through all parts. In reality the conditions are entirely different. When stream lines are drawn by the aid of the wind arrows on synoptic charts it is impossible to connect them so that they circulate all round the depression; we find, on the contrary, that they are discontinuous, the stream lines in certain parts meeting the stream lines in other parts almost at right angles. Also we find large discontinuities in the temperature, each set of stream lines having its own temperature. Further, we find that the areas of rainfall are not confined to the central regions, but are broad bands radiating from the centre like spokes in a wheel, showing that the ascending air is not taking place mainly in the central region.

As the result of recent work we now recognise a structure in a cyclone which was unknown a few years ago. We owe this new knowledge largely to the work of J. Bjerknes and his assistants in the Bergen Geophysical Institute.

We are being forced more and more to recognise in cyclonic depressions the meeting-place of polar and equatorial air. Each body of air is stable to vertical currents within itself, but where the two masses meet, readjustment is necessary; the surfaces of discontinuity tend to set themselves at the angle necessary for stability under the existing condition of velocity and temperature. This involves the bodily raising of the warm air over the cold air and a general sinking and spreading out of the cold air. The energy for the process is derived from the conversion of potential energy into kinetic energy, as the centre of gravity of the air as a whole is slowly lowered during the readjustment of the air masses. The energy derived from the condensation of water vapour is a very insignificant part of the energy developed in a cyclonic depression.

It must be admitted that we are still far from a complete understanding of the mechanism of cyclonic depression; on the other hand, we now know some features which are common to all depressions, and we have a much clearer idea of the source of the energy and the conditions necessary to their production. We have to imagine that in polar and tropical regions the air is relatively stagnant, and so has an opportunity to reach the state of thermal equilibrium appropriate to those regions. As already stated, the atmosphere is only a thin film, and we picture large areas or slabs of this film breaking away from their proper locality and moving into middle latitudes. Apparently the detached films move as a whole, at least to a considerable distance within the stratosphere. When two such portions of the atmospheric film come into juxtaposition they are not in equilibrium relative to one another, and readjustment must take place. The surface of contact remains more or less intact, but the cold air tends to sink and undercut the warm air, while the warm air slides up the surface of discontinuity. The whole motion takes place on the revolving surface of the earth, and the forces called into play by this revolution result in the air movement taking place in what appears to be a great vortex. The energy of the winds is derived mainly from the readjustment of the centre of gravity of the air mass considered as a whole, although the latent heat of condensation provides some additional energy by supplying heat to the warmer air as it ascends the slope of the surface of discontinuity. It will be admitted, I think, that this is a radically new idea regarding the mechanism of a cyclone.

All that I have said so far refers to the cyclonic depressions of middle latitudes. As to whether the mechanism of tropical cyclones is the same or whether we have here something more of the nature of the process described by Sir Oliver Lodge, meteorologists are not yet agreed. We need more observations, especially of the conditions in the upper air over tropical cyclones, before this question can be decided. At present we must leave it an open question.

These new ideas have had a far-reaching effect on the practical applications of meteorology, especially in the domain of weather forecasting. The old method of weather forecasting was mainly empirical and based on the work of Abercrombie. Abercrombie had sketched the distribution of weather about centres of high and low pressures, and forecasting was based on the determination of the movement of these pressure distributions when they appeared on the weather chart, the assumption being made that as the pressure system passed over a place the normal sequence of weather would be experienced.

Now the forecaster has much more knowledge of what I may call the anatomy of a depression. The pressure distribution is of course still the main factor, but the forecaster searches his chart for indications of the surfaces of discontinuity, and examines the characteristics of the air masses to see whether they are of polar or equatorial origin. In this way he is able to determine the structure of the cyclone and whether it is developing or dying. Having determined where the surfaces of discontinuity are situated, he is able to say where rain may be expected, and he knows what weather changes will accompany the passage of each surface of discontinuity as it moves over the surface of the land. He is aided in this by observations taken in the upper atmosphere by means of pilot balloons and aeroplanes fitted out with meteorological instruments.

This has all resulted in greater confidence in the forecasts made, a confidence which is frequently justified by remarkably accurate forecasts. Unfortunately, the processes which take place in the atmosphere are extremely complicated, and perfect forecasts are still far from being attained. The progress made, however, is very encouraging, and, what is still more important, the paths along which further investigation must be made are clearly defined. Many more observations of the upper air are necessary, many more theoretical investigations have to be made in the quiet of the study, and there is room for many more experiments in the laboratory.

Dispersal of Butterflies and other Insects.

By E. P. FELT, State Entomologist of New York.

A 2000-mile air trip appears almost impossible for an ordinary butterfly. It is still something of a feat for an airplane. Many insects are perfectly at home in the air, fly freely here and there, and are usually believed to flit from flower to flower or from one near-by locality to another. Rarely do we think of their travelling considerable distances, and under ordinary conditions it is very difficult, if not well-nigh impossible, to establish the fact that long trips may be made by individual insects. There is a romance about these journeys as well as a practical aspect. The facts are not difficult to understand, and it should be comparatively easy for readers to arrive at satisfactory conclusions.

The "Monarch" butterfly (*Danaida plexippus* L.) is one of the commonest and most noteworthy insect travellers. Its large size and tawny colour with black and white markings make it comparatively easy to recognise even at some distance. This is the very common "milk-weed" butterfly of the northern United States and southern Canada, the insect which occasionally attracts notice because of the immense swarms which appear in early autumn, apparently southward bound. The butterfly, although so common in the north temperate latitudes, is unable to survive our winters north of the sub-tropical portions of the Southern States. Consequently, the annual reappearance of this insect proves a considerable northward movement each year, though it does not establish the fact that the entire journey from Florida nearly to the Arctic Circle is necessarily accomplished by individuals. It may be the successive efforts of several generations working northward with the advance of warm weather.

A similar northward flight is known for the cosmopolitan "Painted Lady" (*Pyrameis cardui* L.) in

Europe. The butterflies cross the Mediterranean Sea, and in the opinion of Mr. C. B. Williams originate south of the north coast of Africa, since they have been seen entering Algeria from the south and have been observed crossing the Nile Valley near Cairo in thousands, coming from the south-eastern desert. He believes that all Europe north of a line through the middle of France and South Germany or Switzerland depends entirely for its Painted Lady butterflies upon African areas south of the great desert, some finding their way to northern Scotland, Scandinavia, the Shetland and Faröe Islands, and even distant Iceland.

The above cannot explain the presence of the Monarch butterfly in the Hawaiian Islands, areas 2000 miles from the American continents, where the insect was not known prior to the establishment of its food-plant, a milkweed (*Asclepias curassavica* L.), in the islands about 1850. At one time it was thought that this butterfly may have made its way to the mid-Pacific with the aid of shipping, in spite of the fact that the habits of the insect are such as to make it improbable that it could be carried with its food-plant in its early stages, or be content to remain upon a ship during an entire voyage. Furthermore, shortly thereafter this butterfly became generally established in a number of other Pacific islands, and if commercial agencies were the carriers, they certainly were very accommodating. The observations of Commander Walker of the British Navy indicate the habitual presence of these butterflies at sea among the Pacific islands and many miles from land.[1]

The above facts are not conclusive as to the ability of the Monarch butterfly to negotiate safely a 2000-mile journey over the Pacific Ocean, and yet they are very suggestive. There is a remote possibility that some unusually favourable condition may have made it possible for this insect to establish itself in the mid-Pacific. It happens, however, that three other large butterflies, the Red Admiral (*Pyrameis atalanta* L.), the Painted Lady (*P. cardui* L.), and the Painted Beauty (*P. virginiensis* Drury), have been found in the Hawaiian Islands during recent years, and in the case of two at least, not until the native food-plants had been introduced. An unusual condition may explain the presence of one insect, but can scarcely be considered as the reason for the establishment of three others many years later, particularly when in all cases the lack of a suitable food-plant appears to have been the determining factor.

The 2000-mile aerial trip of the four butterflies mentioned above still seems rather incredible, and with this in mind we would turn for a moment to the dragon-flies of the Hawaiian Islands. At least two of the larger species are widely distributed in America, and were not found in the Hawaiian Islands until comparatively recent years. Apparently the extensive cultivation of rice and taro has resulted in great expanses of fresh water in which these dragon-flies could breed, and it seems entirely reasonable to think that if the butterflies travelled on the wings of the wind, the same might be true of these dragon-flies, and that the determining factor in each case was the prevalence of conditions favourable to the propagation of the species.

[1] Cf. *Entomologist's Monthly Magazine*, vol. 22, p. 221 (1886), and vol. 50, pp. 230-1 (1914).

Dragon-flies are well known as strong flyers, and there is at least one record of these insects appearing in large numbers in the Indian Ocean about 900 miles west of Australia and nearly 300 miles from the relatively insignificant Cocos-Keeling Islands, tiny land areas where dragon-flies are unable to maintain themselves according to Prof. F. Wood-Jones, and yet frequently visited by considerable flights of these insects, coming with northern winds, presumably from distant Sumatra.

It certainly begins to look as though we must accept the 2000-mile air trip as the most reasonable explanation of the occurrence of these insects in the somewhat isolated Hawaiian Islands, and admit that nearly half that distance is repeatedly travelled by insects journeying over the Indian Ocean. It is perhaps assumed that this is possible only in the case of strong flying insects, such as the larger butterflies and the more powerful dragon-flies. This latter does not necessarily follow. The terrible eruption of Krakatoa in August 1883 devastated that entire group of islands, they being overlaid by hot ashes approximately 90 to 180 feet thick, making it very improbable that anything living could escape, yet twenty years later some 64 species of insects were found upon this seldom visited group, and investigations by Dr. Dammerman, published in 1922, show that certain extremely small flying insects, such as thrips, were represented upon the island by some ten species. He estimates that 80 per cent. of the animals on these islands are winged. Furthermore, the work of naturalists at such outlying points as the Kentish Knock Lighthouse, some twenty-one miles from the nearest points of land, resulted in capturing, among a number of other insects, a delicate plume-moth with somewhat the consistency of a bit of thistledown. Similarly, studies at the Rebecca Shoal Light Station, itself entirely submerged and 12 miles east of the Dry Tortugas, showed the presence of such comparatively inefficient flyers as a lace-winged fly, a damsel-fly or small dragon-fly, and fragile gnats. In other words, insects with supposedly very weak powers of flight undoubtedly drifted considerable distances. Dr. W. L. McAtee records crossing Curritick Sound, N.C., a distance of 6 miles, during which caddis-flies and midges were so numerous over the water that vision was perceptibly restricted and one was constantly annoyed by the impacts of the insects against the face.

