THURSDAY, DECEMBER 13, 1917.

GOLD-BEARING CONGLOMERATES OF SOUTH AFRICA.

The Banket: A Study of the Auriferous Conglomerates of the Witwatersrand and the Associated Rocks. By Prof. R. B. Young. Pp. xv + 125. (London: Gurney and Jackson, 1917.) Price 8*s*. 6*d*. net.

THE British Empire is not uniformly fortunate in its natural resources of the useful and precious metals. The ore-supplies of some of these, *e.g.* copper, aluminium, platinum, and mercury, as at present proved, are either deficient or entirely wanting. In such cases partial or complete dependence upon foreign sources is unavoidable, unless and until greater supplies are discovered. In other cases, although the known ore-resources are plentiful, the domestic output of metal has hitherto been inadequate owing to a deplorable lack of metallurgical enterprise within the Empire—raw materials, or partly smelted products, of British origin being exported to foreign countries and reduced to metal by foreign skill and labour. Zinc, lead, nickel, and until recently tungsten, may be cited as notorious examples, and for supplies of these metals British consumers have been placed in an unwarrantable position of insecurity. In a few cases, however, *e.g.* tin and gold, not only are the ores abundant, but they are smelted entirely within the Empire, and furnish metal sufficient, in normal times, both for Imperial consumption and for export. Cases of this kind should and could be more numerous, and that they will be, in the future, is already indicated by the birth and remarkable growth of a British tungsten industry since the inception of the war, and by the steps that are now being taken to ensure a greatly augmented Imperial production of nickel, zinc, lead, and iron.

In its gold resources the Empire is particularly fortunate. Of the world's current yearly output of 720,000 kilos. of new gold, 450,000 kilos., or more than 62 per cent., are of British origin. Of this amount 283,000 kilos., or 63 per cent. of the British production and 39 per cent. of the world's, are derived from the Transvaal. The remarkable "reefs" of conglomerate or "banket," from which the gold of the Witwatersrand is obtained, possess, therefore, a unique economic importance. They have a considerable scientific interest also, and it is with this aspect of them that Prof. Young deals in the publication now under review. The book summarises the results of researches which have been made by many investigators during the thirty years of gold-mining activity on the Rand. The information it contains is already familiar to many mining geologists, but has not hitherto been available in the pages of a single small volume, and in this conveniently epitomised form it will be widely welcomed.

The subject-matter is presented in five chapters. In the first the geology of the auriferous region of South Africa is briefly described, attention being confined to the Swaziland, Witwatersrand, and Transvaal Systems, in which alone gold occurrences of economic importance have been found. The most important of these, the Witwatersrand System, with its three highly productive "banket reefs," is shown to be a complex of sedimentary rocks, derived from the waste of the underlying Swaziland System, and of igneous rocks intruded into them in the form of dykes and sills.

In the second chapter the author deals with the original constituents of the gold-bearing conglomerates. Among the pebbles, vein-quartz almost exclusively preponderates over quartzite, quartz porphyry, schist, and other rocks. In the sandy matrix also quartz is in large excess over the other minerals recorded—zircon, tourmaline, chromite, diamond, iridosmine, etc.—which occur only in minute proportions. The remarkable absence of magnetite and ilmenite grains is believed to be due to their replacement by pyrite and other substances. The iridosmine, the genesis of which has been much debated, is shown conclusively to be a detrital constituent, and, with the chromite which so often accompanies it, is attributed to the disintegration of ultra-basic igneous rocks of the Swaziland System. It is of interest to note that in modern alluvials which carry this mineral detrital gold is invariably found with it, and the fact that in these ancient pebble-beds also gold accompanies it—although not in the alluvial condition—is one that must be borne in mind when the genesis of the gold in the "banket" is being considered.

In the third chapter the secondary minerals of the "banket" are described. These are especially numerous, and include quartz, chloritoid, chlorite, sericite, tourmaline, rutile, anatase, calcite, dolomite, carbon, pyrite, and gold. Several of them are strongly suggestive of hydrothermal action, and are doubtless rightly ascribed to the operation of magmatic waters emanating from the igneous intrusions. Particularly interesting are the carbon and pyrite, and the vexed question of their origin is discussed at some length. The rounded forms often shown by them, which have caused them to be regarded as original constituents, are referred to concretionary growth and to the pseudomorphous replacement of water-worn pebbles or grains. The gold never shows detrital form, its boundaries being either crystalline or very irregular. Moreover, it is often so intimately associated with certain of these undoubtedly secondary minerals, especially the two just mentioned, that in its present condition, at any rate, a secondary origin must be ascribed to it.

The fourth chapter deals with the sedimentary and igneous rocks with which the "bankets" are associated. Secondary mineralisation is shown to have affected not only the gold-bearing conglomerates, but also the sediments in which they are enclosed, and in many cases a definite connection can be established between this mineralisation and the igneous intrusions.

The concluding chapter is devoted to the geological history of the "banket" and to the much-discussed question of the mode of origin of its gold. The original deposition of the conglomerates has been variously assigned to lacustrine, fluviatile, deltaic, and marine agencies. A marine origin has been most generally favoured, and is here supported. With regard to the genesis of the gold, the well-known "placer," "infiltration," and "precipitation" theories are outlined. The last, in agreement with prevailing opinion, is regarded as untenable. The author, at one time an advocate of the second theory, is now led to adopt that modification of the first to which so many who have followed the controversy have been attracted of late years, viz. that the "bankets" are ancient and highly modified "placers" in which the originally detrital gold has been dissolved by high-temperature solutions and redeposited. This has entailed the loss of its detrital form, and the assumption of the crystallised state and the association with secondary minerals which it now exhibits. There is much to be said for this view, since it reconciles the facts which point to a "placer" origin with those which prove deposition from solution, and from which "infiltration" of the gold from outside has been erroneously inferred.

The author is to be congratulated upon his remarkably fine series of illustrations. The collection and preparation of the material for these must have involved the expenditure of much time and labour. They add greatly to the value and interest of the volume. C. G. C.

MUNICIPAL ENGINEERING.

Municipal Engineering Practice. By A. Prescott Folwell. Pp. xi+422. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1916.) Price 16*s*. 6*d*. net.

THE author defines the purpose of municipal engineering to be the planning, constructing, and maintaining of the publicly owned features and utilities of a city. He points out that its practice must conform to natural laws and legal enactments. A municipal engineer, therefore, should be acquainted with various branches of science and engineering. There is not much reference to scientific principles in this treatise; it is mainly a clear and interesting descriptive account of the methods and devices of city engineering, and that entirely from an American point of view. The large subjects of water supply, sewerage, and street-paving are fully dealt with in other text-books, and are omitted or slightly discussed, but the author thinks that information as to street cleansing, comfort stations, and similar matters is not readily available, and that city planning, street lighting, etc., require treating from the point of view of the taxpayer and the city engineer.

Methods of estimating and forecasting population are described, and some striking statistics are given of the growth of American cities. In a chapter on town-planning, the chequer-board, ring, and radiating systems of streets are examined, and an account is given of broad roads divided for automobile, truck, and street railway services. As might be expected, the construction of streets in the States is often less satisfactory than here. For instance, in St. Paul there are 321 miles of plank footways, which have a life of only three to six years. It is significant that judgment suits for accidents occurring on them cost the city nearly 3*l*. per mile per annum. Concrete footways are now most generally adopted with concrete kerbs.

There is a good chapter on surveys in cities, which are very systematically carried out in America, and plotted records of all the surface and sub-surface structures are preserved. In some cities a large use is made of photographic records, one purpose being to preserve records which may be valuable in future lawsuits. Sprinkling macadam or gravel roads with oil once to three times a season is a practice said to have become quite general, but we think is unknown here except in the different form of tar spraying. The oil is said to be distributed by an ordinary water-sprinkling cart. The disposal of city waste and the laying out of parks and planting shade trees are amongst other subjects described.

A MANUAL ON EXPLOSIVES.

A Short Account of Explosives. By A. Marshall. Pp. viii+96. (London: J. and A. Churchill, 1917.) Price 5*s*. net.

THE two volumes comprising the second edition of Mr. Marshall's treatise on explosives have been recently reviewed in these columns, and the present small book consists of a condensation of parts of the larger treatise in order "to present in a clear and simple manner the main facts concerning explosives and their properties."

After a short introductory chapter, the author deals in the succeeding six chapters with the preparation and properties of black powder and similar mixtures, nitrocellulose, nitroglycerine, military and commercial high explosives, and smokeless powders. Another chapter is given to fireworks, and the remaining three chapters to the properties of explosives, ignition and detonation, and precautions to be taken in the manufacture, handling, and storage of explosives.

Referring to the large Congreve war-rocket of 24 lb. weight, which was used with good effect at Copenhagen, Walcheren, and Leipzig, Mr. Marshall expresses the opinion that the future may see its use revived. Its great defect is stated to be want of accuracy, but an obvious disadvantage is that rockets carry their own propulsive charge, so that for a given destructiveness they have to be relatively very heavy. Trials have been made by the Germans in the present war, but rockets are unable to compete with guns, howitzers, and trench mortars.

In his concluding pages Mr. Marshall deals briefly with the poisonous properties of certain explosives, and thus in the smaller volume meets one of the few points of criticism in the review of his large treatise. He says that in the case of trotyl (T.N.T.) it is apparently that absorbed through the skin which is especially injurious; it passes in a combined form into the blood, and in some cases is eliminated from the system only very slowly. Hence the necessity for scrupulous attention to cleanliness.

Mr. Marshall has produced a very readable and interesting synopsis, and his small volume will undoubtedly prove of considerable service to those who require only an outline of the subject in connection with their work, and of interest to the general reader who wishes to enlarge his store of useful knowledge in a subject of such present-day interest.

OUR BOOKSHELF.

The Discovery of America, 1492–1584. Edited by P. F. Alexander. (Cambridge Travel Books.) Pp. xviii+212. (Cambridge: At the University Press, 1917.) Price 3*s.* net.

THIS volume is one of a series which aims at illustrating the history of geographical discovery by means of selected voyages and travels. The books are intended for use as school readers as aids in the teaching of geography. With this end in view, spelling and punctuation have been modernised, though archaic words have been kept. A list of some dates in the history of geographical discovery and a few notes have been added. The present volume contains the first three voyages of Columbus, Sir Humphrey Gilbert's voyage of 1583, the voyage of Amadas and Barlow to Virginia in 1584, and Jacques Cartier's voyage to the St. Lawrence. There are a number of illustrations reproduced from old prints and woodcuts, and a few useful sketch maps. So far as the plan of the series goes, the present volume is well executed, but it is a little difficult to see what place such a book can find in the school curriculum. The English and style are scarcely suitable for the teaching of reading, while the geographical knowledge to be derived from the voyages is not sufficient to warrant the use of the volume as a text-book in geography. The limited time devoted to geography in most schools could be more profitably utilised. We trust, however, that some use may be found for the series.

Foods and their Relative Nourishing Value. By Prof. W. H. Thompson. Second edition. Pp. 38. (Dublin: At the University Press, 1917.) Price 4*d.* net.

IF the British public has not acquired by the end of the war the art of adjusting its diet on rational and scientifically correct lines, it will not be for lack of sound instruction and good advice. There are no very definite external signs as yet of any widespread reform in this direction in the feeding habits of the mass of the people, but the popularity of food literature is evidence at least that large numbers of people are desirous of acquiring information as to the possibilities of securing economy in food consumption without sacrifice of efficiency. Much of this literature is of the empirical cookery-book type and can scarcely survive the period of food stringency, but it is gratifying to find that a ready sale can be found for the more select and permanently useful literature in which the scientific principles which must underlie food economy are expounded for the benefit of the layman.

There are more pretentious works than, but none which gives as good value for the money as, this booklet by Prof. Thompson, which now appears in a revised, second edition. All the essential information is conveyed in its few pages in concise, lucid form, and is supplemented by a considerable range of diagrammatic and other illustrative matter. The modern views as to the essentials of adequate nutrition are clearly presented without the use of technical terms beyond the "protein" and "Calorie" which are fast acquiring a place in the popular vocabulary. The booklet is supplied to the public at the net cost of issue, and Prof. Thompson is to be congratulated upon the response which his generosity has already achieved.

A Rumanian Diary, 1915, 1916, 1917. By Lady Kennard. Pp. vii+191. (London: William Heinemann, 1917.) Price 5*s.* net.

THIS small volume is nothing more than it claims to be, a diary of life in Bukarest and Jassy before and after Rumania's entry into the war. It touches a phase of the war about which little has been heard in this country. Whatever merits it has are due to its vivid descriptions of conditions in Rumania, written from day to day when anxiety and hope, uncertainty and despair were the daily lot of the author. We gather that most of the diary was written by Lady Kennard, but that after she left Rumania she drew on letters from her friends to complete the story. There are no new facts in the book, but it should be read by anyone who wishes to realise what the intervention of Rumania cost that unhappy country and to what a sad plight she was reduced by the enemy invasion. The volume is illustrated by a few photographs.

How to Collect and Dry Flowering Plants and Ferns. By H. S. Thompson. Pp. 56. (London: G. Routledge and Sons, Ltd., 1917.) Price 7*d.* net.

THESE practical hints on collecting, drying, and mounting plants will prove of real service to young botanists. The author recognises the improvement in the teaching of botany which has taken place in recent years, especially in secondary schools, and realises the importance of basing instruction, where possible, upon living specimens; but he makes out a good case for the herbarium, and we hope his booklet will meet with the success it deserves.

LETTERS TO THE EDITOR.

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Resonance Radiation and the Quantum Theory.

