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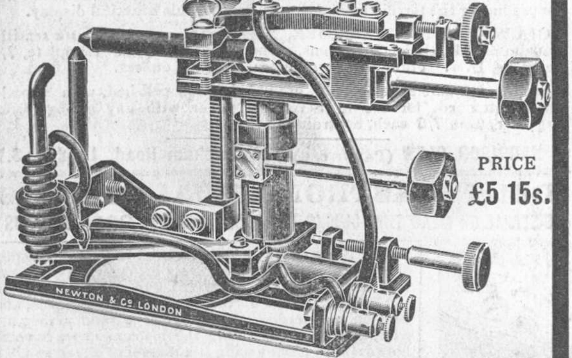

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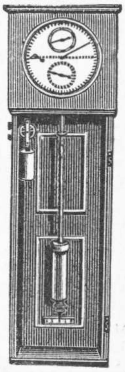

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(1) *Genetic Theory of Reality: being the Outcome of Genetic Logic as Issuing in the Æsthetic Theory of Reality called Pancalism.* With an extended glossary of terms. By Dr. J. M. Baldwin. Pp. xvii + 335. (New York and London: G. P. Putnam's Sons, 1915.) 7*s.* 6*d.* net.

(2) *The Natural Theology of Evolution.* By J. N. Shearman. Pp. xv + 288. (London: George Allen and Unwin, Ltd., n.d.) 10*s.* 6*d.* net.

(1) THIS book cannot be adequately reviewed without embarking more or less on an examination of the distinguished author's whole system as largely presented in his earlier monumental works. Moreover, being concerned with technical philosophy—though a philosophy which accepts and includes science—its appeal is primarily to readers other than those of this journal. It will suffice, therefore, to indicate briefly its scope and purport. The essence of the pancalistic doctrine is its emphasis on beauty. Science tells us what is true; that is science's prerogative. But the universe has beauty and goodness as well as truth. How reconcile and unify? The pancalistic answer is that the good and the true is so because it is beautiful. The final court of appeal is æsthetic. Nothing can be true without being beautiful, nor anything that is in any high sense good. The ascription of beauty, a reasoned, criticised, thought-out ascription of æsthetic quality, is the final form of our thought about nature, man, the world, the all. The volume under notice is an unfolding of this idea, dealing with the aspects of morphology, interpretation, religion (mysticism), and logic.

(2) An excellently written but somewhat diffuse restatement of Paley's argument for design. The author points out that the work of Darwin and his successors does not rule out design; it only requires the supposition that the designing mind works slowly, experimenting through many ages. As to those variations which have turned out failures—the flying reptiles and other extinct creatures of earlier periods—the author makes the suggestion that the direction of variation may to some extent be deputed by God to angels, in the same way as free-will and power is granted to man; and that these failures are the experiments of the angel-subordinates. But the author is not in the least a crank, and he puts forward this fresh and interesting hypothesis (which some would call fantastic) as a speculation only. His main point is that though the Darwinian natural selection is a true cause of change in species, the variations which tend to progress and greater complexity cannot be attributed to chance. They are evidence of a guiding mind which sees and knows before it produces on the material plane.

This, and the accompanying question of what we mean by "chance," is an extremely thorny problem, as the author indeed recognises. His treatment of it is lucid, sincere, and able, whether readers fully agree with it or not. Certainly there is a greater tendency among men of science at the present day to accept a philosophy of Platonic or idealistic type—which looks on Mind as the *prius,* and the material world a manifestation thereof—than at any time since modern scientific method appeared; and to many this very interesting volume will be welcome and useful. It deserves to be widely read.

LIME-SAND BRICKS AND ALLIED PRODUCTS.

Bricks and Artificial Stones of Non-plastic Materials: their Manufacture and Uses. By A. B. Searle. Pp. vi + 149. (London: J. and A. Churchill, 1915.) Price 8*s.* 6*d.* net.

AS intimated by the author in the preface, this book is intended: "(*a*) to supply reliable and unbiased information to those firms and individuals who contemplate making or buying bricks and artificial stones from non-plastic materials; (*b*) to assist manufacturers in solving the problems which occur in the course of their work, to enable them to remedy defects and to avoid other technical difficulties." In proceeding to carry out these objects, Mr. Searle treats in some detail the modes of production and uses of lime-sand bricks, clinker bricks, slag bricks, bricks made of crushed rock, concrete bricks and blocks, and various types of artificial stone, etc. As he points out, these products can often be made advantageously in districts where the manufacture of burnt bricks and tiles would be impracticable. Thus in some places the absence of suitable clay, or the want of a readily available supply of coal, would render any attempt to make bricks unprofitable; whilst, on the other hand, the presence in such a district of abundant deposits of sand might make the manufacture of lime-sand bricks perfectly feasible from a commercial viewpoint. It is even practicable in some cases for the two classes of products to be made side by side, the sand frequently found overlying the brick clays being beneficially utilised for the production of lime-sand bricks instead of being simply put away as so much waste material of no value.

A considerable amount of attention and space is devoted to a description of the raw materials,

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with their favourable and unfavourable characteristics, methods of preparing and mixing the ingredients (including some brief historical notices), the process of pressing, and the final process of hardening. The subjects of cost, of manufacture, and defects are dealt with in special chapters, as are also the physical properties of the products. The work is embellished with numerous illustrations depicting machinery and appliances suitable for properly carrying out the different kinds of operations.

Much of what is contained in the volume is based partly on the author's personal experiences, and partly on such experiences of other people as have come under his notice. This is in itself a highly commendable feature, but the author's confidently expressed opinions, assuming them to be well-founded, would lose none of their weight if the experimental data on which they are based were set forth more frequently than is the case.

There are a number of misprints, some of them trivial, but several may give rise to much doubt and perplexity. Apart from mere misprints, there are some loosely worded statements which would scarcely be expected from such an experienced writer as Mr. Searle appears to be, judging from the number of his published works. Thus, near the bottom of page 26, we are told that "the three essential ingredients—aggregate, lime, and water—*must be:* (1) *Ground* to the requisite fineness and graded (if necessary). (2) *The proper proportion* of each must be weighed or measured. (3) *Mixed* to form a homogeneous mass in which the lime is fully hydrated." The italics here are, of course, not the author's. Comment is scarcely necessary. It is not suggested that the meaning is obscure, but in quasi-scientific works on technical subjects there should be no flagrant flouting of grammatical rules. On page 82, line 18, 7 per cent. is mentioned instead of 0·7 per cent. There seems no valid reason for the spelling, in some of the later chapters, of "absorbtion" instead of the more orthodox "absorption." A curious mistake occurs at the bottom of the table on page 120, where the "cost of manufacture" of "cement-sand bricks" is stated to be "1 month." In the last sentence of the second paragraph on page 10, owing presumably to displacement of a comma, an absurd statement is made. It is true that the real meaning is rendered clear in the following paragraph, but a practised writer ought surely to guard against such slips.

The present writer has arrived at the conclusion that the author is less assailable as regards his treatment of the practical aspects of his subject than when dealing with more speculative questions. Thus, after giving in a tentative way the results of an analysis of the cementing material in non-plastic bricks, and suggesting a formula to correspond, he proceeds to apply this formula in a chemical equation to explain the reaction by which such cementing material is formed. The statement which accompanies it may constitute a fairly accurate general account of what takes place; but although more than one "if" is expressed or implied in the explanatory sentence, the equation somehow seems to suggest a more intimate knowledge of this particular reaction than is justified by the actual facts, as the author himself distinctly states more than once that the composition of the binding material is not definitely known. Again, in criticising the results of experimental work of F. F. Wright, performed at the Carnegie Institute, Mr. Searle goes so far as to assert that "if F. F. Wright had worked on a large scale and with better facilities, he would probably have realised that his experiments afford a much stronger confirmation of the composition suggested by the author of the present volume than they do of the existence of a zeolite, as the latter, so far as is known, do not possess cementitious properties." This may seem convincing to the author, but to a trained mind the conclusion is very far from being established, even when taking into account the experimental evidence by which he plausibly claims to prove the general accuracy of his conclusion.

With some reservation as regards certain of the matters to which attention has been directed, the work should prove useful for the objects the author had in mind when preparing it. One excellent feature worthy of mention is the comparison table occasionally introduced, showing in one view a number of more or less different processes, or the properties of a variety of different products, etc. There is also a serviceable index.

J. A. A.

THE PANAMA CANAL.

The Panama Canal: Comprising its History and Construction, and its Relation to the Navy, International Law, and Commerce. By R. E. Bakenhus, Capt. H. S. Knapp, and Dr. E. R. Johnson. Pp. xi+257. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1915.) Price 10*s.* 6*d.* net.

THIS book has a claim to authority. It consists essentially of a series of papers which were originally published in the Proceedings of the United States Naval Institute. Of the three authors the first, Mr. Bakenhus, is a member of the Corps of Civil Engineers of the United States Navy, the second, Capt. H. S. Knapp, U.S.N., was formerly member of the Naval War College Staff, and the third, Dr. Emery Johnson, is special commissioner on the Traffic and Tolls of the Panama Canal.

Mr. Bakenhus narrates the history of the project, and gives a clear account of the design and construction of the canal. His treatment of the phenomena presented by the landslides is, however, inadequate, and not marked by any originality of thought. They still occur at intervals, seriously reducing the depth of the waterway; it is quite uncertain when they will cease, and until that time comes the canal will not be thoroughly satisfactory as a link in the chain of naval communication between the Atlantic and Pacific Oceans.

Captain Knapp deals with the United States Navy and the Panama Canal, detailing the reductions of sea distance. The strategic aspect of the canal has not received sufficient attention in this country, considering that it was primarily intended for the use of the United States Navy. But if the British public has been in the past somewhat prone to neglect the study of strategy, our condition is one of enlightenment compared to the general misapprehension of such matters by American citizens.

"The United States," says Capt. Knapp, "is not a military nation. There is little consideration and less understanding among the people at large of military matters. The Government has no defined military policy, using military in its wide sense, and it has no defined naval policy."

The plain fact is that the American Government is gambling on the maintenance of the balance of power in Europe. Once let the balance of forces on our side be destroyed and the Monroe doctrine could not be upheld by the naval and military force now at the disposal of the United States, and the whole fabric of American imperial policy would fall. The time which would be required to prepare the United States for war with great Powers is probably under-estimated by most people. The first step must be the education of the people to its necessity, which necessarily takes time. The creation of an adequate staff of trained officers for a large army also takes time; and the building up of a merchant marine, so much required for the navy, is an extremely difficult problem in view of the economic conditions in America.

If the Government of the United States began to-morrow to prepare for a serious war we do not think that the country would be ready in less than twenty years. It is earnestly to be hoped in the interests of Anglo-Saxon civilisation that the great and patriotic democracy of America will turn its keen intelligence to the study of war. V. C.

OUR BOOKSHELF.

Refuse Disposal: a Practical Manual for Municipal Engineers, Members of Local Authorities, etc. By E. R. Matthews. Pp. xiv+160. (London: C. Griffin and Co., Ltd., 1915.) Price 6*s*. net.

"IT is the purpose of this work to set forth modern methods of collection and disposal, embodying the latest practice, so as to enable the municipal engineer and the local councillor to see what is being done in this and other countries"; and information of the type usually accumulated by local authorities in their consideration of the problem of refuse disposal is presented in large quantity having regard to limitations of space.

Given a sound knowledge of the general principles and practice, the engineer will find the collected data with regard to typical plants serviceable, but for the councillor some assistance to the intelligent application of the information presented might well have taken the place of certain non-essential detail and superfluous photographs.

"Discussion" of the advisability of installing destructors for small communities, promised in both preface and text, resolves itself into a description of certain destructors employed in works and institutions, and the statement that destructors "are equally useful for a village of five hundred population as for a city of 500,000."