These latter records suggest that insects may drift with the wind, and the question may well be raised as to the agencies which make possible the long trips mentioned above. We have become so accustomed to a determinate migration by birds that there is a strong tendency to explain insect movements in the same manner. It is quite possible that some insect movements are direct responses to a migration impulse, but on the other hand there is no proof that such is the case in regard to some of the wanderings discussed above. The physical exertion involved in a 2000-mile trip against the wind is so great that one may reasonably question the ability of even the most powerful flying insects to accomplish this successfully. There is no question but that unusual gales may carry insects enormous distances in the same way that such disturbances force migrating birds far from their normal courses. These occasional and unusual wind currents do not appear to be the most effective in promoting the spread of insects, though they undoubtedly assist to a material extent. The observations of Prof. F. Wood-Jones as recorded in his "Coral and Atolls" indicate that dragon-flies go to sea of their own accord, and that they are not blown from the shore. He states that in periods of absolute calm of long duration one species of tropical dragon-fly may be seen hawking about over the sea twenty miles and more from the nearest land, and that he has observed numbers of this insect almost daily in a journey through dead calms all the way from Singapore to Thursday Island. He adds that strong-flying butterflies do the same, flying away from the land in a perfectly irresponsible way, and that moths come nightly to a ship's light when she is lying twenty miles from the shore. This condition obtains in other parts of the world, and is evidenced by the insect drift occasionally found along the shores of oceans and lakes in particular. These insects are not necessarily carried out over the water by strong winds. They are simply the normal population of the air which under ordinary conditions, in the case of the smaller lakes at least, would allow themselves to drift across the water, whereas a sudden chilling of the atmosphere, especially if accompanied by rain, results in driving many of them down into the water and their subsequently drifting ashore. According to Mr. C. B. Williams, Acting Chief Entomologist of Egypt, a number of insects drift many miles into the African deserts.

It is our belief that determinate flight is a comparatively small factor in promoting the spread of insects, and that in many cases this is accomplished largely by a drifting with the wind, the stronger flying species probably being able to remain in the air longer than their weaker associates. Much of this long distance spread is very probably made possible through the higher velocities of the upper air strata, the insects gaining these by the aid of convectional currents arising from heated surfaces and now known to extend to a height of at least 1000 feet above the surface. These upper air currents frequently have a velocity of 30, 50, or even 100 miles an hour, consequently a favourable wind for a relatively short time is all that is necessary to carry an insect long distances. This is probably what occurs rather frequently in the early autumn when swarms of "cotton-moths" (*Aletia argillacea* Hübn.), an insect unable to survive north of the cotton-growing area, appear at lights in the northern United States and southern Canada.

Even relatively high wind velocities would mean an insect remaining in the air a day or so, if it were to make the 2000-mile trip from the American continent to the Hawaiian Islands. This is probably within the physical powers of an insect, though it does not necessarily follow that a non-stop journey is made over such an expanse of water There are several records of the smaller butterflies at least resting upon the surface of the ocean and successfully resuming flight. This has also been recorded of certain grasshoppers, and it appears possible that larger butterflies and even dragon-flies might do the same under extreme conditions.[2]

If the upper air currents are somewhat important carriers of insects, there should be some confirmatory evidence. It is perhaps sufficient to state here that mosquitoes have been met with at an elevation of 3000 feet above the surface, grasshoppers at a height of 2000 feet, and honey-bees at approximately the same elevation. Plant spores have been recorded at an elevation of 11,000 feet. These last must have been carried up by convectional currents. Winds tend to drop over the cooler water surfaces and glaciers of the earth, and on these latter exceptionally large numbers of insects have been observed repeatedly, probably forced down by the falling temperatures. Furthermore, collectors on some of the high mountains, such as Mount Washington, have taken insects which are distinctly southern or south-western in habitat, probably carried there by the upper air currents and dropped upon these cooler mountain tops.

It is not suggested for a moment that the appearance of butterflies and dragon-flies in the Hawaiian and other ocean islands is anything more than the outcome of a somewhat irresponsible flight assisted by favourable winds. There is another phase or supposed phase of insect movement deserving notice, that is, the autumn assembling of Monarch butterflies and their apparent southward movement in considerable numbers. There are a number of records of apparently determinate movement by butterflies, mostly in the tropics, and a somewhat similar movement on the part of dragon-flies, in some cases immense numbers of insects coming under observation. These cases may represent a true migration, though this is scarcely established by available data. It is quite within the realm of possibilities that atmospheric or other disturbances may have resulted in an unusual condensation, as it were, of insect life, and that the movements observed followed a change in conditions and were in some instances at least an instinctive effort on the part of the insects to spread out or move away from each other, in order to secure better opportunities for food, either for the insects themselves or their progeny. The account by W. H. Hudson of the dragon-flies appearing in advance of the dry, cold "pampero" in the Argentine, and the record by Gätke of the millions of dragon-flies appearing in Heligoland in advance of a storm and their rapid scattering thereafter, are both very suggestive in this respect.

The fact that various natural causes result in large swarms of insects should not be overlooked in this connexion. The nearly simultaneous development of millions of mosquitoes, midges, caddis-flies, black-flies, and butterflies within a restricted area accounts for many swarms, and these must disperse in some way, if they are to live and provide for their progeny. A movement in any one direction is likely to establish a trend which might easily be mistaken for determinate migration. The observations of Prof. V. L. Kellogg in relation to the winter assembling of the Monarch butterfly in southern California, to revert to this insect once more, suggest that the swarms of this insect may be really the expression of a hibernating instinct rather than a preliminary to migration.

It may appear to some that a rather large part in the distribution of insects has been given to the winds, and comparatively little left to the physical ability and the desire or instinct of the insect. We are considering particularly those individuals which allow themselves to be carried by winds, and in most instances they are

[2] Cf. Seitz, *Macro-Lep., Palæarctic Region*, 1, p. 77, *re Danaida plexippus*.

a relatively extremely small proportion. It is very probable that many of these widely ranging forms are somewhat local, if that term is not interpreted too narrowly. On the other hand, we should not expect winds to do less for insects, forms inheriting most admirable organs of flight, than for such wingless creatures as spiders. McCook, a well-known authority, states that ballooning spiders have been found more than 200 miles from land and at elevations of more than 1000 feet. He has concluded from a study of distribution in the tropical regions that these spiders may have actually circumnavigated the globe on the wings of the wind. The known distribution of certain small insects in tropical areas likewise suggests that winds may have played a most important part in carrying these minute, fragile insects. In other words, the ability of the organism to support itself in the air appears to be a most important factor in certain types of distribution.

There is very little question but that representatives of many species of insects are carried far beyond any point where they can possibly maintain themselves. Nature is extremely profuse in her provisions for the continuance of both plant and animal life; the greater the hazard, the more liberal the provision as a rule. It appears reasonable to conclude that winds are carrying millions of insects daily into regions where they cannot possibly survive. A few especially favoured forms may by chance find their way to an area where there are livable conditions. One of the notable instances of this kind was the appearance of a caterpillar on the first crop of tomatoes and peas raised from seed in the out-of-the-way Cocos-Keeling Islands, although it was not a native species, and the parent moth must have travelled hundreds of miles over an inhospitable ocean. A similar case came to the writer's attention recently in connexion with a small patch of corn growing in a Chilean desert. Insects are all about us. Only occasionally do we realise the frequency with which they appear in unexpected places.

Fortunately for man, many of the more destructive species find themselves unable for one reason or another to take advantage of the wings of the wind. An economic application is that insect spread may be somewhat definitely limited by the winds which prevail when other conditions are favourable for dissemination.

Obituary.

DR. JOHN M. CLARKE.

JOHN MASON CLARKE, who died at Albany, New York, on May 29 last, was one of the foremost palæontologists of America. The son of a schoolmaster at Canandaigua, New York, he was born on April 15, 1857, and received his early education in the school which his father directed. He was inclined in boyhood to the study of geology and natural history, and he proceeded in 1873 to Amherst College, Mass., where he graduated in 1877. At Amherst he came under the influence of the professor of geology, B. K. Emerson, and so entered on his life-work. He began to study in earnest the Upper Devonian rocks and fossils in the neighbourhood of his home, and while holding a succession of small teaching appointments devoted all his leisure to original research.

By the end of 1884 Clarke had made so much progress, that he felt impelled to compare his results with those of European geologists, and he went to spend parts of two years studying under Prof. A. von Koenen in the University of Göttingen. There he graduated with a thesis on Devonian geology in 1885, and after holding another small teaching post, was eventually appointed assistant to Dr. James Hall, the well-known State Palæontologist of New York, in 1886. Thenceforward until his death he was connected with the Geological Survey of New York, becoming State Palæontologist in 1898, and State Geologist as well as Director of the State Museum in 1904.

Clarke's earliest papers on Devonian fossils were published in 1882, and were followed by a long succession which culminated in his two classic volumes, "The Early Devonic History of New York and Eastern North America," published by the Geological Survey of New York in 1908–9. At the same time he studied the Devonian fossils not only of Germany, but also of Brazil, Argentina, and the Falkland Isles. Among his official duties he was also concerned with several other Palæozoic faunas, and he became the recognised authority on Palæozoic invertebrata in America. With Dr. James Hall he published "An Introduction to the Study of the Genera of Palæozoic Brachiopoda" in 1893–94; and with Dr. Ruedemann a monograph of "The Eurypterida of New York" in 1912. Both these are works of reference of permanent value.

In later years Clarke made good use of his ripe scholarship in considering some of the wider problems of the science to which he had devoted his life. As first president of the Palæontological Society of America, in 1911 he delivered an address on "The Philosophy of Geology and the Order of the State," and in 1921 he published a little memoir entitled "Organic Dependence and Disease." He applied his science to questions of state control, and argued that it pointed to individualism, not socialism, as the essence of progress.

Clarke was an attractive personality with very wide interests beyond those of his special work. As head of the State Museum he also controlled the science division of the department of education, and he was associated with many other organisations in the city of Albany. He will be mourned not only as an eminent man of science, but also as a model citizen.

A. S. W.

MR. D. R. STEUART.

DANIEL RANKIN STEUART, late chief chemist to the Broxburn Oil Co., Ltd., died at his residence, Blackhall, Edinburgh, on August 1. He was a well-known figure in scientific circles in the east of Scotland, and was a recognised authority on the chemistry and technology of shale oil and petroleum. Born at Bogside, Lanarkshire, in 1848, he studied botany and geology in his early youth, and, for reasons of health, spent some ten years in the open-air pursuits of gardening and farming; he received his chemical training at the University of Edinburgh under Crum Brown, at Glasgow under Dittmar, and finally at Munich. His connexion with the shale oil industry, destined to be a lifelong one, began about 1875, when he became a laboratory assistant to the late Sir George Beilby at the Oakbank Oil Works. In 1877 he was appointed chief chemist to the Broxburn Company, and retired from that post five years ago.

Mr. Steuart was a strenuous worker, endowed with a mind of exceptional intellectual insight and power. His writings are well known, and include a number of articles, contributed to the Transactions of the Society of Chemical Industry, on the shale oil industry, petroleum, and brown coal; some of these are of practical interest, others in speculative vein. To the same Society he read a paper entitled "The Oxidation of Mineral Oils," and edited and read one by his nephew, Mr. B. Steuart, on "The Composition of Shale Naphtha." It was one of his regrets that his routine duties did not permit him to devote more time to organised research; he, however, strongly advocated the desirability of industrial research being taken up by qualified university workers. That his eminence as an authority on shale was widely recognised is attested by articles written by request to "Economic Geology" (U.S.), Ure's "Dictionary," Muspratt's "Chemistry," Thorpe's "Dictionary of Applied Chemistry," and an important contribution to the memoirs of the Scottish Geological Survey entitled "The Chemistry of the Oil Shales." In the last mentioned he propounded a theory referring to the origin of oil shales.

Mr. Steuart's humane instincts led him, in 1890–95, to direct public attention to the number of deaths caused by the use of low flashing burning oils in lamps. He wished the standard of flash point to be raised from 73° F. to 100° F., and gave evidence on the subject before a Select Committee of the House of Commons during the reading of the Petroleum Bill. The measure was unsuccessful, but as the light constituents of petroleum (the cause of low flash point) afterwards became valuable as motor fuel, Mr. Steuart had the satisfaction of seeing burning oils made safer by the elimination of much of the danger in the refinery.