IN the *Philosophical Magazine* for September, 1916, Dr. Silberstein has made an attempt to explain the resonance radiation of iodine vapour on the basis of classical dynamics by assuming that the resonator is non-Hookean—*i.e.* that its restitutive elastic force is not simply proportional to the displacement. On this theory, the principal lines in the resonance series should appear at constant frequency-intervals, and to support this view Dr. Silberstein has given a tabular statement of the frequencies and their differences, based upon the work of Prof. R. W. Wood. A critical examination of the figures shows, however, that the frequency-intervals are by no means constant, but have a decided tendency to decrease on the long wave-length side. This has, indeed, been remarked upon by Prof. Wood himself (*Phil. Mag.*, October, 1912). I find on calculation that it is *not* the frequencies themselves, but *their square-roots*, that show constant decrements in the series. The following table, prepared from Prof. Wood's data (*loc. cit.*, p. 684) for the mercury green line excitation, demonstrates this clearly:—

Serial No. n	Frequencies ν_n $10^{10}\times$	$\frac{\nu_0-\nu_n}{n}$ $10^{10}\times$	$\frac{\nu_0^{1/2}-\nu_n^{1/2}}{n}$ $10^{5}\times$
0	54937·5	—	—
1	54279·0	658·5	141·0
2	53646·9	645·3	138·5
3	53013·0	641·5	137·0
4	52386·0	637·8	137·7
5	51759·0	635·7	137·6
6	51144·0	632·3	137·3
7	50523·0	630·7	137·4
8	49911·0	628·2	137·3
9	—	—	—
10	48696·0	624·1	137·2
11	48096·0	621·9	137·1
12	47493·0	620·4	137·2
13	46902·0	618·1	137·2
14	—	—	—
15	45726·0	614·1	137·1
16	45147·0	611·9	137·0
17	44562·0	610·3	137·1
18	43983·0	608·6	137·4
19	43419·0	606·2	136·9
20	42855·0	604·1	136·9

The constancy of the figures in the last column over twenty lines seems altogether too striking to be accidental, and rather suggests an analogy with Moseley's law for the high-frequency spectra of the elements, according to which the square-roots of the frequencies of the K and L characteristic radiations increase by equal steps with the atomic number of the element—that is, on Sir E. Rutherford's theory, with the charge on the nucleus. If, in the same element, we imagine a configuration (permanent or quasi-stable) of the atom, in which the electrons revolve in successive concentric rings, the effect of the nucleus and all the other electrons on any one electron may be approximately represented by a single nucleus of proper equivalent charge; and a mechanism in which this equivalent charge, corresponding with the successive electrons in the atom, varies by successive equal steps would, on the quantum theory, exhibit the phenomena of resonance radiation, as in the case of iodine vapour. It seems possible that this idea may find application in the fuller development of Bohr's theory of spectral series.

T. K. CHINMAYAM.

210 Bow-Bazar Street, Calcutta, October 15.

An Optical Phenomenon.

IN addition to the accounts in NATURE referred to by Mr. J. W. Giltay in your issue of November 22, the phenomenon mentioned by me in NATURE of October 18 had previously been far more fully described by Dr. John Aitken in a paper "On a New Variety of Ocular Spectrum" in the *Journal of Anatomy and Physiology*, vol. xiii., p. 322; and, as stated in this paper, the phenomenon noticed by Mr. C. Carus Wilson (NATURE, October 25), when travelling by train in a rear coupé compartment, was described by Prof. Silvanus Thompson in the report of the British Association for 1877. Dr. Aitken experimented with rotating discs divided into about twenty-four sectors, white and black alternately, and with endless bands of paper with black bars painted across them. A convenient way of viewing the apparent motion was to look at a sheet of mottled paper, after looking at the rotating disc or moving band, when the markings on the paper appeared to move in a contrary direction to the exciting impression. Though some of the mottlings seem to flow past the others, it was found by Dr. Aitken that a straight line drawn across "the spectral stream" did not appear to be bent, as one might have supposed would be the case. If, after viewing the rotating disc, another similar disc or the drawing of a wheel is looked at, the second disc or the wheel appears to rotate in a contrary direction to the first; but if the second disc is larger than the first, or the spokes of the wheel are extended to a greater size than the rotating disc, "this extension will entirely destroy all appearance of rotation, and the wheel will appear at rest. Do not these last experiments suggest that the seat of illusion is deeper than the retina?"

C. J. P. CAVE.

December 3.

THE CONTROL OF THE NON-FERROUS METAL INDUSTRIES.

BEFORE the war the world's markets for the majority of the non-ferrous metals were very largely controlled by a group of German metal companies engaged primarily in buying metals and acting as selling agents for producers. How complete this control was few people knew. The outbreak of war disclosed it in all its formidableness. The most important of these concerns was the Metallgesellschaft of Frankfort-on-the-Main. This place was the centre of certain German financial interests which had combined to establish the Metall Bank and the Metallurgische Gesellschaft. In one way or another this great organisation had established financial interests in metal undertakings, not only in Germany and Austria, but also in the U.S.A., the United Kingdom, and various parts of the British Empire.

This enormously powerful group of companies controlled the world's metal markets, of which Frankfort became the centre. Their connections with other undertakings and their ramifications were exceedingly complicated and difficult to control. In some instances there was a direct financial connection; in others the connection was established by some form of agreement. But whatever the method there was no doubt about the ascendancy acquired by the Germans. The case of lead may be cited as an example. Before the war the Germans were, by means of the so-called Lead Convention, which they organised, placed in complete control of the lead trade of the world. Attempts were also being made to secure the control of all the free lead of the world. As regards zinc the position has already been described in the columns of NATURE (October 19, 1916). At the outbreak of war this control was a source of great embarrassment to the Government, and for quite two years afterwards the cause of this country and its Allies was severely handicapped because we were without the necessary metal supplies, and many trades were in jeopardy. Had not the U.S.A. come to the rescue in supplying these deficiencies, particularly as regards copper, zinc, and lead, it is very doubtful whether the Allies would have been able to avoid defeat.

In order to obtain the best expert advice on the problem of how to meet this difficulty in the future, the late President of the Board of Trade appointed a strong committee composed of representatives of this country, and to this Sir Albert Stanley, the present occupant of the position, added three members representing respectively Canada, Australia, and South Africa. According to the statement made by him in moving the second reading of the "Non-ferrous Metal Industry Bill" in the House of Commons on December 3, the Committee came to the conclusion that an essential preliminary condition of the successful organisation of any counter-measure was to secure, at all events for a period after the war, that all trace of German influence and association—direct or indirect—should be eliminated from any undertaking allowed to do business *in* this country. The Bill aims at achieving this object.

Clause 1 provides that it is unlawful to deal in certain metals and ores without a licence. The licences to be granted are renewable annually. Clause 2 gives the Board of Trade power to require certain information and to inspect the books and documents of persons or firms who apply for, or obtain, licences. Clause 3 provides for certain penalties for contravention of the Act. Clause 4 empowers the Board of Trade to make rules for carrying out the Act, and Clause 5 specifies the metals and ores to which the Act applies. The Act is intended to be in force during the war and for five years after its termination. The President of the Board of Trade stated that the measure is designed, not in the interest of "the trade," but in that of the nation, and that the control of metals which are so essential to the development of British industries must not be allowed to fall again into German hands after the war. He also claimed that the power of control given by the Bill will be a distinct step towards securing our economic freedom.

The discussion took a somewhat curious course. The rejection of the Bill was moved by Mr. J. M. Henderson, but his amendment was not seconded, and, therefore, was not put from the chair. Later the rejection was moved by Sir F. Banbury, and this was seconded. Finally, the debate stood adjourned. The discussion was resumed on Tuesday, December 11, when, in a division on the amendment that the Bill be rejected, there voted against the rejection 182, and for it 79, giving a majority of 103 against rejection. The result was that the Bill was read a second time.

H. C. H. CARPENTER.

THE RÔLE OF SELECTION IN EVOLUTION.[1]

ABOUT the beginning of the twentieth century the current of doubt as to the evolutionary importance of processes of selection grew rapidly in strength, and swept not a few naturalists off their feet. Bateson and De Vries produced evidence of the frequent occurrence of discontinuous variations or mutations; De Vries began methodical testings of what selection could do in the course of years with maize, buttercups, striped flowers, and four-leaved clover—the general outcome being that it did not do very much; and Johannsen, working carefully on "pure lines" of beans, which are self-fertilising but show fluctuating variation in the size of the seed, proved that selection continued generation after generation in a particular direction may be without result, so far as any change in average seed size is concerned. These and other considerations led to a depreciation of the importance of selection processes. As Prof. W. E. Castle says in a very interesting pronouncement:—

> In the minds of many biologists at the present time selection is an obsolete agency in evolution, and an adequate explanation of evolution is to be found only in mutation and pure lines. I believe this to be a mistaken view, not because mutation and pure lines are false, but because their applicability is very limited compared with the broad field of organic evolution. To universalise them is to hide the world by holding a small object close to the eye.

As De Vries has always insisted, mutations come we know not how, but selection determines which must go and which will stay. According to Darwin, new types are for the most part established gradually; according to De Vries, they arise abruptly. According to Darwin, new types are for the most part plastic; according to De Vries, new types are fully stable. According to Darwin, one evolutionary change follows upon, and is made possible by, another; according to De Vries, one evolutionary change has no necessary relation to another. According to Darwin, natural selection determines what classes of variations shall survive, and, in consequence, what shall be the variable material subjected to selection in the next generation; according to De Vries, natural selection determines only what classes of variations shall survive, and exercises no influence on the subsequent variability of the race. According to Darwin, the further evolution of our

[1] Journ. Washington Acad. Sci., vii. (1917), No. 12, pp. 369–87.

domestic animals and cultivated plants (and of man himself) is to some extent controllable, because we can by selection influence the variability of later generations; according to De Vries, evolution is beyond our control except as we discover and isolate variations. Thus does Prof. Castle contrast the two sets of views, which "remind us somewhat of the theological ideas of free-will and predestination respectively." But which view is right?

The evidence from palæontology, geographical distribution, and classification tends on the whole in favour of the Darwinian view that "evolution as an age-long process has been gradual and progressive, not abrupt and unguided," but the evidence from experimental breeding leans to either side. The mutationists hold that selection "can do nothing but isolate variations which may sporadically put in an appearance or which may by hybridisation be brought together into new combinations." The selectionists, with whom Prof. Castle ranks himself, maintain that selection "can accomplish more than the mere isolation of variations, because it can, by a series of selections, influence further variability." How is one to decide?

Prof. Castle considers carefully the attempts that have been made to generalise Johannsen's brilliant discovery of the principle of "pure lines," and shows that this is not warranted. In the case of certain characters in guinea-pigs he has himself found that a *ne plus ultra* is reached which cannot be changed by selection in an inbred race. "Thus a very dark form of Himalayan albino, after a certain amount of improvement by selection, could not be further darkened to any appreciable extent." On the other hand, certain characters of guinea-pigs, rabbits, and rats have been found to respond readily to selection in a particular direction. Prof. Castle's experiment with hooded rats "selected simultaneously in *plus* and *minus* directions has produced one race which is black all over except a white patch of variable size underneath, and another race which is white all over except for the top of the head and the back of the neck, which are black. The races do not overlap at all, and have not done so for many generations, though they still continue to diverge from each other as a result of continued selection."

It comes to this, that divergent conclusions are in part due to the data utilised.

"A study of albinism alone would lead one to believe in the fixity and constancy of Mendelian genes and the impossibility of modifying them by selection." But "in the case of such characters as white spotting in mammals, it is evident that a change in the mean of the character in a particular direction in consequence of selection actually displaces in the direction of selection the centre of gravity of variation, so that in a very true sense selection makes possible further variation in that same direction."

Selection cannot start new lines of variation, but it can continue and extend variation already initiated. J. A. T.

THE FUTURE OF THE TRADE IN COLONIAL RAW MATERIALS.

It is now well known that before the war large quantities of raw materials produced in the British Colonies found their way in the first instance to Germany, where they were converted into manufactured products, of which considerable quantities were then exported from Germany to this country and other parts of the Empire. Most people are now of opinion that this indirect method of trading should not be resumed after the war, and that these intermediate processes of manufacture should be carried on in this country, or at least within the Empire. It has also become clear, especially in the last few months, that immediately after the war there will be great competition among all the manufacturing countries for supplies of raw materials, and probably most people in the Allied countries, who realise that the Allies effectively control the bulk of the world's supplies of such materials, are of opinion that the Allies should utilise this advantage to meet their own requirements first.

There can be little doubt as to the trend of public opinion on these points, but it is not at all clear what action, if any, is being taken to give effect to it, except in the one case of West African oil-seeds, which was investigated by a special committee appointed by the Colonial Office in 1915. That committee recommended the imposition of an export duty on palm kernels exported from British West Africa to be crushed in countries outside the Empire, and this recommendation was adopted by the Secretary of State for the Colonies, with the result that the palm-kernel crushing industry established in this country since the war is likely to remain here in future. The publication of the results of the British committee's investigations has apparently stimulated the Colonial Institute at Marseilles into conducting similar inquiries into the sources of supply of the raw materials which form the basis of two of the chief industries carried on in Marseilles, namely, oil-seeds and cereals.

Committees have been appointed by the Marseilles Colonial Institute to investigate these two groups of raw materials, and the Oil-seeds Committee has already published two special bulletins. The first of these contains the report (in French) of the British West African Oil-seeds Committee, and the second gives a *résumé* of some of the evidence taken by that committee, a translation of a portion of the Imperial Institute monograph on oil-seeds and feeding-cakes (Murray, 1915), and some preliminary information regarding the work of the French committee. The latter is first taking up questions connected with the trade in ground nuts, the most important oil-seed crushed in Marseilles; and the bulletin contains evidence for and against the decortication of ground nuts before shipment, a matter of first-rate importance in connection with the ground-nut trade of India. Hitherto, it has been held that ground-nut oil of edible quality cannot be made from ground nuts shelled in the country of production and exported in the form of kernels, the argument being that the oil in such kernels must always contain too much free fatty acid. It is clear from the French bulletin, however, that lack of tonnage, if nothing else, is now forcing French oil-seed crushers to reconsider this question and to find means of importing ground-nut kernels in good condition.