The bearing upon the cost of disposal, of the special difficulties of collection, of the provision of adequate attention at the destructor, and of finding any practicable use for the heat generated, in a "village of five hundred population" as compared with a city or even an institution, is apparently unrecognised.

The book deals with the uses of destructor clinker and the construction of chimneys, and concludes with some interesting notes upon the principles of vacuum cleaning and dust collecting.

P. G.

A List of Geographical Atlases in the Library of Congress, with Bibliographical Notes. Compiled under the direction of Philip Lee Phillips. Vol. iii. Titles 3266–4087. (Washington: Government Printing Office, 1914.)

THE first two volumes of this valuable work were reviewed in NATURE in 1910 (vol. lxxxiv., p. 325), and as the same general plan and arrangement are followed in vol. iii., a brief notice of this will suffice. It deals almost entirely with acquisitions by the Library of Congress since 1909, but such are the resources at the disposal of this fortunate institution that the present list reaches more than half the bulk of the earlier one. In part this may be due to the somewhat fuller notes and analyses—a feature of great value—but the additions to the collection are extraordinarily numerous and important. They include, *e.g.*, copies of Lafreri's rare Italian atlas, and of Waghenaer's "Speculum Nauticum," the absence of both of which was commented on in our previous notice. But few copies of Lafreri, with title, are known, and no two are quite alike; so that the careful collation now given, and the comparison with Nordensköld's list, will be a boon to students, especially in conjunction with the comparative table of maps in other known copies—one in the collection of the Royal Geographical Society—lately supplied by Dr. Wieder, of Amsterdam. Other additions are the rare first edition of Ortelius, and six further editions of Mercator. The most complete of the latter (1639), of which a copy was lately acquired by the Royal Geographical Society, is not, however, to be found, any more than in our own national collection. We still miss a much-needed guide to the arrangement in the form of page-headings.

Lord Kitchener and his Work in Palestine. By Dr. Samuel Daiches. Pp. 88. (London: Luzac and Co., 1915.) Price 2*s.* 6*d.* net.

THIS lecture will serve admirably to acquaint the general reader with a little-known aspect of Lord Kitchener's great capacity. His Palestine exploration work falls in the years 1874 to 1878, and the success which attended it revealed him as a successful surveyor, a scientific observer, and a writer of convincing and trustworthy reports. The book provides an interesting and instructive account of his contributions to our knowledge of the geography, geology, and natural history of Palestine.

LETTERS TO THE EDITOR.

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

The Manganese-Ore Requirements of Germany.

PROF. CARPENTER, in his article on "Munition Metals" in NATURE of July 15, gives estimates of the resources of the enemy countries in the metals required for war purposes. This information will doubtless prove of great value, especially to those whose duty it is to study the weak points in the armour of our enemies and to devise methods of accentuating those weaknesses; it is consequently desirable that the information so gathered together should be as accurate as possible. In summing up, Prof. Carpenter states that the enemy countries can certainly produce five out of the ten metals considered, without having recourse to imports, these five being iron, manganese, chromium, zinc, lead; whilst he regards it as doubtful whether they can produce from domestic sources sufficient of the remaining five metals—nickel, copper, aluminium, tin, and antimony.

In the course of a lecture delivered in Calcutta recently I had occasion to review the situation as regards manganese-ore, and arrived at the conclusion that the internal resources of the enemy countries in manganese-ore were inadequate to supply more than a small proportion of the internal requirements; so that in my opinion manganese should be transferred to the second group of metals noticed by Prof. Carpenter. Consequently it seems that a short review of the facts of the case will not be out of place.

In the following table are collected statistics stated in metric tons of the steel production of the world, of Germany, and of Austria-Hungary, the manganese-ore production of the world, and the manganese-ore secured by Germany, and by Austria-Hungary, for each of the eight years 1906 to 1913:—

(*In Metric Tons.*)

Year	The World		Germany		Austria-Hungary	
	Steel production, in millions of tons	Manganese ore production, in thousands of tons	Steel production, in millions of tons	Manganese ore secured, in thousands of tons	Steel production, in millions of tons	Manganese ore secured, in thousands of tons
1906	49·64	1,932·8	11·14	328·6	1·20	57·4
1907	51·27	2,334·9	12·06	389·7	1·20	96·8
1908	44·36	1,353·6	10·48	331·8	2·03	63·1
1909	53·50	1,576·5	12·05	379·9	1·97	79·9
1910	58·66	1,835·4	13·70	483·3	2·19	92·7
1911	58·27	1,516·7	15·02	411·1	2·36	112·5
1912	72·7	1,640·8	17·87	515·3	2·79	89·7
1913	75·8	2,426·0	19·29	671·0	2·68	96·7
Totals	464·2	14,625·7	111·61	3,510·7	16·42	688·8
	3·15 tons of manganese ore per 100 tons of steel.		3·15 tons of manganese ore per 100 tons of steel.		4·20 tons of manganese ore per 100 tons of steel.	

Note.—These figures are based on statistics given in the "Mineral Industry." [See also "Records, Geolog. Survey, India," xlvi. pp. 144 145, (1915)]. The German "Manganese-ore secured" is the excess of imports over exports, the German "Manganese-ore" being excluded as referring mainly to manganiferous iron ore, which is excluded from this table. The Austrian "Manganese-ore secured" is the excess of production *plus* imports over exports.

From this we see that the German steel industry has shown a remarkable expansion, and that consequently in order to estimate the German requirements we should use only the most recent statistics. In the three years 1911 to 1913 Germany produced an annual average of 17·4 million tons of steel, and secured possession of an annual average of 622,400 tons of manganese-ore, of which 532,500 tons were imported chiefly from Russia and India, and the balance of about 90,000 tons (consisting, by the way, not of high-grade manganese-ore, like the imported material, but of manganiferous iron-ore) was won in Germany.

Turning to Austria-Hungary, we find that during the same three years she produced an annual average of 2·61 million tons of steel, and secured possession of 100,200 tons of manganese-ore, of which 69,400 tons were imported and 30,600 mined within the empire (including Bosnia-Herzegovina).

Assuming, therefore, that the two Teutonic empires require approximately as much manganese-ore when at war as in times of peace, it is evident that they have to provide 532,500 + 69,400 = 601,900 tons of ore to replace their imports in time of peace. There are four possible sources to be considered:—

(1) A development of internal resources.
(2) Imports from their ally Turkey, which posseses manganese-ore deposits.
(3) Imports from neutral countries.
(4) Accumulated stocks.

(1) A consideration of the German deposits of manganese-ore as at present described shows that they are all of small importance. The manganese-ore usually occurs either in irregular lenticular or nodular deposits, or in thin veins, in no case in sufficient quantity to permit of work on a really large scale, whilst a large proportion of the so-called manganese-ore is of very low grade, and more aptly termed manganiferous iron-ore. It does not seem probable that Germany could increase her annual average production of 90,000 tons by more than a few tens of thousands of tons.

The deposits in Austria-Hungary (especially in Bosnia) contain some high-grade managanese-ore, but the published accounts of these deposits do not indicate that an annual production of a little more than 30,000 tons could be increased to several times that amount.

Perhaps by intense activity the Teutonic empires might increase their output of manganese-ores and manganiferous iron-ores by 100,000 tons annually, but this seems exceedingly unlikely, both from the character of the deposits and from the fact that in times of peace the existence of a large market for manganese-ore must have created every incentive towards intensive working of the domestic manganese-ore deposits.

(2) Turkey is known to have manganese-ores at several localities, but information is very scanty. Of recent years no production has been reported, but a few years ago Turkey produced from 14,000 to 49,000 tons of ore annually. Of the producing localities the only one mentioned in Turkey-in-Europe was the Cassandra district, which is now part of Greece. In Asia Minor manganese-ores have been worked in the provinces of Trebizond and Aidin. In view of Russian naval activity in the Black Sea and the absence of railways, the Trebizond ores must be cut off from Constantinople. Aidin is, however, connected to Constantinople by rail *viâ* Smyrna, and ore from this region could consequently be forwarded, as long as through traffic is permitted at Smyrna by the Allies. But as the Aidin ores are reported to occur in pockets in limestone, no considerable development in this area seems possible. Ores have also been reported as occurring at one or two localities in the country to the south of the Sea of Marmora, and might supply a certain quantity of ore for shipment to Constantinople. Considering, however, the undeveloped state of Asia Minor and the bad communications, it seems improbable that Turkey will be able to aid her allies to any marked extent.

(3) The third possible source of manganese-ore is imports from neutral countries. Now by far the larger proportions of the world's output of manganese-ore comes from three countries, namely, India, Russia, and Brazil, which during the five years 1908 to 1912 (I have not yet been able to obtain complete figures for 1913) contributed respectively 43·8 per cent., 37·2 per cent., and 12·5 per cent., totalling 93·5 per cent. of the world's total production.[1]

The export of Indian ore is prohibited to all destinations except the United Kingdom and France; the export of the Russian manganese-ore to enemy countries is doubtless prohibited, whilst the hard facts of the geographical situation prevent its export to all neutral countries except Rumania and Bugaria,[2] and we can trust our Allies to see that no managanese-ore finds its way to Germany and Austria through this route. There are two reasons why Germany and Austria cannot fall back on Brazil for their supplies of manganese-ore, namely, the British Navy and the fact that Brazilian ore must be more than ever in demand in the United States of America, always its chief customer, now that America is cut off from the Indian and Russian supplies, for the United States, as pointed out in the footnote, has no domestic manganese-ore supplies of her own worth mention.

The 6·5 per cent. of manganese-ore not produced by the three countries mentioned is obtained from Austria-Hungary, Spain, Japan, Greece, France, the United Kingdom, Sweden, and Italy. Of the three neutral countries amongst those enumerated, Sweden is the only one conveniently situated for Germany. The Swedish annual production is a little more than 5000 tons, and, judging from observations made during a visit to the Swedish manganese mines, I should say that the Swedish production was capable of but very small expansion. Manganese-ore deposits are also known to occur in Bulgaria, but they are of low grade and small extent, so that they could not prove of much value. It seems evident then that Germany and Austria cannot find salvation in neutral countries.

(4) As the three possible sources already considered do not appear to hold out hope that Germany and Austria could obtain their peace requirements of manganese-ore in time of war, it is possible that the enemy countries made provision for this disability by accumulating large stocks of manganese-ore in times of peace. Whether this has been done or not can be deduced only indirectly. From the table on p. 170 we see that during the years 1906 to 1913, taking the world as a whole, 3·15 tons of manganese-ore were produced for every 100 tons of steel made, whilst curiously enough the figures for Germany alone for the same period show that that country received exactly the same proportion of manganese-ore per 100 tons of steel, namely, 3·15 tons.

Assuming that German metallurgy requires for its various purposes as high a percentage of manganese as the rest of the world, it seems reasonable to deduce from the foregoing figures that Germany actually consumed most of the manganese-ore received during the eight years in question, and that therefore by the end of 1913 she could not have accumulated any considerable stocks of manganese-ore. I must note that in making the above calculations I have excluded figures for manganiferous iron-ores from both the German and world's figures[3] as confusing the issue. During the eight years in question, however, the German total production of so-called manganese-ore (mostly manganiferous iron-ore) was 622,500 tons. But there is no reason for regarding this figure as a measure of accumulated stocks. It is instead rather a measure of the fact that Germany really requires a higher amount of manganese-ore per 100 tons of steel produced than most countries, owing to the necessity of adding manganese-ore or manganiferous iron-ore to the blast-furnace burden in smelting the sulphurous phosphoric minette iron-ores of Lorraine. During the same eight years, 1906–13, Austria-Hungary obtained 4·20 tons of manganese-ore for 100 tons of steel made. I have no information available to show whether or not there are any peculiarities in Austrian metallurgy requiring the use of a larger amount of manganese-ore than usual. If there are not, then these figures suggest an accumulation of stocks to the extent of about 175,000 tons by Austria by the end of 1913. The conclusions arrived at are admittedly open to considerable doubts, but it seems probable that by the end of 1913 the Teutonic Powers had not accumulated more than 200,000 tons of manganese-ore, and possibly considerably less.