R. H. FINDLATER.

PROF. O. BREFELD.

THE death was recently announced of Prof. Oscar Brefeld, the founder, and for fifty years a leader, of modern mycology. Born at Telgte in Westphalia, on August 19, 1839, the son of a wealthy pharmacist, whose business he was intended to inherit, he early took an interest in the lower plants, but it was not until 1868 that he began his mycological studies in earnest. At the outset he realised the necessity of sterilising the culture media and the apparatus, and of studying microbes and spores as individuals. For this purpose he introduced gelatine—which he replaced later by agar-agar—and devised the method of pure culture by thinning the medium so as to grow a colony from a single cell under continuous microscopic observation. Thus he laid the foundation of all subsequent microbiological study ten years before R. Koch took up the inquiry.

In 1870 the contemporary work of Pasteur led a Munich brewery to seek the assistance of Brefeld. Here he gained experience and a crop of fruitful ideas, but his work there was cut short by the Franco-Prussian war. From the siege of Paris he was invalided home after an attack of typhus and prosecuted his studies in Berlin. Here he took his doctor's degree, and in 1872 published the first volume of his great life work, "Botanische Untersuchungen aus dem Gesammtgebiete der Mykologie" (18 vols.), known as the mycologists' Bible. The following year saw the publication of his epoch-making researches on the Ascomycetes, especially on the cultivation of the blue mould *Penicillium glaucum* from a single spore to a mycelium with complete fructification. One cannot here go through the contents of successive volumes, but his important work on *Bacillus subtilis*, undertaken for the Prussian Government in 1878, demands mention. Brefeld did not, however, pursue bacteriology, feeling that his medical knowledge was too slender: Robert Koch was therefore substituted to become the "German Pasteur."

Brefeld, after habilitating as privat-docent in Berlin, became, in 1876, professor at the Forestry Academy in Eberswalde. Here he lost the sight of one eye. As a consequence of the "Kulturkampf" he was urged by the Government to become professor of botany at Münster in Westphalia. Here he continued to publish the most valuable work, until his removal to Breslau in 1898. In the year before the War, Brefeld resided in Berlin, where he lectured; but he became completely blind and had to resign his professorship.

Brefeld was a hard worker, entirely bound up in his life-work. He did not care to have pupils, but he trained a succession of assistants, among whom may be mentioned the Germans, Zopff, Alfred Möller, and R. Falck; the Norwegians, Holtermann and Sopp; the Swiss, Von Tavel; and the Hungarian, Gyula de Istvanffi. We are indebted to an article by Dr. Sopp in a recent issue of *Naturen* for the details of Brefeld's life.

WE learn from the *Chemiker-Zeitung* with much regret that on August 4, shortly before his fifty-fifth birthday, Dr. Friedrich Auerbach, younger brother of the physicist Dr. Felix Auerbach of Jena, and well known as the collaborator with Abegg in the "Handbuch der anorganischen Chemie," died suddenly of heart failure. Auerbach studied at his native town, Breslau, under Ladenburg, to whom for a while he acted as assistant, after which he was engaged for several years in industrial work. But his real interest lay in scientific investigation, and in 1903 he returned to Breslau, where Abegg had recently begun to build up a flourishing school of chemistry. Shortly afterwards he was transferred to the Imperial Health Department. At Breslau, Auerbach devoted his attention chiefly to physical chemistry, and he published many papers dealing with the theory of electrolytic dissociation and the theory and practice of the electrometric titration of acids. After the death of Abegg in 1910, Auerbach undertook the onerous task of editing the "Handbuch der anorganischen Chemie." Before the War he was a member of the International Association of Chemical Societies.

Current Topics and Events.

A LARGE party from Section D (Zoology) of the British Association visited Hayling Island on Monday for the formal opening of the British Mosquito Control Institute which has been built there by Mr. J. F. Marshall. Anti-mosquito work was commenced at Hayling in 1920, and we have on several occasions referred to the very valuable results achieved. By draining and other operations, the mosquito nuisance in the district has been almost entirely removed, and the measures adopted have been followed with success at other places around the coast. Mr. Marshall's work in connexion with both salt-water and fresh-water mosquitoes has become so widely known that inquiries from medical officers and others continually reach him from many parts of the country, and numerous people interested in the subject have visited Hayling to see his laboratory and his control work in inter-tidal and other areas. This led to the erection of a building containing a demonstration museum, laboratory, drawing office, photographic room, and other facilities for study and research in various branches of mosquito control work. The building, the design and equipment of which are based upon five years' experience in the laboratory and the field, is the first example of an institution devoted exclusively to what may be termed the non-medical side of mosquito investigation. Sir Ronald Ross, in an address at the opening ceremony, described the growth of the organisation at Hayling and expressed high appreciation of Mr. Marshall's work, both as to its scientific value and practical service. We hope to give some further particulars of the Institute and the opening ceremony in our next issue.

THE recommendations of the Committee on the use of preservatives and colouring matters in food have already been noticed in these columns (February 14, p. 217). It will be remembered that the Committee considered that the use of boric and salicylic acids and their salts should be prohibited completely, that sulphurous and benzoic acids and their compounds should be permitted in certain articles of diet in quantities not exceeding a definite limit which varied according to the food, and that a list of permissible colouring matters should be drawn up. The Minister of Health has now issued regulations under the Public Health Acts dealing with this subject. (The Public Health (Preservatives, etc., in food) Regulations, 1925. Statutory Rules and Orders 1925, No. 775, and Circular 606. London: H.M. Stationery Office, 3*d.* and 1*d.*) Certain previous regulations as to the use of preservatives in butter and cream are revoked, and the use of any thickening substance in the latter is forbidden. The foods in which preservatives are allowed, whether sulphur dioxide or benzoic acid, and the maximum amount permissible, are given in a schedule: it will be remembered that the articles of diet concerned are sausages, fruit preparations, wines, non-alcoholic beverages, syrups, gelatin, coffee extract, pickles and sauces. As regards colouring matters, a short list of those forbidden has been drawn up and includes certain metallic salts, a few coal-tar dyes and gamboge. The regulations include a section prohibiting the sale as a preservative of any article the use of which as a preservative is forbidden, and also details as to the labelling of certain of the food products in which a preservative is permissible and of articles sold specifically for use as preservatives. The regulations come into force on January 1, 1927, except in the case of butter and cream, where their operation is postponed for a further year.

THE issue of the Journal of the British Science Guild for August contains a valuable report, prepared by a committee of the Guild, on the supply of trained research workers in Great Britain and their utilisation in industry. According to it, in the year 1923–24, the number of full-time students of science at British universities was 60 per cent. greater than in 1913–14; the number of students who obtained science degrees was three times, and the number engaged in full-time scientific research four times, the corresponding numbers in the former year. While the universities are in this way doing what they can to supply the industries with the research workers they require if they are to hold their positions against their competitors, the industries themselves are doing little to absorb the trained men available. This is particularly the case in the chemical industry, and the Department of Scientific and Industrial Research has taken steps to reduce the number trained in this subject. The committee recommends that a staff of research workers should be maintained in a national institution, and that any firm should be able to secure the services of one or more of them for work at its own private problems.

IN a recent address to the American Institute of Electrical Engineers, published in the June issue of the Journal of the Institute, Mr. E. M. Herr discussed the future of railway electrification. Up to June 1924, the electric locomotives built and under construction in the world numbered 2351, of which the aggregate horse power was more than four million. Of these locomotives 905 were operated by direct current. In Italy there were 504 locomotives, and in the United States 465. Then came France, Germany, and Switzerland with 366, 304, and 214 locomotives respectively. No other country had so many as 150 electric locomotives in service. Great Britain, however, has constructed and is constructing a large number of electric locomotives for use overseas. One curious development in the Italian railways is the use of portable substations. These are of use in the event of a breakdown of an ordinary substation or when part of the line gets overloaded. All the devices, including 100,000 volt transformers, are carried on a railway bogie waggon frame which can be coupled to an ordinary train and travel at a speed of 50 km. (31 miles) per hour. At present they are in regular use in places where the substations have not yet been constructed. One of these substations is being exhibited at the Grenoble Exhibition.

IN an address to the Water Power Congress held at Grenoble in July, a translation of which appears in *Engineering* for August 14, Mr. Bouchayer discusses the regulation of the import and export of electrical energy between neighbouring countries. In France, the demand for electric energy greatly exceeds the supply, and so the main problem is concerned with the import of electrical energy from abroad. Switzerland supplies most of the imported energy. Belgium supplies energy to both works and distributing stations. A small amount of energy also is transmitted across from Italy and Spain. The amount sold to French consumers in 1923 by the Swiss hydro-electric industry amounted to 521 million kilowatt hours and is constantly increasing. This export is watched with some misgivings by the Swiss Federal Council. They are afraid that the use of cheap hydraulic power may enable a foreign industry to compete successfully with one of their own. Should there be a drought, the export "permits" limit seriously the amount of energy that can be transported, and this may be very awkward for the foreign consumer. The suggestion is made that the Swiss law should provide for an indemnity when an authorisation is withdrawn. From the point of view of the French authorities, the import of cheap energy may prevent the development of French hydro-electric power, which, as it has in general to be transmitted over long distances, cannot be sold so cheaply. Mr. Bouchayer suggests that an inquiry should be held and also that a tax should be put on energy imported over a distance of 100 km. (62 miles) into France. The tax suggested is 0·005 franc per kilowatt hour. Electrical energy should only be imported within the limits required by the national interest.

THE Rowett Research Institute has recently issued Volume I. of Collected Papers consisting of 62 communications to a score of different journals. All but two of these have been published within the last five years. The wide distribution of these publications, serving as they do the sciences of agriculture, bacteriology, chemistry, and medicine, make it most convenient to have all the publications in one volume. The name of the editor of the volume, Dr. J. B. Orr, Director of the Institute, is associated with half the papers. The field of research covered by a number of investigators in four different departments is naturally extensive, but the activities of the Institute as a whole have been focussed on problems of nutrition. Although much work has been published on the subject of calorimetry, the staff, while recognising the importance of this aspect of nutrition, realised that other essential factors had in the past been neglected. Several papers are devoted to work on vitamins, but this work seems to have stimulated a reluctance to accept the explanation of deficiency of these accessory factors as the chief cause of lack of growth and of such diseases as rickets, attributed to vitamin deficiency by the majority of modern investigators. Other possible explanations have therefore been sought; the neglected field of mineral metabolism offering the most scope for work. The possibility of a lack in the food supply of any of the normal mineral constituents of the animal body, *e.g.* calcium, phosphorus, iron, etc., and the effects produced by deficiencies of these substances, are complicated by hypotheses of the necessity of rigid mineral balances in the food, thus presenting a very wide field for investigation. The Rowett Research Institute is to be congratulated on the whole-hearted way in which the staff has attacked these problems, for much more work on animal nutrition is urgently required by our oldest industry to make good the deficiencies arising from new animal environments. It is well to remember, however, that this is the output of only five years' work, and the too speedy application of scientific results to agricultural practice has its dangers.