In a recent number (No. 86 of 1917) of *L'Expansion Coloniale* M. Emile Baillaud, to whose activity the Marseilles Colonial Institute owes much of its prestige in France, discusses the problems which these French committees on cereals and oil-seeds will take into consideration. From this it appears that the committees are faced with much the same problems as those mentioned in the first paragraph of this article, viz. that French, like British, manufacturers have not been able to take up new oil-seeds, but have largely left the initiative in such matters to Germany, and that they have not utilised and developed sources of supply in their own colonies. It will be the chief object of the committees to ascertain how this state of things can be remedied. It is interesting in this connection to note that M. Baillaud has a proper appreciation of the necessity for technical investigations, and suggests that the Committee on Oil-seeds will require to initiate investigations similar to those carried on for some years past on the oil-palm by the Imperial Institute in this country in co-operation with the Departments of Agriculture in British West Africa.

NOTES.

As an outcome of the Departmental Committee on the Welfare of the Blind, which recently issued an excellent report, the President of the Local Government Board (Mr. W. Hayes Fisher) has appointed a Committee to advise the department on matters relating to the care and supervision of the blind. The selection of members appears to have been made with discretion, except that, as pointed out by "Ophthalmic Surgeon" in a letter to the *Times* of December 8, there is no medical man or ophthalmic surgeon upon the Committee. The original Committee had an ophthalmic surgeon among its number, and applied to the Royal Society of Medicine for assistance in its deliberations. A Sub-Committee of the Ophthalmological Section was appointed, and devoted much time and trouble to the subject. The report shows that it afforded very material help. Mr. Hayes Fisher, writing to the *Times* of December 11, excuses himself for the absence of any medical representation on the Advisory Committee by saying that "nine-tenths of the Committee's time will be taken up with the consideration of administrative problems," and that "under existing circumstances it would not be right to make a further demand upon the time of any of our eminent ophthalmic specialists, who are already so fully occupied." The courteous terms in which this letter is couched will doubtless be appreciated by the Royal Society of Medicine and the medical profession generally, but they do not succeed in masking the characteristic official attitude. Ophthalmic surgeons themselves are the best judges of the time which they have at their disposal, and the ordinary amenities of social life should have suggested that they at least should be consulted and offered the opportunity of giving their assistance when it is proposed to put their recommendations into action.

THE project, which has been in abeyance for some considerable time, for a ship canal across the Scottish isthmus lying between the Firth of Forth and the Firth of Clyde has lately been revived, partly in consequence of the direction of military opinion towards the strategical value of such a waterway in time of war, and partly also on account of the substantial commercial advantages which would accrue generally. A question on the subject was recently put in the House of Commons, and Dr. Addison, in reply, stated that the matter was under the consideration of the Department of Reconstruction in view of the opening afforded for the utilisation of the labour of demobilised men for the execution of the undertaking. We observe, in the issue of *The Engineer* of November 30, an interesting account of the inception and development of the underlying idea, which was promulgated, in the first instance, so far back as the year 1724 by Daniel Defoe. At present there are two schemes which have been elaborated. The first consists in linking up the rivers Forth and Clyde by the most direct route through the Kelvin valley. The second route, avoiding the congested district of the Upper Clyde, lies along the Forth valley, leaving the river channel near Alloa and ultimately reaching Loch Lomond by means of Endrick Water. A short auxiliary connection between Loch Lomond and Loch Long at Arrochar would then complete the passage to the sea. The broad difference between the two routes is that the Loch Lomond route would be at the loch level, while the direct route would be at the level of high water of spring tides. Exigencies of space forbid us to attempt even a summary of the relative advantages and difficulties of the rival schemes, each of which has its convinced supporters.

WE regret to learn that Dr. A. M. W. Downing, formerly superintendent of the "Nautical Almanac," died suddenly on Saturday, December 8, at sixty-seven years of age.

LADY ROBERTS'S Field Glass Fund, which has now issued 30,000 instruments to the Army, has no funds beyond the sum necessary for returning the glasses to their owners when this is desired. The main expense is that of repairing the glasses which come back for re-issue. An appeal is made for the sum of 1000*l.* to meet the repairing bills, and the need justifies the request. The address for sending contributions (also any field-glasses and telescopes that can still be spared) is the Manager, Lady Roberts's Field Glass Fund, 64 Victoria Street, S.W.1.

THE Executive Committee of the Automobile Association has decided to offer a prize of 1000*l.* for the best invention which will enable coal-gas to be used with advantage as a propellant of motor-cars and motor-cycles. Communications relating to this subject should be addressed to the Secretary, Automobile Association and Motor Union, Fanum House, Whitcomb Street, W.C.2, and marked "Coal Gas."

IT was announced at the Linnean Society of London on November 29 that a new Linnean Society has been established recently in Sweden as "Svenska Linné-Sällskapet," intended as a means for spreading information about Sweden's greatest naturalist, Carl von Linné (1707–78). The society purposes to do this by publication of works by Linné and his pupils; to throw new light from modern viewpoints on Linné's personality; to draw up a catalogue of all known memorials; and to found a complete Linnean library. The president is Dr. Tycho Tullberg, a lineal descendant of Linné.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Prof. J. A. Fleming, a course of six experimentally illustrated lectures, adapted to a juvenile auditory, on "Our Useful Servants: Magnetism and Electricity"; Prof. W. M. Flinders Petrie, three lectures on Palestine and Mesopotamia—discovery, past, and future; Prof. Arthur Keith, three lectures on the problems of British anthropology; Dr. Leonard Hill, two lectures on (1) the stifling of children's health, (2) the climatic adaptation of black and white men; Sir R. T. Glazebrook, two lectures on the National Physical Laboratory; Sir Napier Shaw, two lectures on illusions of the atmosphere; Prof. W. J. Pope, two lectures on the chemical action of light; M. Paul H. Loyson, two lectures on the ethics of the war; Sir J. J. Thomson, six lectures on problems in atomic structure. The Friday meetings will commence on January 18, when Sir James Dewar will deliver a discourse on studies on liquid films. Succeeding discourses will probably be given by Prof. J. Townsend, Prof. A. S. Eddington, Principal E. H. Griffiths, Prof. A. G. Green, Prof. E. H. Barton, and Sir J. J. Thomson.

IN the October issue of the *Agricultural Journal of India* (vol. xii., part iv.), Mr. Wynne Sayer discusses the present position of sugar manufacture and the measures required to place it upon a permanently sound basis. Notwithstanding the present high price of sugar, there is an actual decline in cane cultivation in India, notably in Bengal. Various reasons are propounded for the moribund state of the Indian white sugar industry, such as the predominance of low-grade varieties of cane, the popularity of unrefined sugar or *gur*, minute subdivision of the land, and the competition of crops, such as paddy, jute, and cotton; but it is urged that the greatest difficulties arise from the grossly inefficient manufacturing methods used. Where modern, well-managed factories exist, Indian sugar can be produced at a sufficiently low cost to compete with foreign sugar. Great improvements are also required in the *gur* industry, where inefficient methods commonly reduce the possible output by 35 to 50 per cent. Immediate action is urged with the view of placing both the *gur* and the white sugar industries on a satisfactory basis. The nomination of a strong committee of experts is suggested for the purpose of carrying out a survey of the sugar-producing areas and of considering the extent to which State assistance to the pioneer factories may be needed.

IN the September-October number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* Prof. Marcel Brillouin discusses the question of the desirability of establishing in Paris a research and test laboratory for the musical instrument trade. He submits that any experiments carried out by individual firms have a value that is strictly limited to the manufacturers concerned. Further, such researches are not available to the majority. The laboratory which he now proposes should be created, at the common expense of all musical instrument makers, would comprise three sections: (1) Raw materials; (2) instrumental acoustics; and (3) testing and verifying. The laboratory would be staffed by a certain number of physicists qualified by their training to carry out the work satisfactorily. Section (1) would deal with the physical and mechanical properties of every raw material entering into the composition of pianos, and string, wood-wind, and wind instruments; section (2) would deal with researches in sound as applied to instruments, utilising the theories of Helmholtz, Rayleigh, Stokes, Gouy, Hugoniot, and others; while section (3) would consider methods of checking and testing instruments and their parts and implies the close co-operation of manufacturers. Hitherto German manufacturers—especially of pianofortes—have made very extended use of the results of Helmholtz and other authorities on sound, and it is claimed that the suggested new institution would go far, by utilising existing knowledge, to obtain empirical data which, in combination with the artistic (as applied to tone-quality) peculiarities of individual firms, could not fail to improve the quality of musical instruments in general.

THE death is announced, in the German Army Geological Service, of Prof. Fritz Daniel Frech, professor of geology and palæontology in the University of Breslau. Born in Berlin on March 17, 1861, Prof. Frech was educated in the University of that city, and graduated as Ph.D. in 1885. His thesis dealt with the coral-fauna of the Upper Devonian rocks of Germany, and he devoted his life to the study of fossil invertebrata, with special reference to their use in stratigraphical geology. For a few years he was engaged on the geological survey of Prussia, and among his early publications was an official memoir on the geology of Nassau (1888). In 1893 he was appointed successor of Prof. Ferdinand von Roemer in the University of Breslau, and he immediately began to direct most of his energies to the great compendium of stratigraphical geology which von Roemer had planned and just begun under the title "Lethæa Geognostica," following a similar work of earlier date by Bronn. Prof. Frech himself wrote the greater part of the section relating to Palæozoic formations and the whole of the volume describing the Trias, besides editing some sections of later parts of the treatise by other authors. So far as completed, this is the most exhaustive and useful work of reference on stratigraphical geology that has hitherto appeared, and is full of interesting generalisations based on broad views and wide experience. A few years ago Prof. Frech planned another important work of reference, a "Fossilium Catalogus," intended to comprise a systematic list of all known fossils, critically compiled with full quotations of literature by a series of specialists. He himself contributed the section on Devonian Ammonoidea and edited a few other sections, but, as publication did not begin until 1913, little progress has naturally been made. In 1913 Prof. Frech also succeeded Prof. Ernst Koken as one of the editors of the *Neues Jahrbuch für Mineralogie.* His energy was equalled by his ability, and geological science is distinctly the poorer by his loss.

THE contrast between Oriental and Western thought is well illustrated by a curious list, published in *The New East* (vol. i., No. 5), entitled "190 Things Japanese do differently." In Japan a man is free, woman carries the burdens; in the West "man acts as the packhorse for his lady." Japanese wear the thimble between the first and second joints of the middle finger of the right hand, Europeans on the tip of the middle finger; a Japanese tacks the kimono after, the European before, stitching. The Japanese mother-in-law is a terror to the bride; in Europe she is the husband's bugbear. The Japanese blow their noses with both hands; Europeans usually with one. The Japanese carpenter pulls at his saw; the European carpenter uses his triceps muscle rather than his biceps. Japanese take off their shoes, Europeans their headgear, on entering a house. Japanese say "four or three" where Westerns say "three or four"; and so on. If these facts were rearranged so as to exhibit the physical as well as the moral differences between Japan and Europe, the result might be of some scientific importance.

In a lecture delivered at the Calcutta Museum, reported in the *Pioneer Mail* of September 1, Mr. Percy Brown discussed Indian artistic metal work. The most valuable specimens were executed in the medieval period of Indian history—that is, from the eighth to the eighteenth centuries A.D. Mr. Brown directed special attention to the copper colossus of Buddha found at Sultanganj, in the Bhagalpur district, Bihar. This figure is practically unique and almost unknown. It has been traced with some difficulty to a provincial museum in England. This statue of Buddha stands alone, as several centuries separate it from the other statues of the northern school, which are of the Vishnuvite Hindu type, and belong to the eleventh century A.D. Another admirable piece of work is a little shrine discovered at Dacca, and now in the Indian Museum. It is only 9 in. in height, but for richness of design and finish of workmanship it is the best specimen of this school. It represents Vishnu with the goddesses Sarasvati and Lakshmi, and his symbols, the wheel, mace, conch, and lotus. The figures of the goddesses with their graceful attitudes form an admirable foil to the dignified conventional image of the god.

The new part of the Proceedings of the Prehistoric Society of East Anglia (vol. ii., part iii.) contains the usual profusion of beautiful drawings of flint implements and several noteworthy papers. Grime's Graves again receive much attention, and there is still a tendency to regard them as Palæolithic, but Mr. W. G. Clarke admits "that there is nothing in the knowledge available which actually precludes a Neolithic date for the Graves, and that there is a considerable amount of data concerning fauna and implements which supports that view." Mr. Henry Bury describes some interesting flat-faced palæoliths from Farnham, and discusses their possible relationship to the rostro-carinate implements of earlier date without any conclusive result. Mr. R. H. Chandler and Mr. J. Reid Moir contribute observations on the flaking of flints, and the latter author proposes that "flaking diagrams" of flint implements should be prepared to facilitate comparisons. Mr. R. A. Smith touches geological problems in his elaborate paper on plateau deposits and implements, showing the frequent difficulty of distinguishing between deposits formed by existing rivers and those due to an earlier distinct system of drainage. For students of man in the Stone age the number is indeed full of interest from all points of view.