At present I have been unable to obtain statistics relative to German imports of manganese-ore in 1914, except that there was nothing abnormal in the amount sent from India up to the outbreak of war. Had

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[1] Prof. Carpenter overlooks the Brazilian production, amounting roughly to 200,000 tons annually, and names the United States of America as one of the three chief producers of manganese-ore in 1913, whereas the 1913 production of the United States of America was the insignificant amount of 4048 tons out of the world's total production of over two million tons. This error is doubtless due to a misleading habit on the part of certain American compilers of statistics of including manganiferous iron-ores under the term manganese-ore. This manganiferous iron-ore production ranges from five to nine hundred thousand tons annually, but the percentage of manganese present in this iron-ore is only from 2 to 20, and such ore cannot be regarded as a manganese-ore, is doubtless never sold as such, and must be excluded from the world's totals of manganese.ore production. Another slight error has also crept into Prof. Carpenter's article: he states, referring to the production of Russia, India, and the United States of America, that "the raw material is pyrolusite, a 'straight' manganese-ore corresponding when pure to MnO_2." This is true only of the Russian ore; the American ore referred to is a manganiferous hematite, whilst the Indian ore is of mixed mineralogical composition. Although some of the Indian manganese-ore is pyrolusitic, by far the larger proportion is a mixture of braunite and psilomelane, whilst in some localities hollandite is an important ore.

[2] [Since this letter was written, Bulgaria has ceased to be a neutral country.—ED.]

[3] Manganiferous iron-ores are produced by the following countries:—

	Average for 1908–12
United States of America	686,302 metric tons
Germany	81,040 ,,
Greece	41,842 ,
Italy	15,165 ,,

Germany purchased abnormally from Russia during the first seven months of 1914 the fact would probably have been reflected in an increase in the price of manganese-ore during the year. As a matter of fact, the price per unit of manganese-ore fell steadily from a maximum of 12 to $12\frac{1}{4}$ pence in January, 1913, to $9\frac{1}{4}$ to $9\frac{1}{2}$ pence in July, 1914.

From what precedes it seems justifiable to conclude (*a*) that on the outbreak of war the Teutonic Powers had no great accumulated stocks of manganese-ore, perhaps a maximum of 200,000 tons; (*b*) that, assuming war conditions necessitate a maintenance of the iron and steel industries of those two countries at a peace standard, about 600,000 tons of ore a year must be obtained from fresh sources to replace imports in time of peace; (*c*) allowing that the Teutonic Powers might succeed in increasing their internal production by 100,000 tons and obtain 50,000 tons of manganese-ore from Turkey, if the Allied fleets could prevent all manganese-ore from outside from reaching Germany and Austria these countries would be faced with a shortage of 250,000 tons of manganese-ore in the first year of war, and with a shortage of 450,000 tons per year afterwards, increased to 500,000 tons per annum once the Dardanelles are forced.

The Germans will doubtless find means of dispensing with the use of manganese-ore as much as possible, and they may devise methods of utilising the manganese silicate, rhodonite, of which they appear to possess a considerable quantity; but it seems inevitable that the shortage of manganese-ore, once it is felt, will hamper seriously the German iron and steel industries.

It appears therefore to be of the utmost importance that every effort should be made by the Allied fleets to prevent smuggling of manganese-ore (or ferro-manganese and spiegeleisen) into Germany and Austria, either direct or through neutral ports. It is to be noted that of the small countries adjoining the enemy countries the only one manufacturing iron and steel is Sweden, which does not show either manganese-ore, ferro-manganese, or spiegeleisen, amongst her imports in normal years. L. LEIGH FERMOR.

Calcutta, September 2.

Jupiter's Two Principal Markings.

AT intervals during the work of a comparison of stellar magnitudes, the 26-in. reflector has been turned on Jupiter, in order to determine the present rotation period of the various surface currents, and it is hoped that results of some value will be obtained by the end of the present apparition. The following longitudes, based on transit estimates, of the two most important objects on Jupiter, viz., the S. Tropical Disturbance and the Red Spot Hollow, have been determined:—

S. Tropical Disturbance		
Date 1915	P. end	f. end
Sept. 11	28·3°	—
13	25·9°	—
20	23·5°	—
21	—	117·7°
26	—	112·8°
28	—	111·6°
30	20·4°	110·4°
Oct. 1	—	109·7°

Red Spot Hollow		
Date 1915	P. shoulder	f. shoulder
Sept. 10	—	260 2°
12	224·6°	—
17	224·3°	261·2°
19	224·1°	262·8°
27	—	260·2°
29	—	260·2°

The S. Tropical Disturbance is more than 90° in length at the S. equatorial belt, and in point of size forms a wonderful object when centrally on the meridian. Its length is such as to extend nearly from limb to limb. It first appeared as a comparatively small object in the spring of 1901, and although in the meantime it has fluctuated in size considerably, it exhibits no signs of decadence.

When the air is steady, the Red Spot can be seen without difficulty in the 26-in. reflector. It is, however, well to state that it is now no more distinct than it has been for many years. Displaced towards the f. side of the Hollow, its following end coincides almost with the longitude of the f. shoulder of the Hollow, while its northern contour is nearly in line with the S. edge of the S. equatorial belt. It will be seen from the above longitudes that the length of the Hollow is roughly 38°, a similar dimension having obtained during the last fifteen years.

October 2. SCRIVEN BOLTON.

The Orionid Meteoric Shower.

THE ensuing return of these meteors will deserve, and probably will repay, observation. The moon will be full on October 23, and will somewhat interfere with the display, but it is rather a long-continued one, and may be favourably witnessed in the mornings from about October 17–21 before sunrise.

From a great many observations made at Bristol, and which I have recently discussed, I believe that the shower extends from the first week in October to the first week in November. I have determined two radiants, as follows, from my collected materials from 1873 to the present time:—

October 3–12—$91\frac{1}{4}^\circ+14\frac{1}{2}^\circ$; 10 meteors.

October 25–November 7—$92\frac{1}{2}^\circ+14^\circ$; 18 meteors.

For the intervening period between October 12 and 25 I have a number of radiants of this well-known and annually recurring shower. The two radiants given above are adequately supported by a sufficiency of streaking meteors, and I believe represent genuine positions, but it cannot absolutely be proved that they are based on the flight of true Orionids. Remembering, however, that the radiation is from a fixed point at about $92^\circ+15^\circ$ for certainly a fortnight near the maximum, I believe I am justified in ascribing a month's activity to the shower. It would be serving a useful purpose if observers watched the display very carefully this year, and ascertained the place of the radiant point accurately between, say, October 15 and 25. The fact of this stationary radiant would then be no longer open to criticism. W. F. DENNING.

44 Egerton Road, Bristol, October 8.

Visibility of Distant Objects in Warfare.

I WAS much interested in the article on "Visibility of Distant Objects in Warfare" in NATURE of September 30. The question is of vital importance to many who, like myself, spend much of our time in artillery observing stations.

I believe a good deal of misconception exists as to the reasons why the Germans use various-coloured sandbags. It may be that their use is intended to make for invisibility, but I am inclined to think that it is primarily due to their lack of materials for making sandbags. They lack jute, and are consequently forced to make use of the stocks of various-coloured dress materials, in some cases indeed using the uniforms they have taken from the bodies of any men who may have been killed near their trenches. It is interesting to note that the colour most commonly employed in making their latest sandbags is a pinky-red.

In dealing with the question of visibility, it seems to me that the whole tendency in designing uniforms and in making fortifications is to ignore the important consideration of shadow, which Thayer has shown to have such an important bearing on the coloration of animals.

I have hopes that your article may induce some man of science to take the matter up, and perhaps submit his conclusions confidentially to Lord Fisher's Commission. ARTILLERY OBSERVING OFFICER.

October 6.

Distances at which Sounds of Heavy Gun-firing are Heard.

IN NATURE of September 30 I see a letter from Dr. Henry de Varigny on the above subject. It reminds me of September 2 last year, when I noted in my diary:—"The day here (400 ft. elevation on scarp of the Lower Greensand overlooking the Weald) was brilliantly fine and warm, without a cloud, South Downs misty, a gentle wind from the south-eastward. My sister heard very distant continuous rumbling, like guns, all the morning up to 1.30, and several times mentioned it when sitting in the garden; my coachman and a maid-servant also heard it. What was going on that day in France it would be interesting to know; there was no gun-firing on the coast of Sussex." I wrote, after taking bearing on map:—"It may possibly be as far as 150 miles to Amiens." I find twice since, and only a fortnight ago, similar continuous rumbling has been heard, but unfortunately the date not noted. I am much too deaf to hear such sounds myself. H. H. GODWIN-AUSTEN.

Nore, Godalming, October 1.

THE only papers on this subject with which I am acquainted are the following:—(1) The distance to which the firing of heavy guns is heard, NATURE, vol. lxii., 1900, pp. 377–79; (2) the audibility of the minute-guns fired at Spithead on February 1, *Knowledge*, vol. xxiv., 1901, pp. 124–25. Reference might also be made to NATURE, vol. xli., 1890, p. 369, and vol. lx., 1899, p. 139. The firing during the funeral procession of the late Queen Victoria was heard to a distance of 139 miles from Spithead. There is therefore no reason why firing along the Belgian coast should not, with favouring winds, be heard for many miles inland from our coasts. The air-vibrations affect pheasants and other birds (probably by swaying the branches of trees) for some distance after they cease to be perceptible to the human ear, as was widely observed on the occasion of the North Sea battle on January 24. I would suggest that observations of this kind should also be forwarded to Dr. de Varigny.

I may add that the literature relating to explosions is more extensive and much more valuable than the above. Prof. Omori's memoirs on the eruptions of the Asama-yama (Bull. Imp. Earthquake Inves. Com., Tokyo, vol. vi., 1912, pp. 1–147, and vol. vii., 1914, pp. 1–215) contain many interesting observations. A few cases of recent explosions in factories are noticed in NATURE, vol. lxi., 1899, pp. 91–92, and *Knowledge*, vol. i., 1904, pp. 94–95. Mr. S. Fujiwhara has lately published a valuable memoir on the abnormal propagation of sound in the atmosphere (Bull. of the Centr. Meteor. Obs. of Japan, vol. ii., pp. 1–143). This contains a mathematical discussion of the problem, with special reference to the observations recorded by Prof. Omori. References to recent German literature on the subject are also to be found in this memoir.

CHARLES DAVISON.

16 Manor Road, Birmingham.

The late Prof. E. A. Minchin on "The Evolution of the Cell."

PROF. E. A. MINCHIN was looking forward with interest at the time of his death to distributing the "extra prints" of his Manchester address, which was three times as long as will appear in NATURE. These "extras" are now in my possession, but I have no means of getting Prof. Minchin's "list." I shall be very happy to send a copy to anyone who will send me a postcard asking for it.

EDWARD HERON-ALLEN.

Large Acres, Selsey Bill, Sussex, October 12.

DEATH FROM STATIC CHANGES IN ATMOSPHERIC PRESSURE.

AS mentioned in a note in NATURE of July 8 (p. 515), M. R. Arnoux has found that a momentary diminution of at least 350 mm. of mercury in barometric pressure may be produced within three metres of a bursting high-explosive shell; and he suggests that the sudden diminution of pressure may cause death by the liberation of gas-bubbles in the blood, and consequent blocking of the circulation.