THE British Research Association for the Woollen and Worsted Industries, Torridon, Headingley, Leeds, is awarding next session a number of research fellowships and advanced scholarships. The fellowships will be of the annual value of not more than 200*l.* each and are tenable at an educational institution or at a works. The scholarship grants are such as to cover expenses and maintenance and are intended to enable students to specialise after completing their secondary or university education; they are also open to factory workers. A wide choice of studies is available to textile students who enter for these scholarships.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An assistant lecturer in agricultural zoology in the department of agriculture of the University of Leeds—The Registrar, The University, Leeds (September 14). A lecturer in metallurgy in the University of Liverpool—The Registrar, The University, Liverpool (September 15). A secretary to the Public Instruction Committee, Jersey—The President, Public Instruction Committee, Greffe Office, Jersey (October 1). The Jenner Memorial Research Studentship at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, S.W.1 (October 3). A director of the new pharmacological laboratories of the Pharmaceutical Society of Great Britain—The Secretary, Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, W.C.1 (October 5). A senior lecturer in philosophy in the University of Melbourne—The Agent-General for Victoria, Melbourne Place, Strand, W.C.2 (October 15). A director of the department of medical entomology, and lecturer on noxious and venomous animals, at the London School of Hygiene and Tropical Medicine (Division of Tropical Medicine and Hygiene)—The Secretary of the School, 23 Endsleigh Gardens, N.W.1 (October 31). An assistantship in the Department of Logic of the University of Glasgow—The Secretary, The University, Glasgow. A junior scientific assistant in the ignition and electrical department of the Royal Aircraft Establishment—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 78). A chemist in the establishment of a large textile firm—The British Woollen Research Association, Torridon, Headingley, Leeds.

Our Astronomical Column.

PLANETARY TEMPERATURES.—Dr. W. W. Coblentz's pioneer work on the measurement of the heat of the stars by means of the vacuum thermocouple is well known. In conjunction with Dr. Lampland of the Lowell Observatory, he has recently made similar observations of the heat radiation of the planets and the moon, and the results are published in the June and July issues of the Journal of the Franklin Institute. The substances water, quartz, glass, fluorite, and rock salt are found to be practically opaque beyond the wave-lengths 1·4μ, 4·1μ, 8μ, 12·5μ, and 23μ respectively, whilst the atmosphere itself is opaque beyond 15μ. By the use of screens made of the materials mentioned, it was therefore possible to obtain thermocouple measurements of the radiation incident in the regions 0·3μ to 1·4μ, 1·4μ to 4·1μ, 4·1μ to 8μ, 8μ to 12·5μ, and 12·5μ to 15μ. From these measures the true planetary radiation could be found by subtracting the reflected solar light (0·3μ to 1·4μ) from the total radiation, and the spectral composition of the remainder enabled the planetary temperature to be estimated.

The most interesting of the results are those referring to Venus and Mars. Observations on Venus showed that when the bright phase was a narrow crescent, the dark part emitted an intense planetary radiation (in the region 8μ to 12μ) amounting per unit area to one-tenth of the total radiation from the bright crescent. It is pointed out that this suggests either a short rotation period for the planet or a hot interior. The region near the south cusp was hotter than that near the north, but long-continued observations will be necessary to settle whether this is a seasonal effect. If it is seasonal, the possibility of determining the position of the axis of rotation is foreshadowed.

Extensive observations of Mars were made during the opposition of 1924. The dark regions were found to give an appreciably higher temperature than the bright regions. The noon-day temperature of the bright regions on the equator came out as 5° C., that of the adjacent dark regions as 20° C. At the same time the east (sunrise) limb gave −45°, the west (sunset) limb 0°. These results show a huge diurnal range of temperature for points on the equator, indicating a rare atmosphere. The temperature of the north polar region was found to be steady at about −70°, but that of the south polar region rose gradually from −68° to +10° as the summer season in the southern hemisphere advanced. The temperature of the night-side is thought to be probably below −70° C. The integrated temperature of the whole disc was −30° C. for the month of July 1924.

THE GRONINGEN ASTRONOMICAL LABORATORY.—This institution, founded by Prof. Kapteyn, is continuing its labours under the direction of Prof. P. J. Van Rhijn. Publications 36, 37, 39 have recently come to hand. No. 37 is a discussion of the systematic errors of the trigonometrical and spectroscopic parallaxes published by several observatories. It is well known that systematic differences exist in the parallaxes found at different observatories. Prof. Van Rhijn seeks to determine the true values by correlating angular proper motions with linear velocities for different groups of stars. Systematic errors in the assumed trigonometrical parallaxes necessarily enter also into the spectroscopic ones, since the curves of line-intensity are based on trigonometrical results.

Prof. Van Rhijn revises the Groningen statistical parallaxes given in publication 34, reducing them on the average by 10 per cent. Comparing them with the Victoria spectroscopic parallaxes, he finds the following corrections to the latter: Spectral types F, G, K, correction −0·005″; type M +0·004″.

Publication 36 is a study of the number of stars of each spectral class between definite limits of proper motion, visual magnitude and galactic latitude.

No. 39 is a list of 656 proper motions of faint stars deduced from Helsingfors plates. The largest two centennial motions are 129″ (mag. 10·2) and 38″ (mag. 13·1).

MULTIPLE STARS.—F. Henroteau, of the Ottawa Observatory, contributes an interesting paper to the July issue of *La Science moderne* describing some multiple stellar systems. Many of these are studied spectroscopically, and also photometrically with the photo-electric cell.

σ Scorpii consists of a Cepheid, the pulsation period of which is about 6 hours, having a companion with orbital velocity of some 35 km./sec. and period 33 days. There is a more distant companion the period of which is 12 years. The motion of the Cepheid in this large orbit causes its light variations to be alternately accelerated and delayed, owing to the change in its distance.

σ Cygni is stated to have a density $\frac{1}{3000}$ of the sun's, and a mass 10 times the sun's, while its companion has a diameter $\frac{1}{8}$ of that of the primary, and a mass 7/100 of the sun's, which if confirmed would make it the least massive body yet recognised outside the solar system. Rigel and α Cygni are suspected to have similar small companions, but the detection of such small masses by changes in the line-of-sight velocity is necessarily a very delicate matter.

Prof. Guthnick has studied the eclipses of σ Cygni photometrically, and states that they last about 3 days, their period of recurrence being 11 days.

OBSERVATIONS OF STARS OF SPECTRUM TYPE Be.—Stars of spectrum type B are hot stars, and those which show bright lines in their spectrum are of particular interest because their study will no doubt throw light not only on the conditions of their atmospheres, but may also help to interpret the spectra of new stars and unusual properties of the hydrogen atoms. In the spectra of these stars the hydrogen lines are sometimes very complex, such as was recently described in this column in the case of ϕ Persei as studied at the Norman Lockyer Observatory by Dr. W. J. S. Lockyer. The intensity of the bright hydrogen lines usually decreases from the red to the violet, and as the ordinary photographic spectrum only extends from $H\beta$ to the ultra-violet, it might occur that while $H\beta$ and the other lines towards the violet were not bright, the line at $H\alpha$ might appear as a bright line. In fact, most of the so-called bright-line B stars have been discovered because $H\beta$ or the other hydrogen lines towards the violet were bright.

A recent investigation by Paul W. Merrill, Milton L. Humason, and Cora G. Burwell (*Astrophysical Journal*, vol. 61, p. 389, June), has been devoted to the study of the $H\alpha$ line of B stars, with the result that 90 more bright-line B stars have been discovered. Indeed the discussion brings out the fact that the objective-prism spectrograms have yielded more new bright-line stars than the number previously known within the areas observed. This great increase in the number of these stars has led the authors to inquire into their distribution in the heavens. The result of this study is to show that there is a tendency for them to fall into groups near the centre line of the Milky Way. Four of these groups occupy areas which are also rich in Wolf-Rayet stars. Further, the frequency of bright-line stars in the various spectral divisions has also been examined, and it is found that the spectrum classes B0 to B5 are strongly favoured. The communication includes numerous tables and illustrations, and is a valuable contribution to the study of bright-line stars.

Research Items.

QUATERNARY MAN IN CHINA.—An important addition to our knowledge of the distribution of man in the Pleistocene age is made by the researches of MM. Licent and Teilhard de Chardin, of which a preliminary account is given in Vol. 35, Pts. 3-4 of *L'Anthropologie*. While engaged in examining the quaternary deposits of southern China, they discovered three sites affording evidence of occupation by palæolithic man. The first is situated in the basin of the Choei-tong-k'eou immediately to the south of the Ordos plateau and to the east of the Yellow River, where was found a sharply defined zone of occupation of about 20 m. in length with a deposit of 50 cm. thickness. Upon it was superimposed a bed of loess about 15 m. deep, and above this the gravels of a pre-neolithic river. No human remains were found, but a quantity of fossil bones of *Bos primigenius*, *Rhinoceros tichorhinus*, hyæna, and the tooth of, probably, *Ovis Ammon*. Stone implements were very numerous and of various forms, all being worked on one side only. They were rude in form and rough in workmanship, this being due to the coarse grain of the material employed. At the same time a few scrapers and points showed that, given suitable material such as flint, man here was capable of fine work. Five hearths were discovered in the neighbourhood within an area of about a square kilometre. The third site was found on the Sjara-osso-gol, a tributary of the Hoang-ho, and has yielded the complete skull of a rhinoceros, and bones of a species of elephant, *Rhinoceros tichorhinus*, Equus, Cervus, *Bos primigenius*, *Hyæna spelæa*, etc. The lack of suitable material in this area has affected the character of the stone implements, which, with a few exceptions, are extraordinarily small. Notwithstanding this difference, this site and that at Choei-tong-k'eou may be regarded as contemporary. No traces of industry intermediate in date between this palæolithic culture and the neolithic have been discovered. Although comparison with European cultures is difficult, these sites may be classed as Mousterian or early Aurignacian.

OBSERVATIONS ON A COLLARED FLAGELLATE.—Dr. G. Lapage (*Quart. Journ. Micr. Sci.*, June 1925), records observations upon living specimens of the choanoflagellate *Codosiga botrytis* made with the view of ascertaining the nature of the collar and its function as a food-catching apparatus. Study of the organism does not support the view put forward by some previous observers that the collar is a spiral; Dr. Lapage holds that it is, as earlier workers stated, a protoplasmic, flexible, retractile, conical membrane, closed on all sides except on its upper free surface. The flagellum which arises in the base of the cup and the currents it produces are carefully described. They cause food to be brought to the collar, by which it is caught and passed down the outside of that structure to be ingested at or below the middle of the body, and not at its upper end and never by the area enclosed by the collar. The method of ingesting the food is fully described. Defæcation invariably occurs from the area enclosed by the collar. There are normally two contractile vacuoles; one of these has been misinterpreted as a "gullet-vacuole" at which food was said to be ingested. Dr. Lapage has not met with any examples which exhibited division, encystment, or conjugation.

RECOVERY FROM PLASMOLYSIS.—It has been almost axiomatic amongst botanists to interpret recovery from plasmolysis, when a living cell is immersed in a hypertonic salt solution, as due to the gradual entry of the salt. When the plant cell is immersed in sugar solution or in solutions of certain salts, no recovery takes place and the sugar or the salt in question is assumed not to penetrate the cell. This interpretation of recovery from plasmolysis will need reconsideration in the light of a recent paper by W. S. Iljin (Studies from the Plant Physiological Laboratory of Charles University, Prague, vol. 2, 1924). Iljin points out that the salts which have thus been assumed to penetrate the cell all appear to possess the property of facilitating the hydrolysis of polysaccharides such as starch. The result is the formation of soluble organic compounds within the cell, which raise its osmotic pressure in many cases to a value far higher than would be attained simply as a result of the entry of the salt itself. Salt solutions in which recovery from plasmolysis does not take place also fail to promote hydrolysis of starch. How the monovalent cations and organic anions thus found to be active in hydrolysis produce their effect is not apparent, but Iljin is emphatic that he sees no evidence of any considerable penetration of the cell by these ions.