The present condition of the Quichuas of southern Bolivia is briefly, but ably, summarised by Mr. L. E. Miller in the *American Museum Journal* for October. These people represent a part of the wreckage of the ancient Incan Empire left by the Spanish invaders. Of the physical characters of this tribe nothing, unfortunately, is said, but to the ethnologist this account will be most welcome. In the upper reaches of the Pilcomayo the Quichuas are still to be found in almost their primitive simplicity, both in the matter of customs and of dress. In the latter particular, indeed, they seem to have changed but little since the days of Atahualpa. No jewelry or ornaments of any kind seem to be worn, save huge, spoon-shaped pins of copper, used by the women to fasten their shawls. The llama, once their chief source of food and clothing, is now being replaced by sheep and goats. But the llama is still used as a beast of burden, and blankets of superb quality are still made of its wool. Unfortunately, the yoke of the Spaniard still presses heavily on these wretched people, and the author gives instances of the treatment they have to bear with what equanimity they may, for no redress is theirs.

The directors of the Wistar Institute, Philadelphia, have initiated a bibliographic service which will prove to be a great saving in time and trouble to all biologists. At the present time the leading biological journals of the United States—the *Journal of Morphology, Journal of Comparative Neurology, American Journal of Anatomy, Anatomical Record,* and *Journal of Experimental Zoology*—are managed and issued by the Wistar Institute. For the sum of three dollars per annum the directors of that institute undertake to supply index-cards, which, when filed, will serve as a subject index and an author index to all publications appearing in their journals. An outstanding feature of the scheme is the abstract of each paper, which is printed on the back of the author index-card.

The first number of the new *Journal of Urology* (Baltimore, Ind., U.S.A.; London: Cambridge University Press) has reached us. Its object is the publication of original papers on the physiology, pathology, and surgery of the urinary tract. It is published in the United States of America under the editorship of Dr. Hugh Hampton Young. The contents of the number before us are of a high order of excellence, and include such topics as the surgery of the ureters, the cultivation of tumours *in vitro,* the physiology of the ureter and vas deferens, the effect of the intravenous injection of various substances on the composition of the blood and urine, and on nitrogen metabolism. There can be no question as to its usefulness to those engaged in the special branch of medical practice with which it is concerned; but, at the same time, some doubt may arise as to the wisdom of the publication of papers on more general questions, such as nitrogen metabolism, presumbly because certain products of this chemical activity are excreted in the urine. It would seem that such questions as these belong more appropriately to the less special journals. A useful addition to the *Journal of Urology* would be a section devoted to the giving of the titles, and perhaps abstracts, of papers which bear on the special province of that journal, although they appear in other periodicals. There must be many such papers. The new journal is of attractive appearance and well illustrated.

The *Comptes rendus des travaux du Laboratoire de Carlsberg* (1917, vol. ii., part 6) contains an important article by Prof. A. Klocker on the preservation of fermentation organisms in nutrient media. Hansen's conclusion that a 10 per cent. solution of cane-sugar forms an excellent medium is confirmed, but beer wort is also very good. The Pasteur flask is undoubtedly the best form of vessel for prolonged preservation. The present observations were made, during a period of more than thirty years, on 820 cultures of yeasts and moulds. These included Saccharomycetes, Schizosaccharomycetes, Torulæ, Mycoderma, Endomyces, Monilia, Chalara, Oidium, and Mucor. For the most part the nutrient medium employed was a 10 per cent. solution of cane-sugar, in which 461 cultures were grown, but 290 cultures were made on beer wort and sixty-nine on other media. Of the 461 cultures on cane-sugar solution (231 of these being Saccharomyces) 403 survived, whilst 58 perished. In the case of the 290 cultures grown on beer wort (190 Saccharomyces) 268 survived and 22 perished. Thus it must be concluded that fermentation organisms can be kept alive for upwards of thirty years. The exceptions to this rule are:—(1) The asporogenic varieties of Saccharomyces; (2) *Saccharomycodes Ludwigii*; (3) Schizosaccharomyces; and (4) *Aspergillus glaucus*. Of the first only 44 per cent. survived on cane-sugar and 21 per cent. on beer wort, of the second only one in nine survived on cane-sugar for more than 7·5 years, but all five cultures on beer wort survived for twenty-five years. Only two out of five cultures of Schizosaccharomyces on cane-sugar survived, but ten out of eleven of those on beer wort were living. Of six cultures of *A. glaucus* only one survived, and two of the remaining five perished in less than two years.

THE first annual report of the Zoological Survey of India, a new and promising transformation of the Indian Museum Cinderella, contains a great deal of interesting information. New ground was broken in the Shan States, where the director of the survey, Dr. Annandale, personally superintended a survey of Lake Inlé. The basin of this lake is stated to have been formed by solution, in limestone rock, and to be filling up with silt and aquatic vegetation; the water is shallow and of extraordinary limpidity; floating islands are a notable feature; fishes of many new species were discovered, for three of which new generic definitions are necessary, among them a minute eel so peculiar as to require seclusion in a new family; the molluscs are scarcely less remarkable, and among them occurred a group of pond-snails interesting not only for the bizarre shape and bright colour of their shells, but also because an almost complete series of forms transitional between them and nearly normal forms was found in other parts of the lake, in other neighbouring waters, and fossil in the surrounding country. Mr. Kemp, superintendent in the survey, investigated the Mutlah channel of the Gangetic delta; this is a deep and permanent channel, and its waters, which are never very salt, are heavily charged with silt; a remarkable feature of its fauna is said to be the extraordinary resemblance of some of its fishes and crustacea to deep-sea forms, in colouring, in gelatinous translucency, and in filamentous feeler-like appendages. Dr. Chaudhuri, an assistant-superintendent in the Survey, paid a visit to certain large tanks in Seringapatam, where a century ago Buchanan-Hamilton obtained several species of fishes that have never since been brought to light; Dr. Chaudhuri was successful in rediscovering some of them. A feature of the report, as an official departmental publication, are the excellent illustrations.

MR. A. M. HERON (Mem. Geol. Surv. India, vol. xlv., part i., 1917, price 4*s*.) describes the results of a re-survey of north-eastern Rajputana, where the Archæan Alwar quartzites run south from Delhi and form hills with remarkably level crests. Some revision of the stratigraphical sequence is proposed; an "arkose" series is shown to be in reality a granite intrusive in the Delhi system; and the planing of the Alwar crests is interestingly ascribed to subaerial action going back to the Jurassic period. The deepening of stream-beds among dissected sandhills seems to point to a diminution of aridity in Rajputana.

AN elaborate memoir on "The Origin of Dolomite," by Francis M. van Tuyl, appears in the annual report of the Iowa Geological Survey for 1914 (1916), and would be important merely on account of its references to previous work. The author concludes that "the great majority of the stratified dolomites have had their inception in the alteration of limestones." He is unable to accept Klement's work at high temperatures, or Pfaff's at high pressures, as bearing on the natural problem, but agrees with Steidtmann and Wallace (see NATURE, vol. xciv., p. 459) that greater concentration of salts in the sea-water has much to do with dolomitisation of limestone already laid down. Illustrations are given from North American geology.

THE depredations of the boll weevil on the American cotton crop in recent years have led to the replacement of cotton-growing in large areas by the cultivation of groundnuts (*Arachis hypogaea*). According to *Agriculture* of March last, the value of the groundnut crop in the United States has increased in the eight years from 1908 to 1916 from twelve million to fifty-six million dollars. It has been found that by slight adjustments of machinery cotton-seed mills can be used for crushing groundnuts. An increasing proportion of the crop, however, is being utilised for food purposes in the uncrushed state. Efforts are being made by the Government to discover the best use for the groundnut and to popularise it with American kitchens, and experiments in progress under the auspices of the Chemistry Bureau of the Department of Agriculture are said to promise the production from groundnut meal of a bread equal in nutritive value and palatability to wheaten bread.

SCIENTIFIC PAPER 301 of the Bureau of Standards describes a calorimeter devised by Mr. N. S. Osborne, of the Bureau, for the determination of the specific heats and latent heats of evaporation of materials used in refrigerating machines, *e.g.* ammonia, carbon dioxide, sulphur dioxide, methyl and ethyl chlorides. Ammonia has already been investigated over the temperature range −40° C. to 40° C.; the other substances are to be dealt with and the results published later. The calorimeter is of thin steel, about 4 cm. in diameter and 10 cm. long, with a central electric-heating coil. It is enclosed in a steel jacket capable of withstanding a considerable pressure. The temperature of the calorimeter is measured by means of a platinum thermometer, and the jacket is maintained at the same temperature as the calorimeter to diminish heat losses. The measurements already made show that an accuracy of one part in a thousand can be secured.

THE difficulty of getting coloured lines in exact juxtaposition and of sufficient fineness for the purposes of colour photography has, according to *La Nature* for November 10, been completely overcome by M. Louis Dufay, who is associated with the brothers Lumière. The method is to pass a thin celluloid film between two rollers warmed sufficiently to render the celluloid plastic. One of the rollers has very fine circumferential parallel grooves of square section cut upon its surface, and thus the celluloid has similar grooves formed upon it. The film is then coated with a coloured transparent fatty mixture and wiped off after the manner of wiping an etched plate after inking and before taking an impression from it. The film is next treated with an alcoholic solution of another colour, and this penetrates the exposed surface of the celluloid. Thus there are formed alternating coloured lines in perfect juxtaposition, which may be of a fineness as great as thirty lines to the millimetre. If the film is thin enough to permit it without introducing the possibility of parallax, the other side of it may be similarly treated, either simultaneously or afterwards, so that two other colours may be introduced, or these may be added in the form of any microscopic figures that may be preferred. Three double pairs of colours are given: (1) yellow and blue, red and green; (2) yellow and red, blue and orange; (3) red and blue, yellow and violet.

ATTENTION may be directed to a useful collection of data respecting the absorption of atmospheric gases by water, given in a paper contributed by Mr. J. H. Coste to the Journal of the Society of Chemical Industry for August 15. As regards the significance of the gases dissolved in natural waters, the conclusion is that water freely exposed to the air should, and does, contain the proportion of gases of the air corresponding with the temperature and saline content of the water, provided these have not been recently changed. In respect of oxygen, all the ascertained facts show that if water is found to contain very much less of this gas than the saturation-value for the particular temperature in question, a strong presumption is raised that the water contains matter undergoing oxidation. Since, however, the water may have recently fallen in temperature, the deficiency of oxygen may be only an apparent one, due to the fact that equilibrium between the atmospheric gases and the dissolved gases has not yet been established under the new conditions. In such cases, therefore, the point can only be settled definitely by determining the nitrogen—the constituent which, so far as is known, is not taken up chemically by anything in the water. It appears that slow non-tidal streams will give unpleasant signs of the presence of decaying matter at much higher degrees of aeration than deep streams with strong tidal currents. This is probably due to a variety of causes, such as slowness of downward diffusion in the less rapid streams, and the accumulation of undisturbed mud which, in fermenting, gives off gases that have but little opportunity of being absorbed in their passage upward through the layer of relatively still and shallow water of the slow non-tidal streams. No fewer than seventy-six references are included in the bibliography of the subject given by the author.

THE Engineering Experiment Station of the University of Illinois has published a brief report upon experiments on the utilisation of pyrites occurring in Illinois bituminous coal, drawn up by Mr. E. A. Holbrook. It appears that some of the Illinois coal seams contain bands, nodules, or lenses of pyrites in considerable quantity; these are for the most part thrown out in the course of getting the coal, and thrown back into the goaf, whilst others are picked out at the surface. The proportion of pyrites in the coal refuse varies from 7½ to more than 40 per cent., and whilst it carries too much carbonaceous matter and too little sulphur to be available for sulphuric acid manufacture without treatment, it is shown by these experiments that by simple crushing, screening, and dressing by means of jigs and tables, it is easy to get a product with 40 to 45 per cent. of sulphur, with a recovery of 80 per cent. of the pyrites present. Details are given of the plant proposed for this purpose and of its first cost, whilst an estimate of the cost of operating a plant capable of treating 50 tons of crude pyrites in eight hours shows a very reasonable working profit. It is interesting to find that the possibility of recovering and utilising this hitherto waste material is attracting attention.

THE latest catalogue of Mr. F. Edwards, 83 High Street, Marylebone, W.1 (No. 379, "Drama and Dramatic Art"), is not of very especial interest to readers of NATURE, but attention may be directed to the following volumes on North American Indian tribal customs:—"The 'Hako,' a Pawnee Ceremony," A. C. Fletcher; "The Mountain Chant, a Navajo Ceremony," Matthews; "The Sioux Outbreak of 1890 and Ghost Dance Religion," Mooney; "Ceremonial of Haszelti Dailjis and Mythical Sand Painting of the Navajo Indians," Stevenson; "Tusayan Flute and Snake Ceremonies" and "Tusayan Snake Ceremonies," Fewkes; "The Zuni Indians; their Mythology, Esoteric Societies, and Ceremonies," M. C. Stevenson.

SIR WILLIAM TILDEN has just completed his life of the late Sir William Ramsay, and placed it in the hands of Messrs. Macmillan and Co. for publication.

OUR ASTRONOMICAL COLUMN.

FALL OF A METEORITE IN PERTHSHIRE.—On December 3, at 1.15, what is stated to be a meteorite struck the lodge at Keithick House, Coupar Angus, which is about twelve miles N.E. from Perth. In the Blairgowrie, Coupar Angus, and Strathmore districts a noise was heard resembling a peal of thunder, and at places more remote sounds as of a distant explosion were audible. The meteorite has been taken to Perth for proper examination and analysis. It appears to have been well seen by an observer at Edinburgh during its flight. The time was 1.10 p.m., and the object descended at an inclination of about 12° from the vertical to the left, and disappeared in about azimuth 4° W. of N., at an estimated altitude of 30°. This agrees very nearly with the required direction of a body falling at Coupar Angus, which is in slightly W. azimuth from Edinburgh.