In his book on "La Pression Barométrique," published nearly forty years ago, Paul Bert proved that the various symptoms which often follow decompression from high atmospheric pressure are due to liberation of gas-bubbles in the blood or tissues. In diving work, and various kinds of engineering work under water or in water-bearing strata, men are exposed to high atmospheric pressure. During the exposure the blood passing through the lungs takes up in simple solution an extra amount of gas in proportion to the increased partial pressure of each gas present in the lung air. The gases present are oxygen, carbon dioxide, and nitrogen. The extra free oxygen taken up is, however, very small in amount as compared with the total free and combined oxygen taken up at normal atmospheric pressure; and since much of this total is used up as the blood passes through the tissues, there is no appreciable rise in the very low partial pressure of oxygen in the blood of the systemic capillaries or veins or in the tissues. There is also no rise in the low partial pressure of carbon dioxide in the lung air or blood, since the breathing is so regulated as to maintain a practically constant partial pressure of carbon dioxide in the lung air. On the other hand, the partial pressure of nitrogen in the blood leaving the lungs rises in proportion to the increased atmospheric pressure, and as no free nitrogen is used up, every part of the body becomes gradually saturated with nitrogen at this increased partial pressure. If, now, the atmospheric pressure is again reduced to normal, the blood and semi-liquid tissues of the body are left in a condition of super-saturation with nitrogen, and as a consequence bubbles, consisting almost entirely of nitrogen, are apt to form, and to cause very serious effects. Death may result from blockage of the circulation through the lungs or heart-muscle; paralytic attacks may be caused by blockage in the brain or spinal cord; while characteristic localised pain (so-called "bends") may be produced by the presence of bubbles elsewhere.

It is clear that if the atmospheric pressure is considerably diminished from normal, a similar condition of super-saturation of the body with nitrogen will exist, so that bubbles may be formed; and it is natural to suspect that a sudden, though only momentary, diminution, due to the bursting of a shell, might liberate bubbles. There are, however, facts which tell strongly against this hypothesis.

In the first place, it must be pointed out that a considerable interval of time elapses between decompression and the onset of symptoms due to bubble-formation. It is commonly fifteen or twenty minutes, and often far more, before the appearance of symptoms caused by bubbles after rapid decompression from a high atmospheric pressure. Sudden effects, such as those said to be produced by bursting shells, are never observed, however rapid the decompression may have been. The formation of bubbles of sufficient size to do any harm is evidently a process which takes considerable time. A momentary decompression, even if it were extreme, could scarcely, therefore, have any serious effect.

If, however, minute bubbles were formed, they would rapidly disappear again when the momentary wave of negative pressure had passed. Abundant experience has shown that there is no more rapid and certain means of treating the symptoms due to bubbles than recompression. When men who have come out of compressed air are affected, they can be relieved by returning them to the compressed air from which they came, or placing them in a medical recompression chamber provided for the purpose. As an instance of the application of this treatment, a recent case may be recorded of a naval diver who, owing to some emergency, had returned to surface suddenly, without carrying out the prescribed regulations for safety. About twenty minutes afterwards he became ill, lost consciousness, and was apparently dying from bubble formation. In accordance with the recommendations for dealing with such a case, in the absence of a re-compression chamber, his helmet was screwed on, and he was then lowered to the depth from which he had come. He recovered consciousness rapidly, and was soon able to answer the telephone, after which he was safely brought up, with due precautions. In the case of a man exposed only momentarily to decompression, the remedy for bubble-formation is, of course, automatically applied at once, since he returns at once to the pressure from which he was decompressed.

Recent investigations in this country have shown that symptoms due to bubble-formation do not occur unless the absolute barometic pressure is diminished by more than half. Thus it is safe to decompress rapidly from two atmospheres' pressure to one, or from six to three; and the Admiralty regulations for safety from bubble-formation in diving are based on this fact. Hence a sudden diminution of pressure from normal to half an atmosphere would not be dangerous, even if the decompression were a prolonged one. The momentary diminution observed by M. Arnoux was, however, only 350 mm., or not quite half an atmosphere.

It appears, therefore, to be impossible to accept the bubble theory of the action of bursting shells in killing men without visible wounds or mechanical injury. The newspaper accounts of men being killed by bursting shells in some sudden and mysterious manner, without wounds or bruises, appear to be imaginary. The experience of those who have been exposed to shell fire does not, so far as the writer's inquiries go, lend any support to these accounts. Neither poisonous gases nor any other known cause would account for men being instantly killed without mechanical injuries. An air-wave of sufficient violence may doubtless knock men over and inflict mechanical injury capable of causing death; but the actual fatal injuries caused by shells appear to be almost all due to fragments of metal or of stone or other material set in motion by the explosion.

J. S. HALDANE.

DR. J. MEDLEY WOOD.

WE record with regret the death, on August 26, at the Botanic Gardens, Durban, in his eighty-seventh year, of the veteran director of the Natal Herbarium, Dr. John Medley Wood. Dr. Medley Wood was a native of Mansfield, Nottinghamshire, and had resided in Natal for sixty-three years.

Before his appointment as curator of the Natal Botanic Gardens in 1882 he practised for a time as a solicitor, and then went trading to Zululand, afterwards devoting himself to farming. His home was then at Inanda, where he spent some ten years, and besides undertaking experiments in the cultivation of arrowroot and castor oil he interested himself in the local flora, and contributed large and important collections of Natal plants to Sir Joseph Hooker for the National Herbarium at Kew. His activities in this latter direction were naturally stimulated on his appointment to the Gardens. Not only did he continue to enrich the collections at Kew, but he founded and gradually built up the very valuable Herbarium of Natal plants at Durban, which is a model of what a colonial herbarium should be.

When Dr. Medley Wood was appointed curator of the Natal Garden in February, 1882, by the Durban Botanic Society, the condition of the garden was by no means flourishing, but as funds allowed he was not long in restoring it to a condition of beauty and usefulness. The value of his work was so far appreciated that the Government grant towards the upkeep of the garden and the maintenance of the collections was gradually increased, and in 1902 the new building for the Herbarium was completed. In 1909 the Herbarium collection consisted of some 43,000 mounted and classified specimens. Medley Wood's publications on the Natal flora form valuable contributions to botanical science. In 1886 he published an analytical key to the orders and genera of Natal plants, but the most important of his works is that entitled "Natal Plants," of which six volumes have been published, the first part, consisting of fifty plates with descriptions, having appeared in 1898. Other useful publications include his "Handbook to the Flora of Natal" (1907) and a "Revised List of the Flora of Natal" (1908). His "Guide to the Trees and Shrubs in the Natal Garden," published in 1897, giving dates of planting, is a valuable record of the work he did for the colony in the introduction of useful and interesting plants. He also did much for the improvement of the sugar-planting industry, and investigated many other problems of economic importance. In 1908 the Government grant for the garden and herbarium was much reduced, but although sadly hampered Medley Wood did not relinquish his efforts, and he was keenly interested in his work up to the end.

Dr. Medley Wood was appointed director of the Natal Garden, but he ceased to hold that office when it was recently handed over to the Corporation of Durban, and he then became director of the Natal Herbarium.

Two years ago the honorary degree of D.Sc. was conferred upon him by the University of the Cape of Good Hope, an honour which was a very fitting recognition of the great value of his services to botanical and agricultural science in South Africa, and gave much pleasure to his many friends.

NOTES.

WE notice with much regret the announcement of the death, at ninety-two years of age, of M. J. H. Fabre, whose patient studies of the life-histories of insects, as recorded in his "Souvenirs Entomologiques" and other works, placed him in the front rank of outdoor naturalists throughout the world.

THE Faraday Society will hold a general discussion on "The Transformations of Pure Iron" on Tuesday, October 19. The president, Sir Robert Hadfield, will preside over the discussion, which will be opened by Dr. A. E. Oxley, of Sheffield. Tickets may be obtained from the secretary of the Faraday Society, 82 Victoria Street, S.W.

WE learn from *Science* that Dr. Max Planck, professor of physics at Berlin, and Prof. Hugo von Seeliger, director of the Munich Observatory, have been made knights of the Prussian Order of Merit. Dr. Ramón y Cajal, professor of histology at Madrid, and Dr. C. J. Kapteyn, professor of astronomy at Groningen, have been appointed foreign knights of the same Order.

THE council of the Chemical Society has arranged for three lectures to be delivered at the ordinary scientific meetings during the coming session. The first of these lectures will be delivered on November 18, by Dr. E. J. Russell, who has chosen as his subject, "The Principles of Crop Production." The titles of the two later lectures to be delivered on February 3 and May 18, by Prof. W. H. Bragg and Prof. F. Gowland Hopkins, respectively, will be announced later.

THE new session of the Royal Geographical Society will open on November 15 with a paper by the president, Mr. Douglas W. Freshfield, on the southern frontiers of Austria. Among other papers to be read at evening meetings are:—The work of the Peru-Bolivia Boundary Commission, Sir Thomas H. Holdich; The geographical and ethnic position of the Slavs between the Adriatic and the Drave, Sir Arthur Evans; Cyrenaica, Prof. J. W. Gregory; The Troad and the command of the Dardanelles, Dr. Walter Leaf; The valley of Mexico, A. P. Maudslay; and the Gold Coast, A. E. Kitson.

A REUTER message from Paris states that the French Minister of War has appointed a consulting committee of experts attached to the Under-Secretaryship of Military Aeronautics. Among other well-known names, the Committee, which is presided over by the Under-Secretary himself, includes M. Appell, who occupies one of the chairs of mechanics at the Sorbonne; M. Robert Esnault; M. Pelterie; M. Deslandres, director of the Meudon Obsrvatory; M. Deutsch, president of the Aero Club; M. Renault; M. Clement Bayard; M. Eiffel; and M. Kling, director of the Municipal Observatory.

WE regret to notice that the *Engineer* for October 8 announces the death in action in France of Capt. W. McLeod Macmillan, of the 11th Argyll and Sutherland Highlanders. Capt. Macmillan was the chairman and managing director of the old-established shipbuilding firm of Archibald Macmillan and Son, Dumbarton, and was in his fortieth year. He was educated at Fettes College, Edinburgh, and succeeded his father in 1910. He acted for a period as chairman to the Clyde Shipbuilders' Association, and was a member of the council of the Institution of Engineers and Shipbuilders in Scotland.

AT the recent International Congress of Mathematicians at Cambridge it was decided that the next congress should meet at Stockholm in 1916. The King of Sweden offered a gold medal with the likeness of Karl Weierstrass and a sum of 3000 crowns for an original important discovery in the domain of the theory of analytical functions. Competing manuscripts were to have been sent to the editor of *Acta Mathematica* before October 31 next, the centenary of the birth of Weierstrass. We are informed by Prof. Mittag-Leffler that in accordance with a widely expressed wish, the King of Sweden has decided, in view of the European war, to postpone the last day for the receipt of competing memoirs until October 31, 1916.

IT is announced in the *Pioneer Mail* that the third annual meeting of the Indian Science Congress will be held in Allahabad from January 13–15, 1916, when Sir Sidney Burrard, F.R.S., will be president. The chief sections will be physics, chemistry, zoology, botany, agriculture, and ethnology, and the presidents of the respective sections Dr. Simpson, of the Meteorological Department; Dr. Sudborough, of the Research Institute, Bangalore; Dr. Woodland, of Allahabad; Dr. Howard, of Pusa; Mr. Coventry, of Pusa; and Mr. Burn. It is hoped that the local committee will persuade Dr. Bose to give a public lecture on his own researches. The local secretaries for this year are Dr. Hill, of Muir College, and Mr. P. S. Macmahon, of the Canning College, Lucknow, to the latter of whom all communications should be addressed. The congress is under the general control of the Asiatic Society of Bengal.

WE announce with regret the death in action in Flanders on September 25 of Major A. J. N. Tremearne, of the 8th Seaforth Highlanders. An Australian by birth, he served in the South African war, and later obtained an appointment in the Nigerian Police Force. There he acquired proficiency in the Hausa language, and studied the anthropology and folklore of this people. He then gained a scholarship at Christ's College, Cambridge, and was awarded the diploma in anthropology. The results of his work in Nigeria were published in "Hausa Superstitions and Customs," and "The Tailed Hunters of Nigeria." Later on he visited North Africa and published a work on demonology, entitled "The Ban of the Bori," in 1914. His sympathetic knowledge of the African races enabled him to carry out valuable field work, and the results of this were published in numerous papers in the Transactions of the British Association, the Royal Anthropological Institute, and the Folklore Society. It will be difficult to fill his place as a competent field anthropologist.