NORTH-EAST LAND, SPITSBERGEN.—Mr. F. G. Binney gives an account of the Oxford expedition to North-East Land in the *Geographical Journal* for July. This is followed in the August issue by summaries of the scientific results by various members of the expedition. Some additions to the topography and geology have been made. On the east coast a low-lying spit of granitic and metamorphic rock was discovered and named Isis Point. Its position was found to be lat. 79° 42′ N., long. 26° 40′ E. No islands, such as had previously been reported, were found off the east coast. Soundings showed that the ice cap along this coast is aground and not floating and there is evidence that it is receding at no mean rate. In the interior of North-East Land no features exactly tallying with A. E. Nordenskjöld's "ice-canals" were found but wide crevasses with parallel vertical sides were numerous. They were of great depths and often partly choked with snow, but a definite floor such as Nordenskjöld described was never seen. It is probable, however, that these crevasses were of the same nature as the features discovered by Nordenskjöld.

RAINFALL VARIATIONS OF GREAT BRITAIN.—The *Meteorological Magazine* for June contains an article by Mr. C. E. P. Brooks, of the Meteorological Office, on "Long Period Variations in the Rainfall of Great Britain." The author makes a praiseworthy attempt at grouping past records of rainfall and associating with them the earlier historical records of weather such as storms, floods, and droughts. With the aid of previous work done by G. J. Symons, E. J. Lowe, and Sir Richard Gregory, an approximation is made of the variations of rainfall in Britain since A.D. 1000. Approval is expressed of conclusions obtained by Symons, which is a satisfaction to those who knew Symons' work, and the scrupulous care with which he originated and handled rainfall results. A diagram is given to show the fluctuations of rainfall since A.D. 1000. Prior to 1700 the results are based on generalisations by old chroniclers, and it is only claimed that a rough approximation is obtained; but from 1700 onwards the results are based on actual measurements. There is probably no one who can better claim respect in this research than Mr. Brooks, and the article is of especial interest.

INSTANTANEOUS COLOURED PHOTOGRAPHY.—A method of obtaining coloured photographs by means of a single very short exposure is described by M. G. A. Rousseau in the *Comptes rendus Acad. Sci.* Paris, July 20. Three films are employed, the first of which has an ordinary slow emulsion, the second is coloured yellow with auramine on the side towards the lens, and pale rose with fuchsine on the other side, and has an emulsion which is sensitive to yellow and green, while the third film is coated with an emulsion which is sensitive to yellow and red. The three films are cemented together along one edge, and pressed together in the camera by means of springs between a thin metal plate and a glass plate. The photograph is taken in the same way as an ordinary one, no screen being required. The blue-violet radiations act on the first film, and are largely absorbed by it. When this is developed it serves as a yellow positive. The radiations which pass through the first film are further filtered by the yellow dye on the outside of the second film, so that no blue-violet radiations pass to the sensitive layer, which is acted on by the yellow and green radiations giving a red positive. Finally, the remaining yellow and green is filtered out by the fuchsine on the back of the second film, so that only the orange group passes to the third film, which gives a positive in which the bright parts correspond to the blue in the object photographed. Monochromes can then be printed in the proper colours from the three films, and when these are superposed, the object photographed is seen with its natural colours.

POLARISATION OF THE ATOM TRUNK.—The observed differences between the spectra due to a photo-electron, which circulates in orbits at a distance from the nucleus considerably greater than those of the remaining $n-1$ electrons, and the spectrum calculated from the Balmer formula of hydrogen, have been ascribed to the fact that the photo-electron polarises the atom trunk, so that the configuration of the trunk, to a certain extent, follows the radius vector of the electron in synchronism. The result may be to introduce a term into the law of the force field in which the electron moves, depending on $1/r^3$ or some higher inverse power of r, the distance from the centre of the nucleus. In the *Annalen der Physik* for June, Dr. E. Schrödinger calculates the capacity for polarisation, P, of the "neon" trunk for the d terms ($k=3$), and the f terms ($k=4$) of Na I, Mg II, Al III and Si IV, and finds that P is nearly constant in each series when n varies from 3 to 7. A table based on the arc spectra of the alkali metals (inert gas trunks) shows some regularities and some irregularities in the values of P. A remarkable irregularity discovered by Paschen in the Bergmann series of Al II is explained by assuming that, for frequencies a little smaller than the resonance frequency of the trunk, P is large, and for higher frequencies is negative; this depends on the loosening of the structure of the trunk at the resonance frequency. The relations for the arc spectra of the alkaline earths are not very clear, and the explanation given in the case of Al II is to be taken with a certain amount of reserve in consequence.

SULPHUR SESQUIOXIDE.—The Journal of the Chemical Society for July 1925 contains an interesting paper by J. R. Partington and I. Vogel on sulphur sesquioxide. There has always been some doubt as to whether the blue substance formed by the interaction of sulphur and sulphur trioxide was a definite compound or a colloidal solution. The present authors have proved that it is a compound, S_2O_3, analogous to the well-known $SSeO_3$ and $STeO_3$, which are formed in a similar way. The properties of the oxide are described as well as futile attempts to isolate sulphur monoxide.

NICKEL.—Dr. M. Cook contributes an interesting article on nickel to the *Chemical Age* for August 1. Copper-nickel alloy was in use so early as 235 B.C., but nickel itself was not isolated until 1751, by Cronstedt. The chief sources are the ores of Sudbury (Canada) and New Caledonia. Pure nickel cannot, in general, be worked; it is made malleable by the addition of about 0·1 per cent. of magnesium, a discovery due to Fleitmann. The function of the magnesium is to break down the nickel sulphide which occurs as films around the nickel crystals and so renders the metal brittle. Magnesium sulphide, insoluble in molten nickel, is produced and occurs disseminated throughout the solid metal. The influence of various impurities on the properties of the metal is discussed. The mechanical properties of the metal are listed and the numerous methods of working are briefly described. Some of the toughest non-ferrous alloys known contain nickel. The metal is finding numerous uses, and more than seventy countries utilise it or its alloys for coinage purposes.

DIAGNOSING POTENTIAL OPTICAL ACTIVITY.—An important article on the detection of potential optical activity, by Prof. John Read and Miss A. M. M'Math, appears in the July number of the Journal of the Chemical Society. Until 1914 no one-carbon molecule had been obtained in optically active modifications. In that year, however, Sir William Pope and Prof. Read succeeded in resolving chloro-iodomethanesulphonic acid, and found that the active forms showed pronounced optical activity. This rendered the lack of success which was experienced in attempting to resolve chloro-bromomethanesulphonic acid all the more remarkable. Prof. Read and Miss M'Math have now found that by salt-formation between this acid and *l*-hydroxyhydrindamine in organic solvents, and subsequent recrystallisation from acetone containing a little methyl alcohol, two salts are produced which differ widely in crystalline form and solubility. Their specific rotatory powers are different in organic solvents, but identical in water, and both salts show a remarkable mutarotation in certain organic solvents. The authors adduce evidence to show that these salts are to be represented as *lBlA* and *lBdlA* respectively, and that in pure dry acetone either of them rapidly attains an equilibrium of the following kind:

$$lBlA \rightleftarrows lBdA$$
$$\text{81 per cent.} \qquad \text{19 per cent.}$$

The diastereoisomeric salts thus exist in dynamic equilibrium, and the whole of the original acid may be removed in the form of the less soluble salt, *lBlA*. This salt changes instantaneously into the partial racemate, *lBdlA*, in contact with water, which apparently exerts a potent catalytic racemising effect even when added in small amounts to solutions of *lBlA* in organic solvents. The authors advance the view that asymmetric carbon compounds of simple molecular constitution are as a rule exceedingly susceptible to racemisation, owing to the mobility of the groups attached to the asymmetric atom. Easy racemisation involves the complementary possibility of easy optical stabilisation under an appropriate asymmetric influence, and the new method of diagnosing potential optical activity is based upon this principle. The authors "anticipate that asymmetric compounds containing two carbon atoms in the molecule will also display phenomena of the kind now described, and thus lend themselves to preparation for the first time in optically pure combinations by treatment with optically active bases in organic solvents. Through a systematic application of the method to asymmetric compounds of simple molecular constitution, it is hoped to gather much new information respecting the comparative mobility of groups in systems of the kind."

Developments in Gas Calorimetry.

By Dr. J. S. G. THOMAS.

SECTION 5 of the Gas Regulation Act, 1920, requires that, in certain cases, apparatus for testing towns' gas "shall include a calorimeter for the production of a continuous record of the calorific value of the gas which is being supplied." During the interim period of development of a suitable and satisfactory recorder, the statutory testing of the calorific power of gas has, in accordance with the specification of the Gas Referees, been done in practically all cases by determinations of calorific power made at specified periods with a Boys calorimeter. The cost and elaborate procedure at present necessitated by this method of testing have become a serious burden,

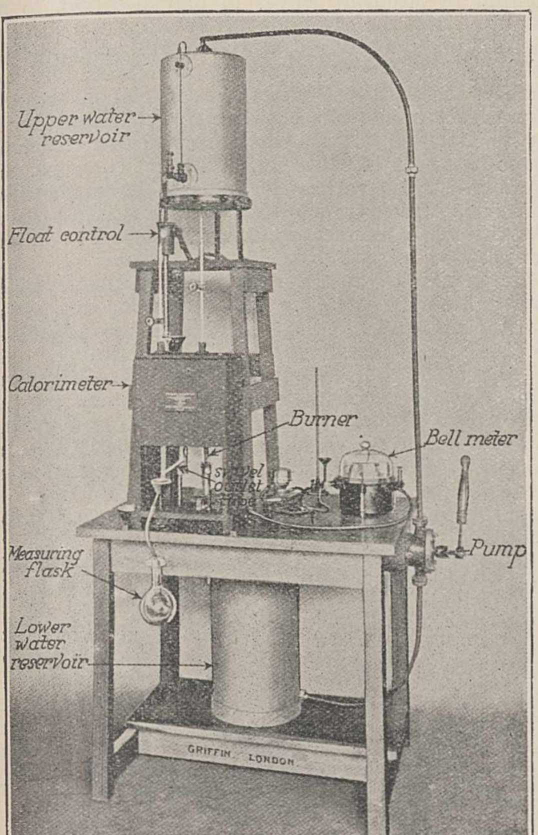

FIG. 1.

particularly in small country places, and with the view of reducing these difficulties Prof. C. V. Boys has designed a simple equipment which he described at the meeting of the Institution of Gas Engineers on June 10 last. The apparatus is illustrated in Fig. 1.

Water required for the test is contained in an upper reservoir, and after passing through the calorimeter is received in the tank or lower reservoir below the table, whence it may be restored to the upper reservoir by operation of the handle of the pump, the water entering at the bottom of the upper reservoir, so that by continuing the pumping operation air is forced into the water, the consequent stirring ensuring uniformity of temperature. The customary overflow funnel system for determining the water rate through the calorimeter has been replaced by a float control, resembling a carburettor in design. Water passes from the calorimeter by a swivel outlet tube moving between stops, so that the water may either flow to the lower reservoir or be collected in a measuring flask during the actual test. Prof. Boys has, very reluctantly, been obliged to abandon the use of "onazote" which he employed in the construction of his "Block" calorimeter as a water-containing and insulating material, and has reverted to a construction very similar to that employed in his recording calorimeter (NATURE, August 19, 1922, p. 251) for the water circulation within the present "Box" calorimeter.