Further information shows that three fragments of the meteorite have been found, weighing 22¼ lb. (which penetrated the ground to a depth of 20 in.), 2½ lb. (which entered the roof at Keithick Lodge, Coupar Angus), and 2¾ lb. (found in a field at Carse Farm, near Blairgowrie, 6 in. below the surface). These pieces were distributed over a distance of six miles in a S.E. to N.W. direction, and sufficiently prove the direction of the meteor's motion.

From the various observations, now about twelve in number, of the luminous flight of the meteorite, it appears probable that its radiant point was in about $302°+24°$. This position would correspond in direction with the line of the fallen fragments from Keithick to Essendy. The meteor seems to have passed over the Firth of Tay, about four miles S.W. of Dundee, and at a height of twenty-five miles, and to have entered over the Scotch coast from the North Sea near Fife Ness, but it is hoped that further observations will enable more certain and exact conclusions to be obtained.

A large number of persons witnessed the luminous flight of the object, and are sending to Mr. W. F. Denning observations from which it is hoped to compute the real path. The meteor was strikingly brilliant, though the sun shone at the time.

OBSERVATIONS OF LONG-PERIOD VARIABLES.—A valuable series of recent observations of twelve long-period variable stars is recorded by M. Luizet, of the Lyons Observatory, in the *Journal des Observateurs*, vol. ii., No. 2. Some of the results are collected in the following table:—

Star	No. of maxima observed	No. of minima observed	Mags. at maxima	Mags. at minima	Period in days
SS Draconis	9	10	8·6–9·1	9·3–9·5	48·2
V Urs. Min.	14	11	7·8–8·2	8·3–9·1	72·1
RR Boötis	6	1	8·2–9·5	12·6–12·8	194·0
AF Cygni	6	2	6·8	8·0	96·8
UU Draconis	9	8	8·8	10·1	Irregular
SV Cassiopeiæ	1	1	7·3–8·4	9·1–10·1	279·4

The other stars observed were UV Draconis, V Aquilæ, SS Cygni, X Herculis, TZ Cassiopeiæ, and V Cephei.

MESSIER'S CATALOGUE OF CLUSTERS AND NEBULÆ.—In *L'Astronomie* for November, M. Camille Flammarion gives the first instalment of a systematic review of the 103 clusters and nebulæ which were included by Messier in the earliest catalogue of such objects which was compiled. M. Flammarion relates how he came into possession of Messier's manuscript, containing detailed remarks on each observation, through good fortune at a second-hand bookstall, and he is thereby enabled to give the original account of each object. Observations commenced by M. Flammarion forty years ago, and afterwards continued with the collaboration of M.

Trouvelot and others, are to be utilised for a descriptive account of the Messier objects in the proposed series of articles. Following an interesting biography of Messier, a useful list of the objects is given, with the original positions and numbers, and positions for 1900, together with the N.G.C. designations. M1 and M2 are described in detail in the first article, and each is illustrated by a photograph, and by a drawing showing the appearance in a telescope of 0·24 m. aperture. It is interesting to note that the present publication coincides with the centenary of the death of Messier, who died at Paris in 1817, at the age of eighty-seven.

SCIENCE IN INDIA.[1]

THE report of the Indian Association for the Cultivation of Science for the year 1915 contains, as well as the usual presidential addresses, a miscellany of scientific papers, ranging from ancient Hindu astronomy and the metallurgy of the Rig Veda to modern anthropological methods and problems of isomerism. Physics and chemistry come in for more attention than the biological sciences; in the former category the more important contributions are those of C. V. Raman and Ashutosh Dey on discontinuous wave motion, of S. Banerji on experiments with the ballistic phonometer, and of J. C. Ghosh on a new method of preparing colloids; in the latter a careful and intelligent analysis of the vegetation of the mouth of the Hugli by N. B. Dutt must be mentioned.

The address of the president, Raja Peary Mohun Mukherjee, is a reminder that the association, although it has always held the advancement of science by research and experiment to be its final purpose, started in life with a mission, which it still upholds, for imparting instruction in the general principles of science; though brief, the address abounds in wise reflections and sage advice adjusted particularly to the educated youth of Bengal.

Some of the special addresses allude to the recent establishment of a University College of Science in Calcutta, and to the opinions expressed in some quarters that thereby the association, on its educational and investigative side, may now be considered superfluous. It is to be hoped that such short-sighted views may not meet with any encouragement; for of all the misconceptions that have attended science since it was taken in hand by bland official personages that about "overlapping" makes the most unfortunate departure from inceptive truth. So far from being a stumbling-block, overlapping in the domain of science brings manifold strength and quintessential purification, for the more widely a scientific theory is tested and criticised the less likely is it to be a source of illusion.

ALKALI SOILS AND SOIL SOLUTIONS.

IN any attempt at agriculture in arid or semi-arid regions, considerable trouble is likely to arise from accumulations of soluble salts at the surface of the soil. The trouble is often intensified by irrigation, and it may become so serious as to counteract the advantages of a reclamation scheme that may be satisfactory in other respects. In a recent issue of the *Journal of Agricultural Research*, Dr. Breazeale estimates that the losses from this cause have already amounted to one hundred million dollars in the United States alone, and the evil is by no means checked. The soluble salts arise from two causes. Some come direct from the weathering of soda feldspars, diorite, etc.; much, however, arises from the circumstance that the area was once largely covered by marine lagoons or landlocked seas, the water of which evaporated, leaving the salts behind. When the soils are first brought under irrigation, the water applied to the higher levels is usually excessive in amount, and drains through the lower ground, carrying with it in solution considerable amounts of the chloride, sulphate, carbonate, and bicarbonate of sodium. Calcium carbonate is almost invariably present in the soil, and both sodium chloride and sodium sulphate react with this to produce sodium carbonate, which is much more harmful to vegetation than the other salts. The action is, however, reversible, and the addition of calcium sulphate to the soil has long been a recognised method of reducing the amount of sodium carbonate. The method, however, has not always succeeded, and Dr. Breazeale is able to furnish an explanation from his curves showing the amount of carbonate formed from the various sodium salts. If the carbonate is arising from the interaction of sodium chloride or sodium nitrate with calcium carbonate, then calcium sulphate is effective in bringing about the reversal; if it arises from sodium sulphate, then calcium sulphate is without effect.

The study of the soil solution is of great importance, both in relation to soil formation and because it is the medium for plant growth and the substratum for microbial life. The difficulty is to obtain sufficiently large amounts of the true soil solution. The drainage water does not faithfully represent the soil solution, soil extracts (using water as a solvent) only yield dilute washings of the soils which cannot be concentrated to reproduce the original solution, and the centrifuge only separates moisture from a soil which contains more than the optimum amount. A paraffin-oil displacement method under pressure has been devised by van Suchtelen and Itano, which has been used by Mr. J. F. Morgan. Some of the results obtained are described in the June number of *Soil Science*. The method consists of forcing paraffin oil, by means of a high-pressure pump, through the soil tightly packed in a cylindrical vessel, the pressure being raised so long as moisture is expelled, until it reaches 500 lb. per square inch. In the case of most soils ample solution for the necessary analytical work is obtained—from sandy soils as much as 74 per cent. of the moisture present—and a large amount of solution is yielded without its coming in contact with the oil. From the results of his experiments the author concludes that the method furnishes a fair representative of the solution as it exists in the soil. Successive portions of the same extraction vary only slightly in physical properties, but to a considerable extent in the various forms of nitrogen (ammonia, nitrite, and nitrate). In the different soil solutions phosphoric acid is fairly constant, but calcium, magnesium, and potassium vary, as do the forms of nitrogen. The obtaining of a soil solution by the method is limited to the moisture content of the soil, and depends upon the type of the latter, since all soils are not entirely penetrated by the oil. Work Mr. Morgan has in progress indicates that the method furnishes a valuable index of the microbial changes in the soil.

LOCAL NATURAL HISTORY SOCIETIES.

THE report of the Winchester College Natural History Society for 1915–17, edited by its president, the Rev. S. A. McDowall, shows that a considerable amount of active work is being done by the members. Mr. McDowall himself is interested in natural orchid-hybrids, and he has succeeded in infecting the older members of the society year by year with his enthusiasm; the present report contains valuable notes by H. McKechnie and D. G. Lowndes, with five good half-tone plates. The former also has an interesting

[1] Report of the Indian Association for the Cultivation of Science for the Year 1915. Pp. iii+150. (Calcutta: Anglo-Sanskrit Press, 1917.)

account of plants introduced from camp fodder. There are lists of additional plants, of Lepidoptera, and of nesting birds, with locality and date of each observation. A golden oriole and a waxwing are among the birds observed. Among papers read at the meetings (which, by the way, are held on Sundays), those by R. F. Lowndes on trout and by J. Comber on ditch plants bear witness to much first-hand knowledge, and are rightly printed at greater length than the others. Although the war has introduced many competing claims on the energy of the school, the membership of this society has not diminished, and all, from its president down to the smallest junior, are to be congratulated on the excellent report that their united efforts have produced. We hope that in this time of stress other schools will do as well in natural history as does this home of the ancient learning.

The Transactions of the Hertfordshire Natural History Society for 1917 contain much interesting matter. Dr. A. H. Foster, a very sound ornithologist, contributes a list of the birds of North Herts; he gives records of 200 species, and, though stray wanderers are included, the list is a remarkable one. Though the county is becoming dotted with small towns and large villages, the birds, being very conservative, still keep to their old haunts and their old lines of migration. Besides this there are a fair number of good observers, so that few rarities pass unnoticed. Among nesting species may be noted especially the grasshopper warbler (scarce and local), the stone curlew, the woodcock, and the quail. Among occasional birds of passage is the common tern. A regular winter visitor is the golden plover; in the south of the county these birds frequently don the black breast before starting for the north. Surely, then, Dr. Foster must be wrong when he says they never do so in the district of which he writes. He has as yet no record of the breeding of the redshank, which nests regularly in Essex, and shows signs of extending its range over the border into Herts. For the common snipe the record is "a few nesting pairs in summer and many individuals in winter." Do these winter and summer birds belong to different sets which keep apart? A paper on "The Response of Plants to Selective Screening," by Col. Rawson, records some valuable experiments that show that variations may be induced in some plants by screening them from the sun when it is at certain altitudes. There is also an interesting paper on Rotifers by T. E. Lones, and a list of the Macro-Lepidoptera of North Herts by Dr. Foster.

The *Vasculum* is an illustrated quarterly magazine devoted to the natural history of Northumberland and Durham, and from the three parts of the current third volume before us it may be seen that it is fulfilling a useful function. The general editor is the Rev. J. E. Hull, whose speciality is the Arachnida, but who also contributes chatty papers on place-names. The other editors are Mr. George Bolam, the author of "Birds of Northumberland and the Eastern Borders," who writes on the coming and going of the birds of the Upper Tyne Valley; Mr. R. S. Bagnall, who records discoveries of spring-tails and their allies new to science and new to the district; and Dr. J. W. H. Harrison, whose recent work in hybridisation has brought him into prominence, who displays in the magazine a wide knowledge of animals and plants and their associations. Other field naturalists of the counties concerned contribute articles, and we note that they represent the other natural history activities of the district—the Natural History Society of Newcastle and Armstrong College. The magazine brings scattered workers in country districts into intimate association, new discoveries are made known, the older workers are stimulated to fresh endeavours, and those who have received the call of natural history are encouraged and guided as to literature and methods. The work of the Northumberland and Durham naturalists is providing material for the presentation of the district from an ecological point of view, and the gathering of the material is fostered by the *Vasculum.*

The Proceedings and Transactions of the Croydon Natural History and Scientific Society for 1916 contain a good deal of detailed information in regard to the intermittent bournes of the district. The late Mr. Baldwin Latham showed that the Croydon Bourne flowed early in 1916, for the fifth year in succession, with a maximum flow of 13,345,920 gallons per day, thus equalling the great flow of 1904. Bournes also flowed at Carshalton, Cheam, Nonsuch Park, Smitham Bottom, and Wickham. With regard to the last-mentioned, Mr. W. Whitaker contributes a paper showing that the Wickham Bourne had not flowed since 1883. On May 28, 1916, it was yielding 1,628,550 gallons per day, at a point where it flowed into and filled up a gravel-pit by the side of the railway near Hayes Station. In Mr. N. F. Robarts's presidential address reference is made to a valuable find of bronze implements made in 1914 in Addington Park, when the golf links were laid out and an enormous destruction of woodland took place. So large was the find that the man who took them away staggered under the weight. Apparently he disappeared, but it was found afterwards that a man had called at the British Museum in the same year and had sold about thirty implements and fragments of bronze from Addington. The find contained six socketed celts, and is thought to be of late Bronze age. The Proceedings contain the usual rainfall returns from more than a hundred stations, compiled monthly by Mr. F. Campbell-Bayard, and these are of great value to water engineers and others. The society may be congratulated on the energy displayed in spite of pressing war vocation.

The 1917 issue of the *South-Eastern Naturalist* constitutes the twenty-second volume of Transactions of the South-Eastern Union of Scientific Societies, and includes the proceedings at the annual congress held in London last June. This meeting was reported in our issue for June 28 (vol. xcix., p. 354), when summaries were given of Dr. W. Martin's presidential address and the more important papers read at the meeting. Among the contributions to which limitations of space made any detailed reference impossible on that occasion may be mentioned Dr. B. Daydon Jackson's well-informed directory to the notable trees and old gardens of London, with its references to the gardens of Gray's Inn, planted by Sir Francis Bacon; and those of Syon House, at one time under the superintendence of Dr. W. Turner, physician to the first Duke of Somerset, Lord Protector. Dr. Turner, the "Father of English Botany," published "The Names of Herbes" in 1548, and dedicated it to the Protector. Prof. MacBride's address on "Are Acquired Characters Inherited?"; Dr. J. S. Haldane's on "Abnormal Atmospheres and the Means of Defence against Them"; and Prof. Boulger's on "The Association of the Chelsea Physic Garden with the History of Botany," are all printed *in extenso.*

PARASITIC BIRDS.