THE *Revue Scientifique* for September 18 reproduces an important address delivered at the Conservatoire des Arts et Métiers in February, by Prof. J. Violle. Its subject is the future of the physical industries of France after the war. By a comparison of the statistics of import and export of the countries of Europe he shows how France has in the last twenty or thirty years lost its place as a leading constructor of mechanical, electrical, and optical apparatus for the civilised world. He urges on the Government the importance of providing schools for the training of skilled workmen, of a National Laboratory of Weights and Measures on the lines of the National Physical Laboratory of this country, the Bureau of Standards of Washington, and the Physikalische Reichsanstalt of Germany. The country urgently needs such a central institution to which the scientific problems which arise in industry may be taken for solution. Behind these requirements he recognises the importance of following the example of Russia and removing the formidable temptation of alcohol from the workman's path, and points out finally how in the workshop, in the field, no less than in the army, France is suffering from "the shameful reduction in the birth rate."

THE abnormal condition of the market for feeding stuffs caused by the war suggested to Prof. Hendrick and Mr. W. J. Profeit the experiment described in Bulletin No. 20 issued by the North of Scotland College of Agriculture. The object of the experiment was to determine the feeding value of palm-kernel cake in comparison with linseed and decorticated cotton cakes. The first of these cakes is a feeding stuff hitherto little used in this country, almost the whole production going to the Continent, chiefly to Germany, where it has always found a ready market. Now, however, large stocks of palm-kernel cake are, or shortly will be, at the disposal of the home feeder. In Prof. Hendrick's experiment thirty head of cattle were divided into three lots, each consisting of six heifers and four bullocks. Throughout the period of eighty-four days covering the experiment, each lot of animals was fed with one variety of cake mixed with locust-bean meal in addition to a diet of swedes and straw to all alike. The three lots of cattle all did well, and the return in live weight increase was practically the same for each kind of cake. The monetary return from the palm-kernel cake was, however, considerably better than that given by either cotton or linseed cakes at present prices. Some doubts have been expressed as to the keeping properties of palm-kernel cake owing to the oil becoming rancid, but no difficulty of this kind was found after nine months' storage. The high percentage of fibre in this cake does not appear to affect the digestibility of the feeding stuff.

THE Board of Agriculture and Fisheries is circulating an appeal by Lord Selborne to the farmers and occupiers of land in England and Wales calling on them to produce as much food as possible during the coming year. No hope of financial support from the State is held out, but farmers are asked to do their part in increasing the supply of food as the special war service which they can render to their country. Leaving the precise means to be adopted to the farmer's judgment and to the advice of his friends and neighbours, it is suggested that the object in view may be attained by one or more of the following methods:—(*a*) By ploughing up the poorest permanent pasture and so increasing the arable land; (*b*) by shortening the period for which existing arable land is kept under clover or rotation grasses; (*c*) by improving the remaining grass land so that it will carry more stock; and (*d*) by reducing the acreage of bare fallow wherever possible. Lord Selborne realises the many special difficulties that have to be overcome, of which the chief is that of labour. Arrangements have already been made that men skilled in agricultural work, such as shepherds and engine-drivers, are not to be accepted for enlistment, yet this difficulty will remain with regard to the supply of ordinary farm labour. Machinery is to be set up to link the actual producer with the Board of Agriculture through the agency of local committees in each district, acting under the guidance of a War Agricultural Committee for each county. The farmer should consult his local committee on any problems or difficulties that may confront him. By this means it will be possible for the President of the Board to be kept informed of the needs of farmers throughout the country and to secure that all the help that can be given them is placed at their disposal.

THE idea of a universal permanent or durable peace has seemed to many minds merely Utopian. But the peculiar circumstances of a world-war are more and more forcibly impressing upon the world the desirability of realising the idea, and are also beginning to make clear the necessary bases of such realisation. The present war may be termed scientific from many aspects, and a permanent world-peace can only be attained by scientific study of the causes of war and of the possible ameliorating conditions. Several publications dealing with these matters have reached us recently. The Swiss thinker, Prof. August Forel, shows, in his "Die Vereinigten Staaten der Erde," how the causes of war and of this war are rooted in every department of social life and organisation. The *brochure* has many interesting *aperçus* on national psychology, and the meaning of race-hatred, warfever, and the like. It is worth translating into English for its scientific insight alone. In 1795 Immanuel Kant drew up a programme, "Zum Ewigen Frieden," which is still a classic. Messrs. George Allen have been well advised to issue this with translation in pamphlet form. The manifesto of the Central Organisation for a Durable Peace, at 51 Theresiastraat, the Hague, gives a minimum-programme for the bases of such peace, chiefly to invite suggestions and co-operation. It is the result of the international meeting held at the Hague last April. The *Comité Suisse pour l'étude des bases d'un traité de paix durable* have, on the lines of the Hague manifesto, issued a valuable *mémoire*, not individual, like M. Forel's, but impersonally legal. It contains references to articles of conventions and to recent literature on the general subject of permanent peace. Certainly there is now in process of creation a science of peace-maintenance, the successful results of which may regenerate both national and international life.

IN the issue of the Journal of the Royal Anthropological Institute for January–June, 1915, the president, Prof. A. Keith, publishes his presidential address on the Bronze age invaders of Britain. He fixes the date of this invasion about the year 2000 B.C., and he states that we are not yet in possession of sufficient evidence to determine how far this round-headed race replaced the older inhabitants of Britain. There were several parts of England, Wales, Scotland, and Ireland which they failed to penetrate; at least, we have not found in these parts their peculiar "round-barrow" graves. The problem is to ascertain the birthplace of this race. We find merely secondary settlements along the eastern shores of the North Sea and at the possible points of their embarkation. The hypothesis that they came from Asia may be discarded, as the belief is growing that our own continent may have produced its own races. The centre of dispersion was probably the central mountainous region of Europe. In Denmark we recognise two invading waves of round-heads, but the older or neolithic wave contained men marked by all the characters which we recognise in the English round-barrow people. They also settled in south Sweden, south-west Norway, at the mouths of the Elbe, Weser, and Ems, advanced down the Rhine valley, and reached the coast of Normandy. The paper deserves attention as an able summary of the results of modern research.

THE *Indian Journal of Medical Research* for July (vol. iii., No. 1) contains a number of valuable papers on subjects relating to tropical medicine. Major MacGilchrist discusses the relative therapeutic value in malaria of the cinchona alkaloids, and finds that hydroquinine is clinically superior to quinine and all the others.

THE report of the director-general of public health, New South Wales, for the year 1913, recently issued, contains a mass of statistical and other information relating to the public health of that colony. One of the most interesting sections deals with an outbreak of small-pox in Sydney, showing how mild and insidious this disease may sometimes be. It is also of interest because the disease was successfuly inoculated upon the calf.

THE third report of the Government Bureau of Microbiology, New South Wales, contains a number of valuable reports on the diseases of man, animals, and plants occurring in the colony, and on agricultural and economic problems. A diphtheroid bacillus was isolated from a number of surgical lesions in children. It was, however, not the true diphtheria bacillus; it conformed to one particular and distinctive type, which can be identified with comparative ease, and is named by Dr. Cleland the *Bacillus chirurgicalis*. The organism was usually non-virulent to guinea-pigs.

MANY biochemical reactions proceed in the manner of a mono-molecular reaction, as, for example, the killing of micro-organisms by heat and by disinfectants. T. Madsen and T. Watabiki show that the same holds good for the destruction of "complement" of blood-serum and of "hæmolytic amboceptors" by heat, the relation between the temperature, and the rapidity of reaction in both cases conforming in general to the law of van't Hoff and Arrhenius (*Bull. de l'Acad. Roy. des Sc. et des Lettres de Danemark*, 1915, No. 2).

"THE bird as a labourer," remarks a writer in the autumn number of *Bird Notes and News*, "is not recognised by the Board of Agriculture." This is indeed the case, because the Board has not yet risen to a full sense of its responsibilities. When it does it will establish a Bureau of Ornithology, such as has long been at work, both on the Continent and in the United States. In these countries the value of birds as destroyers of insect pests and of noxious weeds is fully recognised. The present number of our contemporary contains some valuable information on the subject of birds in relation to the farmer and gardener.

DR. J. M. DEWAR, in the *Zoologist* for September, continues his observations on "The Relation of the Oystercatcher to its Natural Environment." The present notes are concerned with the summer environment, and the nature of the nesting-sites and sources of food supply. The breeding-stations within the area examined fall into three distinct habitats—a hill-stream, a river-valley, and a beach habitat. But a strong similarity exists between all the stations of each habitat, variability of the factors being much less pronounced than in the winter environment. In such inland stations earthworms, tipulid, and coleopterous larvæ form the staple food of the young. In the lake-beach area a large sand-bank at the head of the loch, and a boulder area on its north shore, are used every year by the birds that have failed to breed, as places of assembly for bathing, sunning, and other activities. We should have been glad of some statement as to the number of birds breeding at these stations. But these details will perhaps be given in a later article, for the series is not yet completed.

MR. A. H. CLARKE, in the *American Naturalist* for September, discourses at length on asymmetry as developed in the genera and families of recent Crinoids. He maintains that the less favourable the environment as a whole the greater becomes the proportion of asymmetrical forms. The two main factors in producing asymmetry are bathymetrical and thermal. This feature is least developed at the optimum temperature for crinoid life, and most developed in temperatures which are phylogenetically too warm or too cold. Excessive cold appears to be the determining factor in the asymmetry of the genus Promachocrinus; while the opposite condition, excessive warmth, similarly affects the family Comasteridæ. Internal unfavourable conditions, the author insists, have also to be taken into account, such, for example, as are induced by incipient phylogenetical degeneration through type-senescence, as in the Plicatocrinidæ, which, in recent seas, represent the almost exclusively Palæozoic Inadunata.

A FURTHER instalment of Mr. J. F. Duthie's "Flora of the Upper Gangetic Plain" has now been published. The present section, which forms part i. of vol. iii., deals with the families Nyctaginaceæ to Ceratophyllaceæ, and occupies 168 pages. The Euphorbiaceæ and Urticaceæ are among the most important of the families included, the former with twenty-one genera and the latter with seventeen. The genus Ficus, which has some 600 species, is represented in the Upper Gangetic plain by eighteen species, among which are such well-known trees as *Ficus bengalensis* and *F. religiosa*.

Monthly Weather Reviews are published with great regularity by the Government of India, and the issue for March, 1915, shows considerable activity on the part of the meteorological department. The review, which is drawn up under the superintendence of Dr. G. C. Simpson, is based on observations taken daily at 8 hrs. at 215 stations, and on additional observations taken at 10 hrs. and 16 hrs. at 14 stations. For the summary of rainfall, observations are used from about 2,300 stations. March was remarkably wet over by far the greater part of the Indian area, and with these conditions the air was damper and the sky more cloudy than usual in most parts of the country. The departures from normal temperature were generally feebly marked, whilst the barometric pressure in the plains was in excess of the normal. Observations are given of solar, magnetic, and seismic disturbances. Much detailed information can be obtained from the tabular results and from the illustrations contained in the review.