Gas to be tested is efficiently governed and passes through a micrometer tap to a Boys "Bell Meter," and thence to a burner consisting of a narrow inner tube terminating within a plain silica tube open above and below. There are no moving gas connexions, and as the gas is somewhat aerated before combustion it is possible to burn as much as one cubic foot per hour without risk of imperfect combustion. Readings of inlet and outlet temperatures of the water passing through the calorimeter may be taken after the burner has been alight about 15 minutes.

The Boys "Bell Meter," shown also in Fig. 2, incorporates some of the essential features of the meter employed in Prof. Boys's recording calorimeter

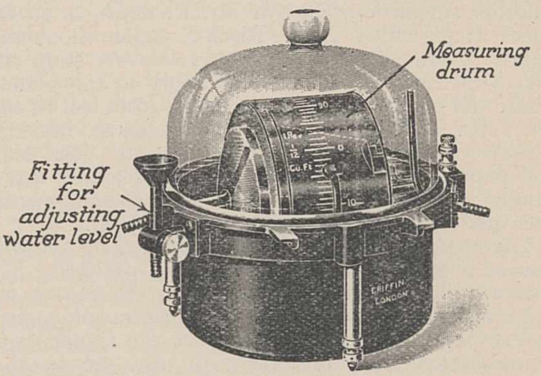

FIG. 2.—Boys "Bell Meter."

(NATURE, *loc. cit.*). A celluloid or nickel drum is graduated along its circumference and is supported on an axle moving in bearings in water, no stuffing box being employed. A buoyancy chamber supports most of the weight of the drum and forms a solid floor to the major part of each compartment of the drum when gas is trapped within it. The water level is determined by a submerged needle. Water may be added to or run off from the meter by means of the fitting seen on the left of Fig. 2. By these means the tiresome operation of meter-proving becomes unnecessary.

In the case more especially of small gas undertakings, where financial considerations unduly limit the number of tests of calorific power of the gas supplied, it is difficult to ascertain the mean value of the gas supplied over the statutory period. The consequence of the present procedure is that small gasworks, in order to prevent an adverse report, have to provide gas which on the whole is of higher calorific value than that declared. Prof. Boys suggests tentatively that in the case of such undertakings the gas supply over any period should be sampled by being slowly and continuously drawn into a small holder in the testing place, maintained if necessary at a uniform temperature, and that the sample so collected should be tested by the Gas Examiner. Owing to the small rate of gas flow and the short time taken, less than half a cubic foot of gas is sufficient for a test. In an apparatus designed by Prof. Boys for such sampling, the gas lifts a balanced bell at a rate controlled by a clock. A chain from the bell to a balance weight made as a sprocket chain passes over a sprocket wheel connected by a clutch to a clock-turned axle, the clutch acting in such a direction that the bell cannot rise faster than the clock permits, whilst it is always free to descend when weighted. This system of clock control of sampling lends itself readily to any agreed scheme of variation of the rate of sampling which may be considered equitable and in accordance with the variation of the rate of gas supply to the district during the hours of day and night. Should experience show that there is no loss of quality due to sampling and storage, the method would ensure one of the most important objects of the Gas Regulation Act being attained.

The Transmission of Excitation in Plants.

THE question of the mechanism of transmission of excitation in plants has been for some time under discussion in the columns of NATURE. The most recent contribution to the discussion is a paper by Sir J. C. Bose, entitled "Physiological and Anatomical Investigations on *Mimosa pudica*," published on August 1 in the Proceedings of the Royal Society (No. B 690, vol. 98).

The first section of the paper is devoted to the vexed question of the nature of the process of transmission. It has been suggested by Prof. Ricca that it is purely physical; a stimulating substance (hormone), produced at the seat of stimulation, is conveyed to the motile leaves by means of the transpiration-current in the vessels of the wood. Another suggestion, that of Mr. R. Snow, is to the effect that whilst Prof. Ricca's explanation may apply to transmission through relatively long distances in the stem, it does not apply to the petiole, where the excitation seems to travel from cell to cell. Sir J. C. Bose arrives at the conclusion that the process of transmission is the same in both stem and petiole; that it is not physical in either, but is wholly physiological, a wave of protoplasmic excitation, just as it is in the nerve of the animal.

The experimental evidence upon which his conclusion is based is both negative and positive. The author failed, after many attempts, to repeat the experiment upon which the transpiration-current theory depends, that is, to observe the transmission of excitation from one piece of stem to another connected with it by a glass tube containing water. Further, if the physical theory be true, it is obvious that the velocity of the transmission of excitation and that of the transpiration-current must be the same; but it was found that the former is far greater than the latter.

On the positive side, Sir J. C. Bose observed that transmission in Mimosa was affected experimentally in the manner well known in animal nerve. For example, in both the velocity of transmission is increased by rise of temperature and by desiccation. Again, on passing a moderately strong electric current (6 volts) through a length of the stem, the effect at "make" of the current was observed, by the fall of adjacent leaves in one direction, to be stimulation at the cathode; on breaking the current, stimulation was induced at the anode, evidenced by the fall of leaves in the opposite direction. It was further demonstrated that transmission is arrested by an electrotonic block; that is, excitation cannot travel along a tissue through which a constant electric current is being maintained. These results, obtained equally with stem and petiole, go to prove that excitation is transmitted in the plant in essentially the same manner as it is in the nerve of the animal.

The remaining sections of the paper deal mainly with anatomical details. The conclusion is reached that the phloem is the tissue that conducts excitation; not the sieve-tubes, but the elongated tubular cells of which the phloem mainly consists. Moreover, evidence is adduced that a strand of these tubular cells occurs also on the inner surface of each xylem-bundle, and this strand is termed the "internal phloem." The results of anatomical observation agree with those of physiological investigation by means of the electric probe. When the probe was inserted gradually into the petiole, maximum negative galvanometric deflexion was manifested when it penetrated the external phloem and again when it reached the internal phloem.

The paper concludes with a comparative study of the pulvinus, from which it appears that the more excitable the pulvinus the more deeply does the protoplasm of its contractile cells stain with safranin; it also reduces osmic acid, indicating the presence of a readily oxidisable substance, not a fat or a lipoid, which is probably concerned in developing the energy required for the active contraction of the organ.

Earthquake Investigation in the United States.

AS already mentioned in NATURE of April 25, p. 615, an act of the United States Congress was approved early this year, enacting "that the Coast and Geodetic Survey is hereby authorised to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau." The reasons for the change and the work that it is hoped to accomplish are given in an excellent popular account (U.S. Coast and Geodetic Survey, Serial No. 304, price 10 cents) by Mr. E. Lester Jones, the director of the Survey.

In 1899, the Coast and Geodetic Survey developed a plan for the magnetic survey of the United States, and five observatories were established in places that proved to be admirably adapted for earthquake observations. Of these places—Porto Rico, Maryland, Arizona, south-east Alaska and Hawaii—three are in major earthquake zones and one near such a zone. As in other places, it was found that the magnetic instruments recorded certain kinds of earthquake waves, and they were supplemented by seismographs which have been in action for more than twenty years. In 1906, after the Californian earthquake, the Weather Bureau installed seismographs at Chicago, Washington and Northfield (Vt.), but, after a time, it was found that seismological investigation, and especially the instrumental part, did not fit in well with the work of the Weather Bureau, nor did the Coast and Geodetic Survey feel justified in attending to seismographs merely as an adjunct to its magnetic work. Accordingly, by agreement of the Secretaries of Agriculture and Commerce, Congress was asked to enact the legislation referred to above.

In several ways, the ordinary work of the Coast and Geodetic Survey is adapted for earthquake investigations. The routine of operating magnetic instruments, with the necessary attention to details which such precise instruments require, gives the observers the qualifications needed to get the best results from high-grade seismographs. The Survey maintains tidal stations at numerous points along the coast with continuous record by automatic gauges. Most important of all is the fact that the changes in the horizontal or vertical position of places in the central area of an earthquake can be determined only by precise triangulation and levelling. Such work by the Coast and Geodetic Survey has been in progress for three years in California, for it is understood that not only have changes occurring at the time of earthquakes to be considered, but also movements of large areas as a whole between earthquakes. C. D.

University and Educational Intelligence.

A SUMMARY of important State Laws relating to education enacted in 1922 and 1923 has been published by the United States Bureau of Education in Bulletin 1925, No. 2. In the year 1923, laws were passed in twenty-two States prescribing instruction in the public schools in the constitution of the United States, the duties of citizenship, or "Americanism," which is defined (North Carolina) as including (*a*) respect for law and order, (*b*) character and ideals of the founders of the country, (*c*) duties of citizenship, (*d*) respect for the national anthem and the flag, (*e*) a standard of good government, (*f*) constitution of N. Carolina, (*g*) constitution of the United States. In Florida, teachers and professors in State institutions were forbidden to teach atheism or agnosticism or to teach as true Darwinism or any other hypothesis that links man in blood relationship to any other form of life.

THE London County Council has again arranged numerous lectures for teachers during the winter, and a descriptive handbook has been prepared (The County Hall, Westminster Bridge, S.E.1.). The lectures scheme is now self-supporting, and last year's attendance approached 14,000. Any person engaged in teaching in London or Middlesex is eligible for admission at fees which average less than 1*s*. a lecture; out-county teachers are admitted at fees 50 per cent. higher. Among the lectures which will interest readers of NATURE are the following:—Special single lectures by Prof. J. Arthur Thomson on "Visualising in Nature Study," by Sir William Bragg on "Quartz," by Sir Sefton Brancker on "Aviation in the British Empire," Dr. A. S. Russell on "Radio-activity," Prof. Leonard E. Hill on "Sunlight and Open-Air Classes," and by Mr. Richard Kearton on "Wild Life round London." Courses will be given by Prof. T. P. Nunn on science for the elementary school, by Dr. L. F. Bates on modern theories of magnetism, by Mr. J. W. Bispham on science-teaching in junior technical schools, by Prof. Cyril Burt on mental tests, and on experimental psychology and its bearing upon education. In mathematics there will be three courses dealing with the teaching of mathematics of different grades, while Prof. H. Levy is giving a course on the work of the mathematical laboratory. Geography is represented by courses on physical, regional and historical geography, on the teaching of local geography and on practical work in geography. These lectures are valuable in that they enable teachers to keep in touch with modern developments in their respective subjects.

THE City and Guilds of London Institute has issued as an addition to its report for 1924 (the forty-fifth annual report since the incorporation of the Institute) a report to the University of London by the University's Visitor, Sir Alfred Ewing, on the research, teaching, and equipment of the City and Guilds (Engineering) College. The Visitor found much to admire and very little to criticise. His observations relate to matters of such fundamental importance, and they are supported by lucid statements of principles so generally applicable, that they deserve attentive consideration by other engineering schools. Referring to the danger, to which all engineering schools are exposed, of overloading the course with a study of technological method and detail which takes up the time and attention that should be given to matters which are far more educative and, in the long run, of greater professional importance, Sir Alfred Ewing remarks that it "tends to become more acute where a school is divided into departments which may tempt a student to specialise prematurely, and where in each department there is a lavish equipment of large-scale engineering plant." He adds, however, that the course at the City and Guilds College, where the laboratories are extraordinarily spacious and splendidly equipped, is, on the whole, well balanced. Among the novel and interesting features of the laboratory work are testing machines of a new type designed by Prof. Dalby. A large section of the laboratory is not in use at present on account of the difficulty of paying rates on it. The technological examinations conducted by the Institute in Great Britain and Ireland were held at 297 centres, and the number of candidates examined was 8578. In addition, 1326 candidates were examined in the Dominions Overseas (chiefly New Zealand) and India.