THOUGH the singular habits of the parasitic cow-birds (*Molobrus bonariensis* and *M. badius*) are well known to ornithologists, Mr. L. E. Miller has been able to add still further to the records of their eccentricities in a valuable paper published in the Bulletin of the American Museum of Natural History, vol. xxxvii. His observations were made during a recent expedition to Bolivia and north-western Argentina, where he found these birds in considerable numbers foisting their eggs upon numerous species of small birds, especially finches. But for choice they seem always to prefer the mud nests of the oven-bird (Furnarius). These seem to have an irresistible and fatal attraction for cow-birds, since all the eggs deposited therein appear invariably to be destroyed by the desertion of the intended dupes, which, whenever they discover the trick that has been played upon them, cover up the eggs with a layer of nesting material, refusing to incubate. In some nests layer after layer of eggs were thus found, but no young were ever met with. The numbers of eggs found in such nests ranged from six to as many as thirty-seven! While this stupidity reduces the numbers of the parasites, it at the same time reduces the number of oven-birds, which, in the areas explored by Mr. Miller, failed to produce offspring. Judging from the coloration of the eggs, Mr. Miller estimated that in some cases as many as thirteen birds may use the same nest. The eggs of a third species (*M. rufoaxillaris*) were also occasionally found in these nests.

That the pin-tailed widow-bird has developed the parasitic habits of the cuckoo seems to be established, judging from the evidence of Mr. Austin Roberts in the Annals of the Transvaal Museum, vol. v., part 4. Mr. Roberts tells us that he has known this bird to deposit its eggs in the nests of no fewer than four different species of waxbill, as well as in those of its relative, the red-collared widow-bird. It frequently deposits more than one egg in the nest of its host, and sometimes it replaces the whole clutch. But in no case does the foundling appear to dislodge the rightful occupants of the nest, which is the invariable custom of the cuckoo. Mr. Roberts believes that two other finches are similarly parasitic. These are Rendall's seed-eater (*Anomalospiza imberbis*) and the red-billed weaver (*Quelea sanguinirostris*). But we venture to think that a mistake has been made, at least in the case of the last-named species, which even in capitivity shows no degeneration in the matter of its parental instincts.

History

SCIENCE AND ITS FUNCTIONS.[1]

SINCE the earliest times, man, like his poor relation the monkey, has always been of a curious disposition, and has wanted to know the why and wherefore, as well as the mechanism, of all the phenomena that he sees about him. No doubt much early science, especially in the fields of astronomy and alchemy, was practised as a cult, with the view of impressing and mystifying the common people, but at the back of it all there can be little question that the great force that impelled inquiry into Nature, both in ancient times and in the modern world, was curiosity, which in itself is probably of all human emotions the one that has been most conducive both to intellectual and to material progress.

With the appearance in history of that wonderful people the Greeks, we come for the first time in personal contact with the scientific thoughts and the scientific theories of individual philosophers. Prior to that period there must have been scientific thinkers, but we have no distinct record of what their scientific ideas were. All that remains are portions of some of their material constructions, and some accounts of others that time and decay have destroyed. Thales of Miletus, one of the seven wise men of the Grecian golden age, though he lived some 600 years before our area, is no mere name. He was the founder of the physical school of Greek philosophy, who first began to consider the nature of things, and was the first to observe electrical action. To Democritus, a Greek of the fourth century B.C., we owe the earliest ideas about matter, while to Hippocrates, another early Greek, are due the beginnings of medicine and biology. To him is ascribed the immortal and pregnant phrase that while "Life is short, Art is long, Opportunity fleeting, Experiment uncertain, Judgment difficult"—an aphorism in which is summed up for all time the difficulties with which the scientific investigator has to contend. And so we pass on to that most famous of classical philosophers, Aristotle, whose writings have done more than those of any other man to influence the progress of science, and whose authority was so great that it bound the scientific world in iron fetters for centuries. In the great library and museum which was founded in the third century B.C. by Ptolemy at Alexandria, then the intellectual and commercial capital of the Grecian world, we find the apotheosis of Greek scientific activity. Here were preserved all the scientific writings and records that a world-wide search had enabled the founder to collect. Here were taught the philosophy of Aristotle and the geometry of Euclid. Here Claudius Ptolemy experimented in optics, and wrote his great work on the construction of the heavens. Here Eratosthenes measured the earth. Here Ctesibius invented the fire-engine, and Hero the first steam-engine, which, it is interesting to note, was a simple form of steam turbine. Here worked Archimedes, the most famous mathematician and physicist of the ancient world, who laid the foundation of hydrostatics, elucidated the theory of the lever, and invented the burning-glass and the screw-pump which still bears his name. As a man of science the world produced no equal to him for nearly two thousand years. But the days of the great library were numbered, and within those marble halls the drip of the water-clocks of Apollonius were counting drop by drop, and second by second, the approach of the catastrophe. During the siege of Alexandria by Julius Cæsar the library and all its contents were burnt—a fitting funeral pyre to the glory that was Greece.

The Romans made no contributions to pure science at all to be compared with those of the Greeks. They were a practical rather than a speculative people, and were great builders, engineers, and road-makers. Size, solidity, and quantity rather than novelty were the outstanding features of their scientific work. They were not like the Greeks, ever seeking after some new thing.

When Rome fell into decay, and the gloom of the Dark Ages settled down upon Europe, there was for a time an almost complete halt in the progress of science. True, some vestige of learning still struggled to maintain itself in what was left of the Alexandrian library, but this was finally extinguished by the latter's second destruction by order of the Arabian Khalif, Omar. After this it is somewhat surprising that the next revival in scientific investigation took place amongst the Arabians themselves, now become a highly cultured people. To this revival we owe the invention of algebra, the beginning of systematic chemistry, and much new work in astronomy, medicine, mechanics, and metallurgy. One of the most famous of the Arabian experimental philosophers was Alhazan, who lived shortly before the Norman Conquest of England.

When there began in Europe that great revival of learning known as the Renaissance, it was the printing press that became its principal coadjutor, and caused things to move at a rate much faster and on a scale much larger than ever before. It was with fundamental concepts that the new learning had first of all to contend, particularly with the geocentric theory of the universe, which gave to the earth and

[1] From an address delivered before the Royal Society of Arts on November 21 by A. A. Campbell Swinton, F.R.S., Chairman of the Council.

to human affairs quite an undue importance, and also with the authority of Aristotle, which had become an article of faith and defied all new ideas. By the end of the sixteenth century experimental science, as opposed to the barren speculations of the schoolmen, was again being practised in Europe with noteworthy results, while, a little later, Francis Bacon published his famous "Novum Organon," and thus became the apostle of the revival of this experimental method of attacking scientific problems. On this method, which had been practically abandoned for some hundreds of years, all modern science is based, and as soon as its practice recommenced results of the highest importance began rapidly to accumulate. How a dread of the tentacles of "authority" still lingered in scientific circles is, however, to be seen in the fact that when the Royal Society was founded in 1662 the fellows took for their motto the words, "Nullius in Verba," an excerpt from a line in Horace which reads, "Not pledged to swear by the words of any master." To-day it is difficult to realise what a hold authority had come to have on even scientific ideas, and how, even as late as the seventeenth century, antiquated and frequently unsound scientific principles, as enunciated in the writings of Aristotle, were still regarded as something that had to be faced when dealing with new problems.

And now we have arrived at a period when there commenced those organised efforts in scientific investigation, and those widespread and continuous endeavours to apply the results thus obtained to practical ends, that have produced during the last two centuries such marked effects on civilisation. We have now, in fact, a better opportunity than ever before of seeing what are the functions of science.

To arrive at some measure of the vast changes that have been brought about, let us consider how matters stood about a hundred and sixty years ago, say in 1754, the year in which our Society of Arts was founded. At that date the steam-engine had not yet assumed a practical form, and apart from some small use of water and wind power, when mechanical work had to be done this was accomplished by the aid of the muscular effort of men and animals. The question of power supply was, in fact, in the same condition that had existed for thousands of years, and, in consequence, the employment of machinery of all descriptions that required power to drive it was extremely limited. Nor as regards travel for persons, or transit for goods, were things very different. The steamship was unthought of, and ocean journeying was no faster, and but little more certain, than in the days of Columbus. Railways in the modern sense were non-existent, and even the coaching era had scarcely begun. Travelling of all sorts was no more rapid or more convenient than in the days of the Romans. Indeed, emperors such as Hadrian and Severus, who visited this country in late classical times, probably made the journey to and from Rome quite as expeditiously, and very likely even much more comfortably, than did any traveller of the eighteenth century. Furthermore, at the time of which I speak, the communication of intelligence was limited to the speed at which postmen could travel, for, of course, there were no electric telegraphs, such as have shortened the time of communication with the ends of the earth to a few seconds, and have reduced even ambassadors to the status of clerks at the hourly beck and call of the Home Government. In the eighteenth century, moreover, illuminating gas and electric light had still to be invented, public lighting was practically non-existent, and even in London and other large cities linkmen with torches were required to light the passenger to his home after dark. If printing was in use it was slow and expensive, without any of the modern mechanical, photographic, and other adjuncts that have rendered possible our numerous newspapers and the other derivatives of the press. Nor were there any proper systems either for water supply or for the disposal of sewage. Disease, born of filth and neglect, stalked through the land practically unchecked. Medicine was still almost entirely empiric. Little or nothing was known of the causes and nature of illness, of infection by bacilli, or of treatment by inoculation. Anæsthetics had not yet been applied, and the marvels of modern surgery were undreamt of. It would be easy to multiply instances, but in the aggregate it is not inaccurate to state that at the time this society was founded the general mode of life had not much improved on what obtained in civilised Europe in the days of the Antonines, while, in some respects, it fell much short of this.

To-day we live altogether in a different world, in an age of travel accelerated by steam, petrol, and electricity; of railways on the level, overhead, and in tubes; of trams and motor omnibuses, of bicycles and motor-cars; of steel ships and steel bridges; of mills and factories, with their products of every possible description; of telegraphs by wire and wireless; of telephones; of hourly newspaper editions and tape machines; of electric light indoors and outside; of electric power for every purpose, from carrying us upstairs to brushing our hair and our boots; of gas fires and gas cookers; of electric bells and electroplate; of automatic machines and thermos flasks; of pianos, pianolas, concertinas, and gramophones; of kodaks, snapshots, and kinematographs; of fountain-pens, sewing-machines, typewriters, lawn-mowers, knife-grinders, vacuum cleaners, and barographs; of cigarettes and lucifer matches, which are much newer than many people think; of innumerable new and cheap textile fabrics; of plate-glass, aluminium, indiarubber, celluloid, vulcanite, and all manner of new artificial materials; of laughing-gas for having a tooth out, of chloroform and ether for more serious operations; of X-rays for inspecting our interiors; of dozens of new medicines for every ailment, and ailments with new names discovered every day; of balloons and aeroplanes, in which we may all soon be travelling; besides all the masses of diverse machinery used in manufacture, in agriculture, and in the arts. All these things, as well as many more, are younger than our Royal Society of Arts.

It has been the fashion to divide what we understand by science into two portions, pure science and applied science; but these are only halves of one great whole. Pure science, which is the domain of the research worker and the discoverer, supplies the data, physical, chemical, and mechanical, which it is the function of applied science to turn to account for practical utilitarian purposes. For this latter operation are required the services of the inventor and the engineer, and other experts of a similar character.

Even great scientific discoveries have in some cases been made by chance, but generally only by men of marked intuition and acutely developed powers of observation. More often they have been the result of prolonged thought and of laborious and patient investigation, with delicate experiments. Many have been the issue of elaborate mathematical reasoning. As subjects become more complex, complete knowledge of what has been done before in the same field is more and more necessary. One of the most fruitful sources of new discovery in all branches of science in modern times has been the greater attention paid to quantitative as against merely qualitative research, very accurate measurements of every kind being one of the special features of present-day research methods. A noteworthy point is that the results of research are cumulative, one discovery almost invariably leading to others in course of time.

As a matter of experience all discoveries in pure science, however recondite and however seemingly useless at the moment, find their practical application sooner or later. It may not be for years or even for centuries, but in its own time the application comes. Invention is a faculty of the imagination, the inventive temperament being akin to the artistic temperament, and real inventors, like true artists, being born and not made. In order to be great both must have creative powers in a high degree. Unless gifted at birth with the inventive afflatus, the ordinary man can no more by taking thought make himself an inventor than he can add a cubit to his stature. At the same time, the inventor, to be fully successful, must be suitably educated. By study and the acquisition of knowledge he widens his scope, and can apply his gifts in fields of invention to which, without such knowledge, he could not hope to aspire. This notwithstanding, it is a noticeable and curious fact that many great inventions have been made by men whose ordinary vocations were quite outside the particular field in which their inventions applied. This is no doubt a case of the fresh mind of the outsider looking at things from a new aspect, whereas those who are daily working in any particular line are apt to get into a groove and to be trammelled by usage and convention. Perseverance, and a capacity for continuity in keeping to one subject, are outstanding qualities to be observed in all successful inventors. Many with brilliant ideas fail for lack of these. As has been justly said, great discoveries are never, and great inventions very seldom, the work of a single individual.

At certain periods the general state of progress, both in pure and in applied science, renders particular inventions possible, with the result that a number of persons gifted with the necessary imagination almost simultaneously attack the problem. In such cases, if one individual inventor had not succeeded, it is probable that another would have done so, though perhaps in some slightly different manner.