RAINFALL values for August, 1915, are given in *Symons's Meteorological Magazine* for September, and the results show very varied conditions for the month. Last August is so commonly quoted as being wet that it is somewhat surprising to find that the percentage of the average rainfall was 72 for England and Wales, 68 for Scotland, 83 for Ireland, and 75 for the British Isles as a whole. The London rainfall was 95 per cent. of the average, from the observations at Camden Square, but it may be remarked that the rainfall was much heavier at South Kensington, the recording station of the Meteorologcal Office, where the fall was about 50 per cent. above the normal. The values given for the several stations in different parts of the British Isles show very varying results. The greatest excess on the normal occurred at Shoeburyness, where the fall was 166 per cent. of the average, and this is at a station which is notably one of the driest in the whole kingdom. Scathwaite, which is normally the wettest portion of the kingdom, had only 37 per cent. of the average, which is as great a deficiency for August as any part of the country. The map giving the rainfall for the Thames Valley shows that the rains were extremely irregular and patchy, particularly in the neighbourhood of London.

A NOTE on the divide produced by a plate in a moving liquid is contributed by Mr. Tsuruichi Hayashi to the *Tôhoku Mathematical Journal*, viii., 1. The author arrives at the conclusion that "the divide is the locus of point (*sic*) from which two shortest equal normals can be drawn to the periphery of the plate immersed." But this result is based on an assumption for which justification is sought in quotations from Duchemin's results, taken from De Villamil's recent book on "Motion of Liquids," with explanatory additions in square brackets. From these extracts the Japanese writer bases his conclusions on the assumption that the lines of flow along the face of the plate are straight lines normal to the boundary. Unfortunately, however, this assumption appears to be based on a distorted quotation of Duchemin's actual statements, and the reference to "curved" diagonals in the case of a rectangular plate, which is attributed to Duchemin, would appear to "unjustify" (if such a word may be made) the interpretations which have led to the present writer's conclusions. It is easy to construct cases where the result would evidently not hold good, in particular in the case of figures with re-entrant angles, or again, figures composed of two or more separate areas.

AN important paper, which marks a real advance in the chemistry of the sulphites, has been contributed to the September issue of the Journal of the Chemical Society by Mr. C. S. Garrett from the University of Liverpool. It is shown that no power of selective absorption of light is possessed by the neutral sulphites, such as Na_2SO_3, or by the two types of alkyl sulphites, such as $C_2H_5.O.SO.O.C_2H_5$ and $C_2H_5.SO_2.O.C_2H_5$. Sulphurous acid in aqueous solutions, on the other hand, gives a very well-marked maximum of absorption at wave-length 2760. The important discovery is now announced that the acid sulphites, such as $NaHSO_3$, and the metabisulphites, such as $Na_2S_2O_5$, show no selective absorption in freshly prepared aqueous solutions, but develop this property after keeping for some weeks, especially if exposed to light. It is suggested that this alteration of properties is due to the chemical changes represented by the equations—

$$2NaHSO_3 \rightleftharpoons Na_2SO_3 + H_2SO_3$$
$$H_2O + Na_2S_2O_5 \rightleftharpoons Na_2SO_3 + H_2SO_3,$$

whereby the non-absorbent compounds on the L.H. of the equation are converted into a non-absorbent sulphite and an absorbent form of sulphurous acid. Incidentally, it follows that this absorbent compound must have a different structure from that of all its derivatives; but as the gas gives an absorption-band at wave-length 2961, it is suggested that the absorbent compound is a hydrated form of sulphur dioxide formed according to the scheme—

$$(x-1)H_2O + H_2SO_3 \rightleftarrows SO_2,xH_2O.$$

THE use of chains for power driving has increased greatly, and we note with interest from the *Engineer* for October 8 an account of a chain drive transmitting about 5000 horse-power in a hydro-electric plant on the Snake River in the State of Oregon. The chains connect the waterwheel shafts to the generator shaft, and the arrangement was designed to meet conditions imposed by financial considerations. These conditions necessitated the adaptation of generators designed for direct connection to waterwheels running at 225 revs. per minute under 50-ft. head, to the same wheels running at 160 revs. per minute under 20-ft. head. The generator is of 3600 kilowatts, three-phase, 60 cycles, and had to be operated at the intended speed. The problem was solved by changing the position of two waterwheel units, providing additional shafting, and driving the generator shaft from the two waterwheel shafts by driving chains and sprocket wheels. Each set of driving chains consists of four Morse silent chains, 22 in. wide, and transmits 2500 horse-power. This is believed to be the most powerful chain drive plant in the world, the nearest to it being that at Indianapolis, which drives a 1200 horse-power generator.

OUR ASTRONOMICAL COLUMN.

COMET 1915*d* (MELLISH).—A card from the Copenhagen Observatory informs us that the following elements and ephemeris have been calculated by Messrs. Braae and Fischer-Petersen for Mellish's comet from observations at the Yerkes Observatory on September 18 and the Lick Observatory on September 19 and 20:—

$$T = 1915 \text{ Oct. } 11{\cdot}933 \text{ M.T. Berlin.}$$

$$\left.\begin{aligned} \omega &= 108^\circ\ 33'{\cdot}16 \\ \Omega &= \ \ 72^\circ\ 50'{\cdot}17 \\ i &= \ \ 49^\circ\ 41'{\cdot}62 \end{aligned}\right\} 1915{\cdot}0$$

$$\log q = 9{\cdot}72054$$

M.T. Berlin.

	R.A. (true)			Dec. (true)	
	h.	m.	s.	°	′
Oct. 14	13	38	38	+5	5·7
16		50	47	2	45·6
18	14	2	27	+0	25·7
20		13	39	−1	52·6
22		24	24	4	8·3
24		34	47	6	20·6
26		44	49	−8	29·0

A LARGE FIREBALL.—Mr. W. F. Denning writes:—"On the night of October 5 at 10h. 56m. Mrs. Fiammetta Wilson saw a large fireball from Portscatho, near Falmouth. It appeared in the N. by E. sky, its observed path being from 140°+68° to 126°+57°. A remarkable feature about the object was that it left a streak which remained visible for 17½ minutes, and underwent some curious transformations during the time it continued luminous. At first a straight band of glowing light, it gradually resolved itself into a large oval, which drifted slowly eastwards.

"The meteor must have been one of the most brilliant which has appeared for some time, and it is desirable to obtain further observations, both of the flight of the object and of the successive positions of the streak it left."

Mr. Arthur Mee sends us the following note upon the object:—

"A remarkable meteor was seen in south-west Wales on the evening of October 5. An observer at Mumbles says it appeared at seven minutes to eleven, and that the 'tail' retained its form for a minute and a half, and then gradually took the appearance of a hook, broadening as it did so, and finally fading away some seven minutes later. The meteor itself was so brilliant that it alarmed a dog and made it run indoors. An observer at Milford Haven says the appearance after the explosion of the meteor was that of a luminous cloud, 'a gigantic smoke-ring with wings.' It was first noticed in the zenith, and then gradually drifted in a north-easterly direction, becoming more diffuse, and finally disappearing soon after 11 o'clock. It was a bright, starry night, and the meteoric cloud was evidently self-luminous; the stars were seen quite clearly through it."

RECENT OBSERVATIONS OF VARIABLES.—One of four variable stars discovered by Dr. Silbernagel in 1907, since designated SS Aurigæ, belongs to the small class of long-period irregular variables of which U Geminorum is the best-known example. Almost from discovery it has received attention at Utrecht, where a large number of visual observations have been made by Prof. A. A. Nijland and Mr. van der Bilt (*Astr. Nach.*, 4814). Although most of the time it remains beyond visibility in the 10-in., twenty-five of its rather sudden accessions of lustre were followed during 1912–13. Of these, fourteen were "long" and eleven "short" maxima; correspondingly it was recorded brighter than 14·0m. for periods on the average of 14·6 and 8·2 days, attaining in the one case to 10·7m., in the other only reaching 11·0m. The mean curve for the "long" type of maximum almost precisely parallels that of U Geminorum, the latter being just one magnitude brighter. At Harvard the minimum brightness of SS Aurigæ has been measured as 15·9m., equivalent to 14·7m. in Prof. Nijland's system.

Mr. Torvald Köhl (*Astr. Nach.*, 4813) obtained further observations of 25, 1913, Ursæ Majoris during January–March of this year, from which the period of twenty-eight days gains additional weight.

A new variable star, 2, 1915, Cephei, has been found by M. Kostinsky, using the stereo-comparator (*Astr. Nach.*, 4809). The photographic magnitude increased by three units between November 29, 1911, and November 6, 1913, when it was 10·0m. M. Blazko has made confirmatory observations.

THE VICTORIAN OBSERVATORY.—The existence of this institution—better known as the Melbourne Observatory—is now definitely threatened. From Australian papers we learn that the State Astronomer, Mr. P. Baracchi, tendered his resignation last August after some thirty-nine years of Government service, the last fifteen years as successor to Mr Ellery. According to the *Age*, no successor is to be appointed, the State Government having decided to drop the work, thereby saving upwards of 4000*l.* annually. We trust some scheme of Commonwealth control will be evolved before it is too late.

THE PROPER MOTION OF A.G. WA. 5002.—In *Astr. Nach.*, No. 4814, Mr. R. J. Pocock, Nizamiah Observatory, Hyderabad, states that this star, No. 267 in Mr. van Maanen's recent list of proper-motion stars, has been photographed on two astrographic plates, neither of which shows any trace of proper motion.

FAMILY HISTORIES AND EUGENICS.

IN the thirteenth bulletin (June, 1915) from the Eugenics Record Office (Cold Spring Harbour, Long Island, New York), Messrs. C. B. Davenport and H. H. Laughlin give precise directions for making "a eugenical family study." The general lines are similar to those of the records of family histories which Sir Francis Galton sought to initiate in Britain many years ago. Such a study, carefully made, is, the authors tell us, important to the individual, who may understand and guide himself better if he knows his hereditary assets and liabilities; important to society, which "can treat the delinquent individual more reasonably, more effectively, and more humanely, if it knows the 'past performance' of his germ-plasm"; important with a view to "vocational selection," the end of which is to get the right man in the right place; important for education, which should take some account of the inborn potentialities of the individual; and important, finally, in the selection of marriage-mates, or at least in avoiding obviously unfit unions.

The bulletin tells the inquirer how to construct his "family tree" when the facts have been secured, and how to make an "individual analysis." This rather formidable enterprise involves answering sixty questions as to life-history, and as to physical, mental, and temperamental traits. The framing of the questions embodies long experience, and even to put them to oneself is interesting. Drs. Hoch and Amsden supply an even more elaborate *questionnaire* as to mental and temperamental traits. It will be hard to discover any trait that this catechism leaves out. It begins by asking the victim "if his education is up to his opportunities," and it ends by asking in what he gets "his deepest satisfaction." The questions are much more penetrating than those of the census paper or the income-tax return, and some of them seem to demand for their truthful answer a rare degree of detachment. But the authors meet this objection by pointing out that the records are to be kept as confidential documents in the central bureau, and that one must not think too much of personal privacy when the welfare of the race is concerned. Certain it is that a scientific genealogy is worth working towards, and that this bulletin is a useful step in that direction —useful in educating public opinion and in giving critics something to work on. In this connection it may be doubted, for instance, whether it is a wise discretion to refrain from any attempt to differentiate in the recording of family data between heritable and non-heritable traits. It may also be asked whether there is not a distinct risk of developing a self-conscious pre-occupation about one's "traits"—that Herbert Spencer was always talking about—and a paralysing obsessional conviction of the fatalism of heredity, which is only one side of the case.

CHARACTER AND INTELLIGENCE.