THE League of Nations (Information Section) sends us a report on the "Instruction of Children and Youth in the Existence and Aims of the League" which is to be submitted to the Sixth Assembly opening in Geneva on September 7. The report shows that the League's propaganda has led to a vast amount of activity on the part of government departments, national associations of teachers, and other national and international organisations in the preparation of special pamphlets and magazine articles, the provision of special lectures and courses of instruction, the organisation of conferences, exhibitions, schemes for awarding special diplomas and badges, inter-scholar correspondence, exchange of students and international visits, and obtaining travelling facilities and collective passports. The Sixth Assembly is to consider, *inter alia*, a proposal that the League's Committee on Intellectual Co-operation should invite all professors and teachers to collaborate by preparing and distributing to all scholastic institutions literature instructing the young in the aims of the League. The effects of all these activities in different countries will depend to a great extent on the place already held in the national system of education by instruction in the duties of citizenship and practical exercises in those duties. Where, as in the United States, these are commonly recognised as an essential part of primary education, the attempt to establish a new loyalty to the ideals of the League may find a safe foundation of patriotism on which to work, but when this foundation is lacking the results may be unfortunate. In Great Britain, at any rate, it may well be asked whether the teaching of loyalty to that older league of nations known as the British Empire should not take precedence. "The internationalism that denies the worth of patriotic preference," says Wickham Steed in the preface to his reminiscences, "is as debilitating as is unqualified scepticism in regard to philosophical or religious belief."

Early Science at Oxford.

September 9, 1684. A letter from Mr. Creech, dated from Worcester, September the 4th, was read; it gave an account of a Woman in Worcester, who, for these twenty years last past, has every Sunday had a Convulsion Fit, and at no time else, unless she puts both her feet over her threshold; which if she does, a fit certainly seizes her; the case of this woman is drawn up by ye learned Dr. Cole, Physitian at Worcester, and was comunicated to severall of the physitians in Oxford about a year and a half since.

Mr. Francis Davenport's account of the Tides at Tunquin and Mr. Halley's Theory of those Tides, were read, and will be printed very suddenly.

Dr. Plot communicated an Instrument made by Mr. Bard of Fretwell, for ye better æstimating ye increase, and decrease, of ye weight of oil of vitriol exposed to ye open air: ye Doctor promises us to make use of it, and give ye Society an account of ye success.

Dr. Plot also communicated an account of ye weather here at Oxon: during ye last month; and an abstract of a letter from the Reverend Dr. Thomas Smith, now at London, who says, that a Naturall History of Scotland is lately printed at Edinborough by Sir Robert Sibbald.

The Doctor further communicated to the Society that, in a visit made by himself to ye men of Siam lately come into England, he received from them a present of a black lead pen of their country, and a nut whose kernell is call'd Areka, which has a smart aromatick tast, and is said to be purgative.

He understood from them, that their alphabet, and numerall figures, were ye same with those of ye Indians.

Dr. Smith shewing himself very ready to oblidge ye Society, by proposing to those men of Siam any quæries which shall be sent him hence, it was offered by Mr. Bernard, that ye Doctor be desired to discourse with them on ye severall heads of Dr. Plot's sheet of enquiryes.

There being some discourse concerning Barometers, particularly it being affirmed, That a candle placed near ye upper and empty part of ye Tube will make ye quicksilver descend; it was proposed by Mr. Bernard, that tryall be made, whither spirit of hartshorn, applied to the top of ye Tube, will cause ye quicksilver to ascend?

Mr. Præsident proposed that enquiry be made whether the quicksilver arises and falls in old barometers, to as many degrees, as it did in ye same barometers, when they were new? In one, which he for many years made use of, he has found it does not.

Dr. Plot presented ye Society with a peice of heavy wood from Jamaica, called *Kicongo*; 'tis of a smell like *Enula Campana*. Some Experiments will be tried on it very suddenly; and an account of them brought in to the Society.

The Doctor, haveing finished his discourse *de Origine Fontium*, was, at this meeting, desired by ye Society, to communicate it to them, and begin reading it the next week.

The Society then tooke into consideration the enlarging of their Correspondence; for ye effecting of which, they concluded, that some attempts be made for ye settling a Correspondence in Scotland, in like manner, as it is now carried on between ye Royall Society, and that of Dublin, and this of Oxford; in order whereunto, it was ye most humble request of this Society to Mr. President to take on him ye trouble of writing to the Heads of ye Universitys in Scotland, concerning this affair.

Societies and Academies.

LONDON.

Institute of Metals (Autumn Meeting, Glasgow), September 2.—J. H. **Andrew** and Robert **Hay**: Colloidal separations in alloys. The β constituent may break down into colloidal α and colloidal γ, and upon submitting these to an electrical current, the colloid is destroyed and the crystalline phase begins to make its appearance. The ageing of duralumin may be due to the deposition of the magnesium compound in the colloidal form, when the increase in hardness would be due rather to the fineness of state of division of the separating phase than to its specific properties.—John S. **Brown**: The influence of the time factor on tensile tests conducted at elevated temperatures. With non-ferrous alloys there is a critical temperature condition, above which the rate of application of the load has an important influence on the observed strength. This time factor tends to lose its effect when the rate of loading is kept below 1 ton per sq. in. per day, and this value is consequently put forward as of basic importance in such investigations.—R. B. **Deeley**: Zinc-cadmium alloys. A note on their shear strengths as solders. A substitute for brazing spelter was required for the motor-cycle industry. The working temperature of the substitute solder had to be below that likely to promote coarse crystallisation of the hard-drawn steel tubing of the frame, and the melting point had to be sufficiently above the enamel stoving temperature (about 180° C.) for joints made with the alloy not to fail during enamelling. Zinc-cadmium alloys in pure shear show the strongest alloy to be near the eutectic composition. This alloy is considerably stronger than tinman's solder, 8 tons/sq. in. compared with 4 tons/sq. in.—J. W. **Donaldson**: Thermal conductivities of industrial non-ferrous alloys. The thermal conductivities of 70 : 30 brass, high tensile brass or manganese bronze, Admiralty gunmetal, ordinary gunmetal, bearing phosphor bronze, white bearing metal, and monel metal are low, ranging from 0·067 for monel metal to 0·242 for 70 : 30 brass. Increasing the temperature increases the conductivities. The alloys of tin and copper have a lower conductivity than those of zinc and copper, while nickel lowers considerably the conductivity of an alloy containing it.—Marie L. V. **Gayler**: On the constitution of zinc-copper alloys containing 45 to 65 per cent. of copper. In an equilibrium diagram, no change in microstructure of alloys consisting wholly of the β constituent could be detected.—J. L. **Haughton** and W. T. **Griffiths**: The β transformations in copper-zinc alloys. The change of resistivity with temperature was determined for some alloys containing from 46 to 63 per cent. copper. Above 55 per cent. copper the β-transformation temperature is 453° C.; between 55 per cent. and 51 per cent. copper it takes place at temperatures rising from 453° C. to 470° C.; with less than 51 per cent. copper the transformation temperature is 470° C. These data are opposed to the theory that this is a eutectoid transformation. The specific resistances at room temperatures were also measured after annealing just above the transformation point. The resistance falls rapidly as the copper decreases from 61 per cent. to 53·5 per cent., and less rapidly to about the 50 per cent. copper alloy; it rises steeply from this point with further decrease of copper content. Thus the two boundaries of the field at room temperature occur at 50·0 and 53·5 per cent. of copper.—C. H. M. **Jenkins**: The physical properties of the copper-cadmium alloys rich in cadmium. Alloys containing up to 5 per cent. of copper in the cast, rolled and annealed states, were used. The effect of even a small addition of copper to cadmium is to cause the formation of a second constituent $CuCd_3$; this increases the tensile strength and Brinell hardness and prevents the grain growth of cadmium on annealing. Additions of more than 3 per cent. of copper do not materially improve the mechanical properties of cadmium owing to the presence of too large a proportion of the brittle compound.

PARIS.