For these reasons in all these cases it is very difficult, if not impossible, justly to apportion the credit. The public and the Press usually award it all to the individual who makes the first practical and commercial success, being entirely ignorant of all the previous stages that have led up to the final result, and oblivious of the fact that, without the vast amount of previous research by other workers, the final inventor would never have had the data wherewith to achieve what he did.

On the other hand, a contrary and equally mistaken view is not seldom taken by the workers in pure science, who, absorbed in the intricacies of their own achievements, are prone to underrate what the actual inventor accomplishes, usually by slow degrees, and with infinite pains and patience. They, further, do not understand what a long step there is between the mere idea and the worked-out invention, and how much labour, practical ingenuity, and perseverance, and also how much money an invention usually requires to make it successful and to get it taken up industrially. Indeed, this last-mentioned commercial operation is frequently the most difficult of all to bring about, particularly as it is not common for inventors to be good men of business.

The history of particular inventions is frequently instructive, and a good instance is that of wireless telegraphy, which is comparatively recent, so that we know all about it, and can follow accurately each single step in its development.

It, moreover, shows how pure and applied science are indissolubly interwoven, and how the one is dependent upon the other.

According to modern views, enunciated in the first instance about the year 1807 by Thomas Young, light consists of undulations or wave motions in a hypothetical ultra-material substance, known as the æther, which is supposed to fill all space, permeating the solid earth, the planets, the stars, and all material objects, and reaching to the utmost limits of the universe. Just as sound is known to be a wave motion in the air, so light is believed to be a wave motion in this hypothetical æther. About the year 1870 James Clerk Maxwell, professor of physics at the Cavendish Laboratory at Cambridge, chiefly by mathematical reasoning, showed the close connection between electricity, magnetism, and light by demonstrating that all three could be explained on the basis of motions and stresses in the æther. Thus, according to Maxwell, light was an electro-magnetic phenomenon, and consisted of disturbances in the æther of exceedingly short wave-length, whereas longer waves and stresses in the same medium explained the phenomena of electricity and magnetism.

As mentioned, Clerk Maxwell's discovery lay purely in the land of theory, discovered mathematically, and he attempted no experimental proof. Some twenty years later Heinrich Hertz, by a series of most beautiful experiments, proved the truth of Maxwell's theory. By means of suitable apparatus he first of all created electro-magnetic waves, and then with other apparatus he detected them, showing that they could be reflected and refracted, and, in fact, obeyed all the laws with which light is known to comply. Indeed, so completely was this accomplished that, on hearing of it, Lord Kelvin exclaimed that Hertz had annexed the whole science of optics to the domain of electricity.

Up to this stage nothing in these investigations had hinted even in the slightest degree at any useful application. Neither Young, nor Maxwell, nor Hertz was moved by any other ambition than a curiosity to explore the nature of things. On the other hand, had it not been for their labours, what was to follow could not possibly have occurred.

Hertz died young, almost immediately after making the experiments to which allusion has been made, but his work was taken up and largely extended in this country by Sir Oliver Lodge. Hertz's experiments had been on an exceedingly small scale, while Lodge employed, for creating his waves, methods which gave a much greater power; moreover, as a detector of these waves, Lodge used an exceedingly delicate instrument, which he christened the coherer. This was due to a discovery by Branly, of Paris, who also was investigating Nature without any ulterior utilitarian aims.

Lodge, no doubt, was impelled by similar motives, but having a practical mind he threw out the suggestion that the Hertzian waves might possibly be employed for signalling. Indeed, he went so far, at a lecture which he gave at the Royal Institution in 1894, as actually to ring a bell by this means from one end of the building to the other, through the thickness of several partition walls. In the same year, at the British Association meeting at Oxford, he transmitted similar signals over yet greater distances.

These experiments of Lodge led several persons to consider whether the method was not applicable to telegraphy, but nothing practical was done until Mr. Marconi, who was acquainted with the work of both Hertz and of Lodge, and was impressed with the possible commercial value of the idea, came upon the scene, and with great skill very soon showed that it was feasible by Hertzian waves to telegraph across the Channel, and even over much longer distances.

The rest of the history of wireless telegraphy, very interesting though it is, does not concern us here, for what I wish to impress upon you is how, in this instance, as in many others, researches and experiments in pure science, which, so far as their authors could see, showed not the faintest sign of any practical application, led in time to inventions of the greatest possible public utility. Many years elapsed between the researches and theories of Young and Maxwell, the experiments of Hertz, and the advent of practical wireless telegraphy, and when it came all the three original investigators were dead; yet, unless these three great men had evolved their brilliant ideas and worked them out as they did, wireless telegraphy had never been. How difficult it is for the uninitiated to realise the importance and the practical potentialities of some discoveries in physics at the moment of their birth may be made plain by a few words about the remarkable developments that have taken place during the past few years in that department of science known as molecular physics. Up to comparatively recently the theory of the atomic structure of matter, and the idea of the indestructibility of the atom, that smallest material particle that was thought possible to exist, still held its own. First enunciated more than two thousand years ago by the Greek Democritus, developed later by another Greek philosopher, Epicurus, and popularised by the Roman poet Lucretius in his celebrated poem, "De Natura Rerum," this theory of matter was put on a proper scientific basis by the English chemist Dalton rather more than one hundred years ago. Quickly following the discovery of the X-rays by Prof. Röntgen in 1895, and of radio-activity by Prof. Becquerel a few months later, came a most surprising development—indeed, one of the most remarkable in the whole history of science. Mainly owing to the labours of Sir Joseph Thomson and his Cambridge school of experimenters, starting from the previous researches of Sir William Crookes, we now know that the atoms, once called the ultimate atoms, so far from being the indivisible entities as was once thought, are, each individual one of them, something very like a complete solar system, comprising a positively electrified sun or nucleus and a number of negatively electrified electrons or planets. More than this, though the whole atom is so small that it is quite invisible to the most powerful microscope, and that it would take at least three million atoms, perhaps ten or twenty times as many, set close together in a straight line, to cover a single inch, the constituent electrons are so much smaller that, though contained within the compass of the atom, they are as distant from one another, relatively to their size, certainly as are the earth and the moon, and possibly as the sun and the planets. The imagination reels at such an illustration of the microcosm of the infinitely small, just as it reels at the macrocosm of infinitely large astronomical space and its population of innumerable stars; but in Nature, as has been truly said, the adjectives "large" and "small" have no meaning. In Nature there is nothing absolutely great, and there is nothing absolutely little. Whether it be a matter of the dimensions of space or of the lapse of time, all is relative. To us humans space is measured in terms relative to the dimensions of our bodies, time in periods relative to the duration of our lives. To us things appear large or small, periods long or short, but these are appearances only, and have no absolute reality.

Now to those who have not studied the question all this must seem very remote from the practical politics of applied science, such as we make use of in our daily life. But it is not so, for it is to these almost infinitely small negative electrons that we owe the Röntgen rays. When propelled at the incredible velocity of something like fifty thousand miles per second, which they attain under electrical stimulation inside a Crookes vacuum tube, and caused to bombard a piece of metal, they create these rays in much the same way as the bullets from a machine-gun may rattle on a target and thus create sound. The Röntgen rays themselves are a description of light which, until artificially produced by man in the manner described, had never been observed in Nature, and, indeed, had perhaps never previously existed in the whole history of the universe. Their practical utility is, however, now universally realised, and in surgery and medicine they are in everyday demand.

Now, not only have these abstruse and seemingly quite academic discoveries about the electrical structure of the atom, and the properties of its constituent parts, brought about great improvements during the last few years in the design and use of Röntgen-ray tubes, but they have also borne practical fruit in other directions, as, for instance, in what is to-day much the most sensitive and trustworthy apparatus for receiving wireless telegraph signals. Their further utility, moreover, is just now beginning to make itself apparent, and quite recently they have been applied by Sir Joseph Thomson to an entirely novel form of chemical analysis, the possibilities of which it is as yet too early to estimate. Anyway, we see how in a space of only about twenty years discoveries of apparently purely academic interest, in perhaps the most abstruse of all lines of scientific investigation, are already beginning to be usefully applied. We see how the function of science to be utilitarian obtains just as much in the case of highly recondite investigations as in those that are more simple and in which the practical applications are more obvious.

It is impossible to study the history of civilisation without recognising that scientific research and invention, with their innumerable and incalculable actions and reactions, constitute the soul of industrial progress. Consequently, if this progress is to be maintained, every inducement must be provided to encourage those who are capable of carrying on the work. Since the beginning of the world it is not to the masses, but to the few exceptional individuals that all great advances have been due, and it is greatly to be deprecated that politicians, who must, or, at any rate, should, know better, continue to flatter the so-called working-man by telling him that he alone is the creator of wealth. To those who know the facts such a suggestion is, of course, absurd. Still, it is highly necessary that the masses should be educated to learn that unless those who have the requisite capacity are afforded the necessary leisure and facilities to work at research and invention, industries can be neither developed nor even maintained in the face of the world's competition, and that the working-man himself will be the principal sufferer from the resulting stagnation and decay.

It is unfortunate that in this country of late years it has become a fashion to consider the making of large profits as almost a crime, for the working out of many industrial scientific processes and inventions can be accomplished only by great and prolonged expenditure and the risking of vast sums of money, such as only very rich persons or companies can afford. The history of the fine chemical trade in Germany for some years before the war is a good case in point. Here very large sums were in some instances spent on the development of special processes. In many cases the money was lost, but the few speculations of this nature that succeeded recouped all that had been spent on the others, a single product in some instances bringing in an enormous net annual profit. This, again, enabled other similar problems to be attacked. With our system of taxation—income tax and super-tax, and now excess profits tax in addition, and the jealousy and outcry that the making of large profits engenders—it is very difficult to arrive at such results in this country, and this undoubtedly is one of the main reasons for our backwardness in diverse directions. A remedy should be found in exempting from taxation all money spent in new scientific developments. Otherwise, with stinted resources, we cannot expect to maintain our position.

Another point in connection with invention is the injustice and the inexpediency, from a public point of view, of the present system whereby the Patent Office makes a large annual profit out of the fees paid by inventors. There might possibly be some justification for this were the money thus obtained spent on scientific education, on provincial scientific libraries, or on some other object that would further invention and discovery. The money is, however, merged in the ordinary revenues of the country, and thus becomes a veritable tax on brains. It is, moreover, a tax on the cerebral activity of a class of men who are usually by no means overburdened with wealth. Though all inventors are fortunately not driven by poverty to such expedients as Palissy the potter, who actually had to burn his household furniture in order to provide heat for his furnace, still the majority of inventors are undoubtedly poor, and find the cost of protecting their inventions by patent, and still more of maintaining these patents when granted, a considerable strain upon their finances. The truth of this may be seen by the frequency with which patents are dropped merely in order to save the renewal fees, and the patentee in some cases deprived of profits to which he is justly entitled.

We shall, however, never get justice done to science by the Government and its departments until some knowledge of science is made a compulsory part of the curriculum for the training of the Civil Service and an important item in the entrance examinations. Only in this way shall we get the departments filled by men who realise what science means, and how it lies at the root of all material progress. There is an idea afloat in the political world, as also in the bureaucratic mind, that no man can at the same time be a master of science and a good administrator or organiser, either in public or commercial affairs. This idea probably originated from observation of scientific men of the scholastic and professorial types, whose training has been mainly directed to the art of teaching, and who have never had much opportunity of developing their faculties in the administrative sphere. To show, however, how false is the assumption, it is only necessary to mention two such names as those of Benjamin Franklin and Count Rumford, both of whom were consummate men of science and did very valuable original scientific work, but were also both prominent men of business and managed great political undertakings with remarkable success. Or, if we come to more modern times and turn to captains of industry, there are, without going out of this country, and to mention only one or two, such men as Joseph Whitworth, Henry Bessemer, William Armstrong, and Andrew Noble, all of whom had high scientific gifts and knowledge, and also were very successful in the organisation and administration of large industrial enterprises. Indeed, for any business employing technical methods the ideal chief must necessarily be a man of scientific attainments, as it is only such a one who can properly weigh the pros and cons of the propositions put before him by his technical staff, while, what is even more important, it is only such a chief who can command the real respect of his employees, who will never have complete confidence in, or a proper veneration for, a leader whose scientific and technical knowledge and experience are in the aggregate less than their own. These considerations, of course, apply to Government departments which deal with scientific questions equally with industrial undertakings carrying on technical processes or manufacture.

In obtaining Government support for the promotion of applied science, it is most necessary to beware of political interference.

The dangers that arise from this may be seen from the history of one or two typical industrial applications of science during the last century. Take, for instance, the application of mechanical power to road locomotion. In the period covered by the years 1820 to 1836 this made rapid strides, and towards the close of the period many steam-coaches were maintaining regular services between various centres in different parts of the country. In this, England was many years ahead of the rest of the world, and a new and what promised to be a very profitable industry was being developed. Parliament, however, at the instance of rival interests, passed hostile legislation which absolutely shut the whole movement down, and automobilism in this country was completely crushed, not to be heard of again for more than fifty years. When, moreover, a new beginning was made, the fresh start did not take place in England, its original home, where it was prohibited by law, but in France, where legislation was more enlightened. In this way, owing entirely to the politicians, we lost an opportunity of becoming pioneers throughout the world of a completely new and what proved to be a gigantic industry, which might have brought to our manufacturers much wealth and to the working classes much lucrative employment.