THE *British Journal of Psychology* has published as a monograph supplement (Cambridge University Press) the results of a research by Mr. Edward Webb on character and intelligence. The subjects of the inquiry were ninety-eight men students at a training college in 1912, ninety-six students at the same college in 1913, and four groups of schoolboys, amounting in all to 140. At the training college the prefects (second-year students), and at the schools the class-masters were utilised as judges, a pair of independent judges being employed in each case. Very careful instructions were given and detailed lists of qualities supplied. Examination results and experimental tests of intelligence were also used. All the assessments were ultimately translated into a scale of marks from +3 to −3. The "reliability coefficients" (correlations between the estimates of the same quality in the same individual by the two judges) were in many cases very low, the average being rather under 0·5, and nearly one-seventh of the qualities marked were rejected on the ground of unreliability. For those retained the average reliability coefficient is 0·55. The lowness of the "reliability coefficient" is held in part to be due to the care taken to secure independence between the estimates of the two judges. For intelligence-qualities the results are held to give a "strikingly thorough support" to the theory of a general factor. The deduced correlations of the general factor with the various estimates are discussed in detail, and give some interesting and unexpected results. Amongst the latter may be mentioned the fact that sense of humour, which has little correlation with the general factor, is fairly highly correlated with the estimates, the prefects' judgments being apparently biased by this quality. The character-qualities are discussed in the same way, and here again there is held to be evidence of a central factor, and this factor is in some close relation to "persistence of motives." This general factor markedly dominates all the correlations yielded by the estimates of moral qualities, the deeper social virtues, perseverance and persistence; also, negatively, qualities related to instability of the emotions and the lighter side of sociality.

SCIENCE IN THE WAR AND AFTER THE WAR.[1]

IT is universally acknowledged that the outcome of the present war must be an entirely new chapter in human history and a point of fresh departure in social, economical, and intellectual life. Hence it is well to begin even now to take stock of our resources, to examine not only the reasons for our deficiencies but the directions of our reforms. Particularly are we concerned with the improved attitude which we shall have to take nationally with regard to all that study and knowledge which we call science and scientific research and invention. Hence an important matter is to consider the position of science in the war and after the war.

Scientific knowledge is the accumulation of exact information concerning the facts and laws of nature, and the scientific method is the process by which we gain it, viz., by experiment or observation and logical deduction therefrom.

The cardinal fact which lies at the basis of all this nature-study is that there is no finality in it. Its possibilities are infinite, and we can never touch bottom in all that there is to be known about the simplest objects or phenomena of nature.

Hence the very essence of scientific study is that the votary should himself make some advances. Merely to know what others have done or discovered may be necessary, but this alone does not make a scientific student. Accordingly the training required is that which imparts the power to make new knowledge, and the results must be judged by the degree to which it succeeds in so doing.

At this stage we may distinguish, however, two classes of workers. There are first those who are most interested in new facts or principles regardless of immediate utility, and, secondly, those who show ability in utilising this knowledge in so-called useful applications of science. The first class em-

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[1] An introductory lecture delivered at University College, London, on October 6, by Prof. J. A. Fleming, F.R.S.

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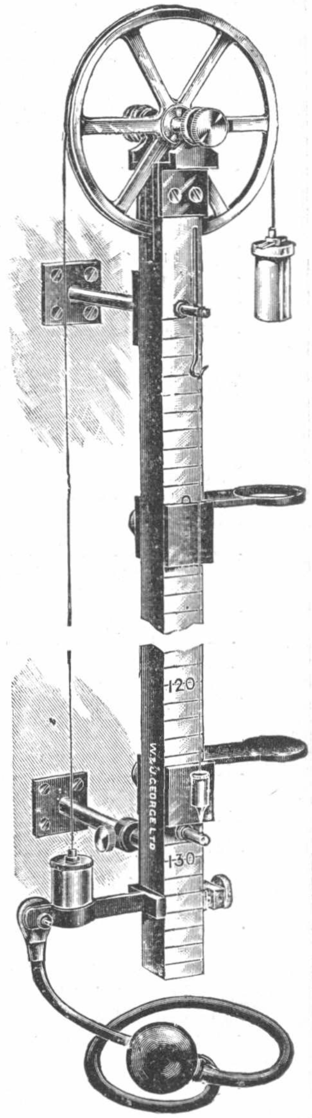

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braces the purely scientific investigators, and the second the inventors.

The public is, unfortunately, apt to attach more importance to the inventions than to the investigations, regardless of the fact that there could be no applications if there were no knowledge to apply. This failure to recognise the value and unspeakable importance of a progressive disinterested study of nature is a characteristic British quality, and it is something very much more serious than a mere national trait or idiosyncrasy.

Philosophical students of politics have long recognised that all forms of government have their special defects, and democratic or representative Parliamentary government is no exception. One of the chief defects of the latter is that the men who gain the upper hand are too often the fluent or persuasive speakers or those who are skilled in managing public assemblies and masters in oratory and debate.

Hence, as Mr. F. S. Oliver points out in his very suggestive book, "Ordeal by Battle," in all countries where representative government prevails this type of leader exercises a considerable and predominant influence on public affairs. But with the professional speaker and politician an over-great importance attaches generally to phrases and to words. Success with them depends very much on how a thing is put, and the form of expression often overrules even the subject-matter itself. But the whole object of scientific work is the discovery of the truth, and not its obscuration. Therefore the ascertainment of fact or principle is in all this work of infinitely more value than the form of words in which it is expressed. Hence to the politician there is a certain uncongeniality about the scientific habit of mind, whilst the man of serious scientific training becomes at times impatient of the methods of the party politician, which have not facts at the back of them.

Accordingly the principal idea which it is necessary to instil into the public mind and drive home by every means is that our chief concern should be to bring the scientific method to bear upon all the affairs of the nation.

The second equally important truth is that the disinterested but systematic study of nature is of primary importance for national well-being. By disinterested study we mean pure scientific research not undertaken mainly for commercial reasons. Pope, I think, tells us that the proper study of mankind is man; but an even more important object of study for man is that of nature, and if we undertake that properly all other things in the way of applications will be added unto us. The point to notice, however, is that it is not everyone who possesses the necessary turn of mind for scientific investigation. There is a mysterious aptitude in some children for music, drawing, or other pursuits, and suitable training cultivates it. It is the same with the ability to discover or invent. Hence the primary duty of the nation with regard to its children is from the very earliest days to begin with them the study of nature, not in the repulsive form of learning things out of books, but by taking the child direct to the lap of Mother Nature and letting her teach the lessons about flowers, animals, stars, and earth structure.

All this, of course, means expenditure, but the nation has to learn this hard lesson, that education of the right kind cannot be given without wise and large outlay, and that there is nothing so expensive in the long run as cheap education. Another thing that has to be drilled into the public mind at all costs is that there are no short cuts to national efficiency or scientific pre-eminence.

The moment a deficiency is discovered, the tendency of the public is to cry out for some quick remedy; but quick remedies are very often quack remedies at best. We require, therefore, in the first place an entirely altered attitude of mind on the part of our public men, statesmen, and, above all, editors and managers of great daily newspapers towards scientific work, research, and teaching. We want a far greater appreciation of its supreme importance and of the attention that should be given to the cultivation of it under the guidance of expert leaders. The small degree to which genuine scientific work is appreciated, contrasted with mere sensational announcements not based on genuine discoveries or inventions, is seen in the treatment of scientific work by the daily Press, which, after all, only reflects the attitude of mind of the general public. Compare, for instance, the attention accorded before the war to politics, amusement, and fashion, and that accorded to accounts of scientific researches or lectures, in the principal daily papers. Worse still, some of them are apparently easily led to take up and boom perfectly unscientific but sensational announcements.

An illustration of this occurred not long ago in connection with a supposed great invention of a flying train. The scientific principle utilised was one discovered thirty years ago independently by Prof. Elihu Thomson and by me, and familiar for years to all electricians, viz. the repulsion exerted on electric conductors by a powerful alternating-current magnet. By this means the inventor proposed to raise a train off the rails and propel it, I think, at three hundred miles an hour. Every engineering student, however, knows well that the resistance to the motion of a train at high speed is largely air resistance, and that this increases very rapidly with the speed. Hence even if there were no rail or axle friction at all, an economical limit to the velocity is soon reached at which the cost of driving power becomes prohibitive.

The inventor ignored this important fact, and for a week at least the utmost nonsense was written in daily papers by journalists whose only qualification for the task was an exuberance of language and metaphor combined with an utter ignorance of scientific facts. New inventions or suggestions require careful, sympathetic, yet critical treatment, but the public are misled when imagination is allowed to run riot too soon. Nevertheless, even great discoveries or inventions, such as the Röntgen rays or wireless telegraphy, have been received with scepticism and their utility denied at first.

The daily Press, which has such immense influence on public opinion, should exercise wise guidance in these matters, aided by competent scientific opinion, yet with discrimination and care not to denounce novelty merely because it is new or strange.

Turning to the applications of science in the war, we can mention four chief departments of it under the headings: chemical, mechanical, electrical, and physical, which cover such appliances as high explosives, aeroplanes and dirigibles, submarines, wireless telegraphy, and range-finders. I shall not attempt to discuss the details of a fraction of all these applications, but just touch briefly on two departments which happen to have occupied my own attention during the vacation, viz. range-finders and wireless telegraphy from aeroplanes.

An extremely important matter in all war with projectiles is to ascertain the exact distance of the objective, whether it be ship or gun or building. The range of the projectile depends on the angle of elevation of the gun and the character of the ammunition and several other factors.

The proper setting of the gun can, of course, be determined by trial shots, but the larger the gun the more expensive this process, and the more necessary not to let the enemy know anything until a shot or shell falls exactly where it can do most damage to him.

Range-finders have for their object to determine this distance by some optical appliance. They are divided into two classes: first, prism or base range-finders, and, secondly, subtend range-finders. We can explain the principle of these by reference to our eyes and the method by which we roughly judge the distance of an object. When we look at an object the optic axes of the eyes converge on it, and by long practice we are able to appreciate the inclination of the axes. The centres of the eyes are about 2½ in. apart. Hence we have a very short-based isosceles triangle, but we are enabled by our muscular sense to give a rough guess as to the angles at the base and practically to infer something about the length of the triangle. Again, we do it in another way by estimating the relative sizes of the image of known objects, such as a man or house or other thing which is formed on the retina. Another thing which assists us is the amount of detail we see in the object looked at.

The range-finders used in war are only more exact applications of the same principles. One of the most accurate is that of Profs. Barr and Stroud. This is a base or prism range-finder. It consists of a tube varying from half a metre to two metres, about 6 ft. in length. At the ends of this tube are two totally reflecting prisms, which receive rays from the object and send them down the tube. At each end of the tube is an object glass, which forms an image which is received on a peculiarly cut prism at the centre and by an eye-piece. The arrangement virtually forms a sort of double telescope corresponding to two eyes set 6 ft. apart. When the observer looks into the right eye-piece he sees a field of view which is divided into two parts, one produced by light coming into one object glass, and the other by that coming in at the other. If the object seen is a mast, say, of a ship, it appears broken in two parts. The observer can rectify or bring into agreement these two parts of the image by moving to or fro in the tube a thin prism. The position of this prism is read off on a scale seen with the left eye-piece. This scale shows the distance in yards of the object.

Thus on board our battleships a range-finder of this kind is placed in one of the fighting-tops on the masts, and the observer looking at a distant ship can in a few seconds move the prism, adjust the two parts of the image to agreement, and read off the range. He then sends down the range by telephone to the gun-layers. Thus in the battle of the Dogger Bank, and in that of the Falkland Islands, firing by our battleships began at about 17,000 or 18,000 yards. The range-finder would thus be continually sending down the ranges 20,000, 19,000, 18,000 yards, etc., and the gunners would keep the object vessel in sight and fire when the command was given as the known range of hitting was reached.

The same principle is applied in a smaller instrument for military use, called the Marindin range-finder, invented by Major Marindin, only in the latter instrument the means adopted for bringing the two parts of the field of view or image into agreement are by a movement of one of the prisms.

The Barr and Stroud range-finder is a very accurate instrument, and will determine ranges up to 20,000 yards, or about 12 miles, with an accuracy of 50 to 100 yards.