Academy of Sciences, July 20.—A. **Haller** and R. **Cornubert**: The constitution of the dimethylcyclopentanone and the dimethylcyclohexanone obtained by alkylation by means of the sodium amide method.—Nicolas **Kryloff**: A method based on the principle of the minimum, for the approximate integration of differential equations.—R. A. **Fisher**: The solution of the integral equation of V. Romanovsky.—W. **Stepanoff**: Some generalisations of nearly periodic functions.—Rolf **Nevanlinna**: A theorem of unicity relative to uniform functions in the neighbourhood of an essential singular point.—N. **Lusin**: The use of the diagonal of Cantor.—R. **Roudaire-Miégeville**: A new grapho-mechanical determination of systems of real or imaginary solutions of algebraical equations.—J. **Seigle**: Tests of mild steel by combined stresses.—Marcel **Peschard**: The magnetisation of ferro-nickels (paramagnetic properties).—G. **Athanasiu**: The sensibility of actinometers with electrodes coated with silver iodide and copper oxide.—G. **Bruhat** and M. **Pauthenier**: A theoretical study of 320 mμ of carbon disulphide.—R. de **Mallemann**: The calculation of rotatory power starting with the molecular structure.—S. Pina de **Rubies**: The arc spectrum of scandium. The scandia was extracted by G. and P. Urbain from Madagascan thortveitite, transformed into the acetylacetonate and the latter purified by repeated sublimations in a vacuum at 190° C., followed by recrystallisation from absolute alcohol. A table of wave-lengths and intensities is given.—Gabriel A. **Rousseau**: Method for instantaneous photography in colour. Three films are superposed: the first receives a slow ordinary emulsion, the second an emulsion sensitive to the yellow and green, and the third an emulsion sensitive to the yellow and red. Details of the preparation of the sensitised films are given. The photograph is taken without a screen, working as with an ordinary plate.—Adolphe **Lepape**: The radioactivity of some cold springs in the Bagnères-de-Luchon region and on its origin.—Mlle. Germaine **Cauquil**: Study on viscosity and surface tension during esterification.—**Pariselle** and **Laude**: The magnesia carried down by alumina in ammoniacal media. The presence of a large excess of ammonium chloride prevents co-precipitation of magnesia with aluminium hydroxide.—Pierre **Bedos**: A new racemic menthone and the two corresponding stereoisomeric menthols.—R. **Locquin** and R. **Heilmann**: The decomposition of the pyrazolines by spontaneous oxidation. The spontaneous oxidation of pyrazolines by air is complex and gives either a saturated or an unsaturated ketone, together with basic substances of high boiling point, so far not identified.—E. E. **Blaise** and Mlle. M. **Montagne**: The transformation of the dialkylcyclohexenones into dialkylbenzenes. Methylethylcyclohexenone heated in a sealed tube on the water bath with a saturated aqueous solution of hydrobromic acid gives *o*-methylethylbenzene. The reaction appears to be of a new type.—I. **Pouget** and D. **Chouchak**: The radioactive mineral waters of Guergour, Algeria.—Mlle. H. **Popovici**: The formation of essential oils.—Raoul **Combes**: Does light exert a direct action on the decomposition of chlorophyll in leaves in the autumn? The results of the experiments described are not in agreement with Wiesner's hypothesis, and light does not appear to be a direct cause of the disappearance of chlorophyll from leaves in the autumn.—André **Mayer** and L. **Plantefol**: The equilibrium of the cellular constituents and form of oxidations of the cell. Imbibition and respiratory types in reviviscent plants.—H. **Colin** and A. **Grandsire**: The mineralisation of green leaves and of chlorotic leaves.—P. R. **Bohn**: The presence of crystals of calcium oxalate at the surface of certain Caryophyllaceæ.— — **Kuhner**: The development of *Lentinus tigrinus*.—Emile **Saillard**: The method of Clerget. Coefficients of inversion. Inversion at the ordinary temperature for 28 hours, or at 70° C. (11 minutes) gave the same results. The inversion coefficient varies slightly with the concentration of the saccharose: figures are given for coefficients of solutions from 4 to 16 per cent. of saccharose.—Ch. **Brioux** and J. **Pien**: The use of the quinhydrone electrode for the determination of the P_H of soils. This method is advantageous from the point of view of rapidity and simplicity, but there are divergences between the results obtained by the quinhydrone and hydrogen electrodes at present unexplained.—M. and Mme. A. **Chauchard**: The law of excitability of the electrical apparatus of *Torpedo marmorata*.—A. **Rochon-Duvigneaud**, E. **Bourdelle**, and J. **Dubar**: An attempt at the determination of the anatomical binocular visual field of the horse.—F. **Vlès** and A. de **Coulon**: Relations between the experimental displacement of the muscular isoelectric points and the evolution of grafted tumours.—L. **Hugounenq** and J. **Loiseleur**: The superposition of the phenomena of dissociation and elective adsorption in the proteolytic diastases.—E. **Kayser** and H. **Delaval**: Radioactivity, nitrogen fixers and alcoholic yeasts. In an earlier communication it was proved that the addition of a radioactive mineral to the ordinary nutritive medium stimulated the action of Azobacter, and the increase varied with the strain of the organism. These results are now supplemented by varying the proportion of the radioactive mineral, by ascertaining the influence of repeated use, and by determining the ratios between sugar used up and nitrogen combined. The effect of the radioactive mineral on alcoholic fermentation has also been studied.—Jean **Bathellier**: The period of the determination of the castes in *Eutermes matangensis*.—Ch. **Champy**: The disharmony of the secondary sexual characters and the proportionality of the sexual glands in insects.—G. **Ramon**: The production of antitoxins.—F. **Diénert**: Contribution to the study of activated sludge.—Georges **Bourguignon**: The physio-pathological signification of Babinski's test.—C. **Levaditi**, A. **Girard**, and S. **Nicolau**: The treponemicidal action of gold and platinum.—Georges **Truffaut** and N. **Besszonoff**: The predominance of the activity of anaerobic nitrogen fixers in the soil.

CALCUTTA.

Asiatic Society of Bengal, August 3.—H. L. **Chhibber**: Microscopic study of the old copper slags at Amba Mata and Kumbaria, Danta State, N. Gujarat, India. The sites are two old metallurgical centres more than six hundred years old. The slags are mostly the remains of low grade minerals of the oxidised zone; no great depth below the surface was worked.—N. G. **Mazumdar**: Dacca image inscription of the reign of Lakshmaṇasena. Iconographically this is an important image, as representing an otherwise unknown type of Chaṇḍī.—B. S. **Guha**: Preliminary report on the anthropometry of the Khasis. Measurements were made of inhabitants of Cherapunji and neighbouring villages. Special attention was given to the measurements of the face; there is difficulty in determining the shade of colour of the skin of brown people.—Hem Chandra **Das-Gupta**: Palæontological notes on the Panchet beds at Deoli, near Asansol. Descriptions of three specimens: (1) the carapace of a brachyurous crab (?); (2) a stegocephalian cranium; (3) a reptilian coracoid. The second specimen is tentatively identified as belonging to *Pachygonia incurvata*, Huxley; the third specimen, similarly, to *Epicampodon* (*Ankistrodon*) *indicum*, Huxley. The first specimen differs from the only two described genera of Triassic brachyurous crabs.—Sukumar **Sen**: Notes on the employ of the cases in the Kāṭhaka-saṃhitā. An analysis of the use of the cases as exhibited in Leopold von Schroeder's edition, published from 1900 to 1910, shows a marked difference in language and idiom as compared with other Vedic prose texts.

MELBOURNE.

Royal Society of Victoria, July 16.—Gerald F. **Hill**: Termites from the Ellice Group. The only species of termite hitherto recorded from these islands has been confused with an American species until recently supposed to have been introduced into Hawaii. The species is identical, however, with an imperfectly known Samoan insect—*Calotermes samoanus* Holmgr.—and not with any described Hawaiian or American form. *Prorhinotermes inopinatus* Silv., hitherto known only from Samoa, is now recorded from the Ellice Group. Both species are destructive to coconut palms.—C. E. **Eddy**: The *L* absorption limits of lutecium, ytterbium, erbium, and terbium. The *L* series critical absorption wavelengths were measured relative to tungsten *L* lines as standards. A metal X-ray tube, with a thin window, and capable of being operated at 30 kilovolts and 30 milliamperes, was constructed, and used in conjunction with a low pressure spectrometer. The values of the critical absorption wave-lengths were as follows:

	L_{I}.	L_{II}.	L_{III}.
Lutecium	1136·21 X.U.	1194·0 X.U.	1337·5 X.U.
Ytterbium	1176·4	1238·14	1382·64
Erbium	1265·5	1335·60	1479·19
Terbium	1417·0	1499·4	1644·2

—W. J. **Harris**: Victorian graptolites (new series), Pt. 2. Four graptolites are described, three being new species, and one of these representative of a new family. Atopograptidæ (*fam. nov.*)—a biserial form with thecæ with extroverted apertures; represented by *A. woodwardi*, *nov.*, from Bendigo East. *Didymograptus nodosus*, *sp. nov.*, and *Cardiograptus crawfordi*, *sp. nov.*, from Bendigo East and Gisborne (Victoria). These three species are from Upper Darriwil beds, near the top of the Lower Ordovician.—W. M. **Bale**: Further notes on Australian hydroids, V. This paper describes *Sertularia nana* and *S. gracillima* new species, and gives a detailed account of *S. furcata* Trask, a common Californian species recorded doubtfully as Australian. A Sertularella, originally referred to *S. polyzonias*, is now described as *S. peregrina n. sp.* It is most nearly related to *S. mediterranea* Hartlaub. *Plumularia delicatula* Bale is given a new name—*P. Wilsoni*—on account of the priority of *P. delicatula* Busk (an Aglaophenia). A variety of *Aglaophenia divaricata* Busk, formerly referred doubtfully to *A. acanthocarpa* Allman, is named var. *Briggsi*.—Irene **Crospin**: The geology of Green Gully, Keilor, with special reference to the fossiliferous deposits. Green Gully is near the Keilor township, ten miles from Melbourne. The rocks consist of a succession of cainozoic sediments overlying the older basalt which rests on the Silurian bed-rock. The lowest of these cainozoic sediments is a moderately deep-water limestone which passes into a fossiliferous ferruginous rock, both of which are of Miocene (Janjukian) age. The limestone is characterised by a rich growth of calcareous alga (Lithothamnium) and by the abundance of the discoidal tests of several species of Lepidocyclina. The ferruginous bed contains a large assemblage of molluscan fossils, mainly in the form of casts, as well as some corals, which show close relationship with the Janjukian fauna of Table Cape, Tasmania, some species being restricted to the two localities.—Frederick **Chapman**: Geological notes on Neumerella and the section from Bairnsdale to Orbost. Fossils are of Miocene (Janjukian) age and were collected at Neumerella during the construction of the Bairnsdale to Orbost line. 150 species of fossils are recorded and notable additions made to the lists of fossil fishes, ostracoda, mollusca, polyzoa, and foraminifera. The fossil bands are seen in the cuttings, with remains of cetaceans and sharks' teeth; there are intercalated marly limestone layers, and evidence of local crumpling and faulting in the Janjukian. Large volutes and Nautilus frequently occur in the yellow marls as casts, and many are encrusted with a crystalline coating of calcite, probably representing the dissolved shell.

ROME.

Royal Academy of the Lincei, June 21.—B. **Grassi**: Contribution to the study of the biology of *Anopheles superpictus*.—B. **Longo** and A. **Cesaris-Demel**: The possibility of anaphylactic sensitisation in vegetable organisms.—S. **Saks**: Integration of the polynomials of Stieltjes.—Bruno **Finzi**: The motion of the boomerang.—Luigi **Carnera**: The new Washington catalogue of fundamental stars and the Berlin catalogue of circumpolar stars.—D. **Pacini**: Observations on the vertical air-earth current.—E. **Fermi** and F. **Rasetti**: Effect of an alternating magnetic field on the polarisation of resonance light.—E. **Persico**: Amplitude of the oscillations produced by a three-electrode lamp.—L. de **Caro**: Surface tensions of gelatin solutions of different hydrogen-ion concentrations.—E. **Clerici**: The diffusion of certain microscopic organisms of the rocks accompanying the Roman volcanic tufas.—Silvio **Ranzi**: The organ of sense derived from the first epibranchial placoid of Selacei.

Diary of Societies.

WEDNESDAY, *THURSDAY*, *FRIDAY*, SEPTEMBER 9, 10, 11.

IRON AND STEEL INSTITUTE (Birmingham Meeting) (at the University, Edmund Street, Birmingham).—J. H. Andrew and R. Higgins: The Dilatation of Cast Irons during Repeated Heating and Cooling.—M. L. Becker: Equilibrium at High Temperatures in the Iron-Carbon-Silicon System.—D. F. Campbell: High Frequency Induction Furnaces.—E. D. Campbell and J. F. Ross: The Chromium-Iron Equilibrium in Carbides recovered from Annealed 2·23 per cent. Chrome Steels.—A. L. Curtis: Steel Moulding Sands and their Behaviour under High Temperatures.—Prof. C. A. Edwards and L. B. Pfeil: The Tensile Properties of Single Iron Crystals and the Influence of Crystal Size upon the Tensile Properties of Iron.—Dr. C. F. Elam: The Orientation of Crystals produced by heating Strained Iron.—Dr. J. Newton Friend and W. E. Thorneycroft: Ancient Iron from Richborough and Folkestone.—R. H. Greaves and J. A. Jones: The Effect of Temperature on the Behaviour of Iron and Steel in the Notched Bar Impact Test.—L. Grenet: Notes on the Iron-Nickel and Iron-Cobalt Equilibrium Diagrams.—H. Kamura: Reduction of Iron Ores by Hydrogen.—J. L. Keenan: Blast Furnace Practice in India, with special reference to Economy in Coke Consumption.—W. R. Martin: The Davis Steel Wheel and its Manufacture in England.—J. A. Mathews: Retained Austenite.—H. Flodin: A New Direct Process.—J. H. Partridge: The Magnetic and Electrical Properties of Cast Iron.—A. Sauveur and V. N. Krivobok: Dendritic Segregation in Iron-Carbon Alloys.—A. Sauveur and D. C. Lee: The Influence of Strain and of Heat on the Hardness of Iron and Steel.