Or, to turn to another case, take the history of electric lighting and of the supply of electric power. Here, again, the development of a new scientific industry was greatly impeded by Parliamentary action. In 1882 this country was as far advanced in everything pertaining to the application of electricity as any other country on the globe. Indeed, many of the developments in this branch of science were peculiarly British, having originated in this country. Again Parliament intervened, and with a mistaken idea of protecting the consumer from the dangers of monopoly, so effectually strangled the whole movement that for six years there were practically no consumers at all, as the conditions imposed on undertakers were so onerous that no one would risk the money required to institute a supply. In 1888 the political powers that were, realising their mistake, made some legislative amendments that enabled a start to be made; but it was then too late, for other countries had got ahead, and even then the electrical industry was still hampered by artificial conditions, some of which endure to the present day, with results that have been inimical to proper development. There are other similar instances, such as the telephone, in regard to which the politicians have interfered to the detriment of progress.

To a society such as this, the object of which is the encouragement of the arts, science is mainly interesting from its pre-eminent value for purely materialistic ends, and it is therefore from this point of view that I have endeavoured to give some account of its functions. It must not, however, be supposed that science has not also a very high value from the ethical point of view. As Adam Smith wrote in his "Wealth of Nations" nearly a century and a half ago, "Science is the great antidote to the poison of superstition"; moreover, science is, so far as the limitations of the human intellect will permit, a search for absolute truth. Accuracy is its foundation-stone, acute observation and strict logic are its most powerful agents. These have all an educational value of the highest importance. The study of Nature and the pursuit of knowledge have, in addition, an elevating influence, and produce a breadth and a strength of mind that rise superior to material environment. This is well seen in the blameless lives of the great masters of science, and in the way that many of them sacrificed everything to their work. Some encountered persecution and even martyrdom for their ideas, and met their misfortunes with a fortitude quite equal to that shown by other men for their faith. Among the functions of science we must not therefore forget its moral power.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE geophysical discussions arranged by the Geophysical Committee of the British Association on November 7 and December 5 were well attended and very successful. The meetings will begin again in February, and will continue until June inclusive. At the February meeting Dr. A. Strahan will be in the chair, and the speakers will be Col. Close, on the effect of variation of barometric pressure on mean sea-level, and Major Henrici, on precise levelling. At the March meeting Sir Napier Shaw will be in the chair, and Prof. H. H. Turner will open a discussion on seismology, in which it is expected that Mr. G. W. Walker and Mr. R. D. Oldham will take part.

MR. BERTRAND RUSSELL'S lectures on the "Philosophy of Mathematics," at Dr. Williams's Library, Gordon Square, W.C.1, have been so successful that a second course, to be given after Christmas, has now been arranged. The new course will be quite distinct, and, like the present, will be designed to expound the logical basis of mathematics. The lectures presuppose no special mathematical training, and technical terms and symbols are dispensed with. The present course, which concludes on December 18, has dealt with the more specially mathematical questions. The new course will be devoted to philosophical problems, and Mr. Russell will expound his theory of logical atomism. The lectures are on Tuesday evenings at 5 o'clock; they will begin on January 22.

MR. ASQUITH, in his address in the Town Hall, Birmingham, on Tuesday, December 11, at a meeting promoted by the National War Aims Committee, referred to problems of reconstruction, and is reported by the *Daily Telegraph* to have said:—"In regard to these matters, you will not be surprised if I put in the forefront, as of paramount importance, a comprehensive rebuilding, and a far more adequate equipment, from the very bottom to the very top, of our system of national education, of which the Bill introduced by Mr. Fisher gives the hope, and, indeed, the promise. To put it from the lowest and most material point of view, it is largely, indeed mainly, through our educational deficiencies that we have either lost or never established some of those basic industries which no great country can afford to be without. The future relations of employers and employed will have to be readjusted, starting from the proposals, which I believe to be in spirit and principle almost universally accepted, of the Whitley Report, with developments for securing greater elasticity, more representative authority, and a more vital contact with new conditions, in the organisation of both; and, above all, with the purpose of achieving for men, women, and children opportunities, which were never given them under the old factory system, for a freer, a more self-developed, a humaner life."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 6.—Sir J. J. Thomson, president, in the chair.—Prof. W. H. **Young**: The series of Legendre.—L. **Hartshorn**: The discharge of gases under high pressures. It is well known that when gas discharges through an orifice from a vessel in which the pressure is p_0 into one in which it is p_1, the rate of discharge is approximately constant from $p_1=0$ upwards to some critical value, but then, as p_1 further increases, the discharge falls off, slowly at first, afterwards with greater rapidity. In the present investigation, this phenomenon is examined with greater accuracy than has hitherto been obtained. In every case it was found that the flow was constant to at least one part in 10,000 for a considerable range of p_1. The critical value of p_1, at which the flow began to change, varied widely for different nozzles, being about 0·2 p_0 for the convergent and parallel ones, but as high as 0·7 p_0 for certain divergent ones. Thus, the theoretical value for convergent nozzles, viz., 0·527 p_0, cannot be accepted as applying even approximately to all nozzles.—Lt.-Col. A. G. **Hadcock**: Internal ballistics. This paper deals with the burning of the explosive in the gun and the expansion of the gas, both before and after the charge has been consumed. On firing the gun the action is threefold:—(1) The driving band on projectile is forced into the rifling grooves. (2) In subsequent burning of charge, the gas from any fraction of charge expands with consequent reduction of temperature. The still burning powder gives additional heat. The expansion is thus partly adiabatic and partly isothermal. (3) After the charge is consumed the gas expands adiabatically. From expressions given in the paper, and knowing the rate of burning of cordite under various pressures, formulæ are developed for finding velocity of projectile, position in gun, and pressure of gas. The magnitude and position of maximum pressure are found by a further development of formulæ.—Dr. A. **Russell**: The electrostatic problem of a conducting sphere in a spherical cavity. The author gives formulæ by means of which the capacity, the electric force between the spheres, and the maximum electric stress on the dielectric between them can be readily computed in all cases to any required degree of accuracy. The solutions of these problems are required when determining the ratio of the measure of the electrostatic to the electromagnetic unit of charge by means of a spherical condenser for the calibration of a spherical condenser of variable capacity, for the calibration of a high-tension voltmeter, and for the determination of the electric strengths of insulating materials.—Prof. G. N. **Watson**: The zeros of Bessel functions. The paper contains a statement and discussion of some general theorems concerning the zeros of Bessel functions; the theorems are true for functions of any order, and, unlike results previously known, are of particular interest in the case of functions of high order. It appears that comparatively general considerations of a non-arithmetical type yield fairly precise information concerning the position and numbers of the zeros of the Bessel functions of the first kind. It is doubtful whether results of this character could be obtained without making use of the method of steepest descents which has been prominent in various recent investigations.

Aristotelian Society, December 3.—Dr. H. Wildon Carr, president, in the chair.—F. C. **Bartlett**: The development of criticism. An attempt to trace broadly the development of criticism reveals four main stages—the simply appreciative, the conventional, the rational, and the intuitional. At the first, criticism is the immediate outcome of the feeling accompanying ease or hesitation of reaction; at the second, a situation or object is criticised by virtue of its relation to a mass of preceding experience, the latter remaining relatively vague and unanalysed; at the third, definite rules of criticism are developed; at the fourth, the verdict passed is regarded as the outcome, on one hand, of the peculiar nature of the object, and, on the other, of the relation of the object to the critic. Affective factors play a dominant part throughout in the production of criticism, while the direction of development is determined by a persistent "effort after meaning."

Mathematical Society, December 6.—Prof. H. Hilton, vice-president, in the chair.—Col. R. L. **Hippisley**: A new method of describing a three-bar curve.—O.

Hoppe: Proof of the primality of $N=\frac{1}{9}(10^{19}-1)$.—Messrs. **Hardy** and **Littlewood**: New Tauberian theorems.—C. V. H. **Rao**: The curves which lie on the quartic surface in space of four dimensions, and the corresponding curves on the cubic surface and the quartic with a double conic.—Prof. W. H. **Young**: (1) The connection between Legendre series and Fourier series. (2) Series of Bessel functions.

PARIS.

Academy of Sciences, November 26.—M. Camille Jordan in the chair.—G. **Humbert**: The development of irrational quadratics in a Stephen Smith continued fraction.—H. **Le Chatelier** and B. **Bogitch**: Silica bricks were prepared with different proportions of large quartz grains (4 mm.), and fine (0·1 mm.) or alternatively impalpable (0·01 mm.) quartz powder. The resistance to crushing of the silica bricks was determined at 1600° C., and cold. The substitution of fine quartz for impalpable reduced the strength at 1600° C. in a very marked manner; 75 per cent. of quartz grog to 25 per cent. impalpable quartz powder, with 2 per cent. of lime as cement, gave the best results. The crushing resistances of silica bricks, measured cold, do not necessarily correspond with the resistances measured at 1600° C.—E. **Perrier**: The exchanges of fauna between the sea and fresh water and the consequences from the point of view of sexuality.—E. L. **Bouvier**: The distribution of fresh-water crabs of the family of the Potamonidæ.—C. **Guichard**: The C networks such that the Laplace equation which corresponds with them is integrable.—P. **Humbert**: Expression of the Legendre function of the second species.—F. **Ventre**: Theorem on rolling loads.—Mlle. Y. **Dehorne**: The microscopic constitution of the skeleton of the Stromatoporidæ.—J. **Feytaud**: The parthenogenetic reproduction of *Otiorhynchus sulcatus*.—A. **Vernes**: The precipitation of colloidal ferric hydroxide by human serum, normal or syphilitic. If human serum is added in gradually decreasing quantities to the same amount of colloidal ferric hydroxide, with subsequent digestion at 37° C., at first there is no flocculation, then for a certain concentration of the serum there is complete flocculation. The phenomenon is periodic, decreasing amounts of serum giving alternately flocculation and no flocculation. With syphilitic serum the results are different, and it is possible to prepare a fine suspension of a determined stability which will flocculate with a certain amount of syphilitic serum, but will not flocculate with the same amount of normal serum.—J. **Ducuing**: The publication of MM. Heitz-Boyer and Scheikevitch concerning the *rôle* of bone in osteogenesis in the adult, the relations of osteogenesis with infection, and the corresponding applications.

BOOKS RECEIVED.

My Four Years in Germany. By J. W. Gerard. Pp. xiv+320. (London: Hodder and Stoughton.) 7s. 6d. net.

Il nostro Soldato Saggi di Psicologia Militare. By A. Gemelli. Pp. xii+339. (Milano: Fratelli Treves.)

Report on Agricultural Damage by Vermin and Birds in the Counties of Norfolk and Oxfordshire in 1916. By R. T. Gunther. Pp. 92. (London: Oxford University Press.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 13.

ROYAL SOCIETY, at 4.30.—The Formation of Nitrites from Nitrates in Aqueous Solution by the Action of Sunlight and the Assimilation of the Nitrites by Green Leaves in Sunlight: Prof. B. Moore.—The Transition from Rostro-carinate Flint Implements to the Tongue-shaped Implements of River-terrace Gravels: J. R. Moir.

LINNEAN SOCIETY, at 5.—Seeds with a Stony Endocarp and their Germination: A. W. Hill.—*Inter se* Experiments in Pheasant Crossing in evidence of Mendel's Law: Mrs. R. Haig Thomas.

ROYAL SOCIETY OF ARTS, at 4.30.—The Trade of India with Russia, France, and Italy: D. T. Chadwick.

OPTICAL SOCIETY, at 8.—Proposed Standard Optical Notation and Sign Convention: J. W. French.—Optical Nomenclature and Symbolism: T. Smith.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Discussion on the Metric System. Introductory Papers by L. B. Atkinson and A. J. Stubbs.

FRIDAY, DECEMBER 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) The Determination of Photographic Magnitudes. II.; (2) Prof. Sampson's Note on the Southern Magnitude Distribution: J. Halm.—The Classification of Long-Period Variable Stars: H. H. Turner.—The Resonance Theory of the Origin of the Moon: H. Jeffreys.—Variations in the Fourteen Months' Component of the Polar Motion: Hisashi Kimura.—Further Notes on the General Solution of Hill's Equation: E. Lindsay Ince.—The Errors in a Sum of Tabular Quantities: H. C. Plummer.—*Probable Paper:* The Short-Period Variable RZ Cephei: C. Martin and H. C. Plummer.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—The Use of Soap Films in Solving Torsion Problems: A. A. Griffith and G. I. Taylor.

MONDAY, DECEMBER 17.

ARISTOTELIAN SOCIETY, at 8.—The Conception of Reality: Dr. G. E. Moore.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The Drift of the *Endurance*: 2nd Lieut. J. M. Wordie.

ROYAL SOCIETY OF ARTS, at 4.30.—Progress in the Metallurgy of Copper: Prof. H. C. H. Carpenter.

VICTORIA INSTITUTE, at 4.30.—The Mosaic Origin of the Pentateuch: Rev. A. H. Finn.

SOCIETY OF ENGINEERS, at 5.—High-speed Railways: E. W. C. Kearney.

TUESDAY, DECEMBER 18.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—The Buenos Aires Western Railway Tunnels under the City of Buenos Aires: W. L. L. Brown.

ROYAL STATISTICAL SOCIETY, at 5.15.

ILLUMINATING ENGINEERING SOCIETY, at 5.—Presidential Address: A. P. Trotter.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Prospective Oil-fields of Barbadoes: E. H. C. Craig.

WEDNESDAY, DECEMBER 19.

ROYAL METEOROLOGICAL SOCIETY, at 5.—Computation of Wind Velocity from Pilot-Balloon Observations: P. Bolton.—The Use of Monthly Mean; Values in Climatological Analysis: E. G. Bilham.

ROYAL SOCIETY OF ARTS, at 4.30.—Science and the Cold Storage Industry Prof. J. Wemyss Anderson.

GEOLOGICAL SOCIETY, at 5.30.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Cytology and Genetics: Prof. W Bateson.

THURSDAY, DECEMBER 20.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—A Neglected Chemical Reaction and an Available Source of Potash: E. A. Ashcroft.—Syphoning Gravel: J. Jervis Garrard.

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