In the next place there are range-finders called subtend range-finders, which depend on the measurement of the size of an image of a known object. When we look at an object either with the eye or with a telescope at different distances, it appears to be smaller the farther away we are from it. In the case of the eye we have no means of measuring accurately this variation in size except by comparing the apparent size of the distant object with some near object the size of which is known. Hence judging distance by the eye requires long training, as all sportsmen, sailors, and travellers know.

Moreover, we are apt to be deceived as to the apparent size. Ask anyone, for instance: How large appears the full moon? Many people would say, As large as a shilling—meaning that it has the same apparent angular magnitude as a shilling seen at 10 ins. or 1 ft., which is the usual distance we hold a book or paper when reading.

But now, if you try the experiment, you will find that the full moon is covered by a very small pencil, like a pocket-book or dance-programme pencil, held at 10 in. from the eye. In scientific language, the apparent size of the moon is about half a degree, which means that it is covered by an object 1/10th in. in diameter held 1 ft. from the eye.

A man 6 ft. high would subtend the same angle at a distance of 720 ft. Hence you can tell the distance of a man by ascertaining the distance at which an object of known size, say a pencil, must be held so as just to cover his height. An ordinary pencil ¼ in. in diameter held horizontally at arm's length (=2 ft.) would just cover a man 5 ft. 8 in. high at a distance of 544 ft., or 181 yd. The subtend range-finder works on the principle of measuring the angular magnitude of the object. One way of doing this is to place in the focus of the eyepiece a plate of glass with divisions ruled on it with a diamond. If we know how many divisions are covered by an object of known height at a known distance, we can tell the distance of any other object of known height.

It is very seldom, however, that we do know the exact height of the object, and, moreover, it is very difficult to count up accurately many very small divisions ruled on glass when the object seen is at all dark.

During the vacation I have been turning attention to methods for overcoming some of these difficulties. As these inventions are being submitted to the Ministry of Munitions, I do not think it desirable to go into details as to the methods, but I will tell you the results. I have invented three forms of range-finder—one which is an improved subtend range-finder with which I can find the distance of any object the dimensions of which are known, whether height or width, or any part of it. Also I have invented methods for using two such instruments to measure the distance of objects the dimensions of which are not known. In the second place, I have invented a simple form of base range-finder which measures what is called in astronomy the parallax of any distant object, and hence determines its distance. In the third place, I have devised a simple form of depression or elevation angle meter by means of which the height of any hill, and also the distance of any object from it, or from an elevated position, can be determined by an observer standing at the top of the hill, provided that he can also see two marks placed at the base in line with the point of observation on the hill and at a known distance apart. These instruments are simple and inexpensive to construct, and give an accuracy of measurement quite sufficient to direct rifle or artillery fire or bomb throwing in trenches. One great advantage of my range-finder is that it can be used with a periscope from the bottom of a trench so that the observer need not be exposed at all, but can determine the distance of the enemy's trench by observation on any post of a wire entanglement or stick or rock or anything with a sharp outline. Another principle which may be applied in making a range-finder, which I have also done in my instruments, is to observe the variation in the size of an object as seen in a small telescope by moving away from it a certain distance. Thus, suppose that a man was seen at a distance of 200 yd., or 600 ft., then his apparent height would be covered by the width of a pencil held about 2 ft. from the eye. Suppose the observer were to approach to half that distance or move in 300 ft., then the apparent size of the man would be doubled. If, however, the man were a mile away, then moving towards him 100 yd. would only increase his apparent height by about 6 per cent. Hence we can determine the distance of an object by finding out how much the apparent size is increased when we move in towards it 100 yd. or any assigned distance.

Another marvellous application of science in war is that of wireless telegraphy in connection with aeroplanes and airships as a means of scouting and rapid communication of intelligence.

The difficulties connected with it are, however, considerable, and it has greater limitations than the uninitiated would suppose.

In the case of aeroplanes the first of these is the weight of the apparatus. The military aeroplane is already loaded to its fullest extent. In addition to the pilot and observer and the bomb ammunition, it carries in nearly all cases some gun equipment. Hence any wireless apparatus must be made as light and compact as possible. A wireless transmitter of the so-called spark type involves three elements: (i) some source of electromotive force such as a battery or dynamo, (ii) an induction coil or transformer for creating a high electric potential or pressure, and (iii) some form of condenser or Leyden jar which is charged and then discharged across a spark gap, thus creating rapid movements of electricity called electric oscillations. These oscillations are then caused to create others in a long wire called the aerial wire.

In the case of aeroplanes and airships the source of electromotive force is generally a small dynamo or alternator, which is coupled to the engine, and the voltage or pressure is raised to 30,000 volts or so by a small transformer sealed up in oil in a box. The condenser consists of metal plates sandwiched between sheets of glass or ebonite, and the spark balls between which the spark passes are also enclosed. The weight of the whole apparatus has to be kept below 100 lb., and such apparatus has been designed having a weight of not more than 30 lb. The French use a set weighing about 70 lb. One of the difficulties is to dispose the aerial wire conveniently and safely. It is sometimes made of aluminium and stretched on insulators carried by light supports on the wings, but the difficulty is to obtain in this way sufficient length. One plan adopted is to coil the wire on a reel, which the observer can uncoil and let it float out behind the aeroplane.

The wire must be connected to the reel by a safety catch so as to be released at once if it catches in trees or buildings. By this means an aerial wire of 100 ft. in length can be employed. The observer has near his hand a key by which he controls the spark discharges and so sets up in the aerial wire groups of electric oscillations which create electric waves in the æther, and signal the message in Morse code.

In this manner there is not much difficulty in equipping aeroplanes with transmitters which will send messages 30 miles or so to a corresponding earth station.

These latter are the military portable motor-car or pack stations, the details of which were described in a lecture given here last year on "Wireless Telegraphy in War."

The receiving arrangements used on aeroplanes comprise a head-telephone which is worn by the observer associated with some simple form of detector such as a carborundum crystal, aided by which the observer hears the signals sent to him in Morse code as long and short sounds in the telephone.

The noise of the aeroplane engine and that of the rush of air renders this method of aural reception a matter of great difficulty, especially as the messages must be sent in secret code, and the observer must therefore hear every letter distinctly if the message is to be intelligible. Great efforts have been made to devise methods of reception which shall appeal to the eye by a visual signal rather than to the ear, but the exceedingly small electric currents set up in the aerial wire by the arriving waves make this a matter of extreme difficulty, and the problem has not yet been completely solved. There is then the difficulty caused by "jamming." If the signals from an aeroplane are picked up by a hostile station, this latter at once sends out powerful but unmeaning signals the object of which is to blur and drown out the reception or sending of signals by this aeroplane. Moreover, the sending of wireless signals by an aeroplane reveals its presence to hostile earth stations before it can be seen by the eye.

Hence wireless telegraphy may be a means of revealing the enemies' scouts, and it involves a certain kind of war in the æther as well as war in the air.

In the case of airships there are other difficulties as well, and it is interesting to note that there are special difficulties in connection with Zeppelins. These aerial monsters are, as everyone knows, constructed with a framework of aluminium, containing in its interior the eighteen or twenty balloons inflated with hydrogen. Now as we rise upwards in the air the electric potential increases rapidly, and if a conducting body at a height gives off water drops or products of combustion, it is rapidly brought to the potential of the air at the place where it is. In the case of Zeppelins this equalisation is no doubt brought about by the escape of products of combustion produced by the engines. When the conducting body is brought down suddenly to earth again, there may be a great difference of potential between it and the objects on the earth. If it is a good conductor, a spark may pass, and if it is, as in the case of a Zeppelin, a conducting body containing a highly inflammable gas, leakage of which cannot altogether be prevented, this spark may cause an explosion and destruction of the airship. Again, the violent electric oscillations created in all metal objects near powerful radiotelegraphic apparatus may cause sparks to jump between metal parts, and hence may inflame a hydrogen leak.

It has therefore been recognised that there are special electrical difficulties in connection with the working of wireless on rigid airships with metal frames and also in connection with the use of spark apparatus. However carefully the actual working spark is enclosed there is always risk of induced sparks.

There is room, therefore, yet for much research and experimenting in connection with the use of wireless telegraphy on aeroplanes and airships, and the practical problems are by no means completely solved.

This leads to the consideration of the methods we have adopted for dealing with these and all other suggestions of the same kind of the nature of war inventions.

The Royal Society appointed certain committees at an early stage in the war to deal with engineering or mechanical and with chemical inventions. These committees were constituted secret committees, and none of the fellows except the council and the small number of the appointed fellows were allowed even to know the names of the members. The ostensible reason for this unusual secrecy was that the committees should not be inundated with correspondence from eager inventors and that their work was confidential, but this argument is scarcely valid because the names of the members of other inventions committees, such as those afterwards appointed by the Admiralty and the Ministry of Munitions, were made public. The publication of the names of members in no way necessitates the publication of information as to their work. In the formation of such committees the important qualification should be not merely scientific or theoretical learning, but sufficient practical knowledge of the matters considered.

The men whose opinions are valuable on war inventions are the men who have to use them, namely, experienced military and naval officers. Again, the value of an invention can usually only be estimated by a practical trial, and this means expenditure. It is an almost impossible matter to judge of an invention merely from a written description. An idea may be old or a method may be familiar, and yet it may be carried out in detail in such a manner as to have great practical value under certain conditions. The ability to form a correct judgment of an engineering invention requires a very wide experience, since it is not easy to appreciate the good points or anticipate the defects of an invention or suggestion or idea which has not been put to the test of practice. Nevertheless, the experts appointed by the Ministry of Munitions are doing valuable work in sifting out the useful ideas from the hundreds already submitted to them.

It is beyond any doubt that this war is a war of engineers and chemists quite as much as of soldiers.

The 42-cm. Krupp gun which smashed in a few days the fortifications of Liège, Namur, and Antwerp, which were confidently expected to hold out for months, is only a piece of heavy engineering. The complete gun weighs 87 tons, and the foundations or carriage 37 tons. Two hundred men are necessary to erect and work each gun, which requires twelve railway wagons for its transport and is composed of 172 parts. It takes twenty-five to twenty-six hours to erect in place. The projectile or shell weighs 8 cwt., and is 5′ 4″ long and 16½″ diameter. It is fired electrically from a distance of about a quarter of a mile, and each shot costs 550*l*. The range at which the Liège forts were destroyed was fourteen miles. The mere transport and erection of this gun, let alone its manufacture, demands engineering knowledge of a special kind. It is the same with smaller arms. The rifle, except as a support for a bayonet, has almost become obsolete in face of the machine gun.

To win this war we have to achieve engineering feats. The mammoth howitzer, the great armoured triple-engined aeroplane, and the quick-firing machine guns are all products of the engineer's workshop, and the pivot round which all Germany's maleficent power turns is Krupp's works at Essen, and the chemical and ammunition factories in Westphalia. The knock-out blow will be given at those points, and they must be reached through the air if trench work proves too slow.

But in addition to the concentration of engineering knowledge and skill on the problems of the war, we have to think as well of what will come after. What is required is not merely opinions on inventions already made, but the proper organisation of inventive power and scientific research to bring about new and useful results. This is only to be achieved by bringing to bear adequate combined inventive or scientific power on definite problems which are not too far removed from practical possibilities.

We have as yet made scarcely any progress in the creation of a disciplined army of scientific workers which shall embrace all the abilities in the Empire. We are still in the stage which by comparison with an army is that of a mob of civilians equipped for war with shot guns and sticks.

One reason for this, I think, is because our chief scientific body, the Royal Society, has not taken upon itself more the function of guiding and assisting the general direction of research and invention.

The real function of the Royal Society should be to organise, direct, influence, assist, and promote scientific research, and to do it by an efficient organisation embracing the whole of its fellows. It represents, or should represent, the very best ability in all departments of scientific knowledge, and it should be organised into grand committees of subjects, as suggested by Prof. Armstrong, on one or more of which every fellow should have his place. The work of these grand committees should be to guide and instigate research in their own departments, to organise general discussions on leading questions in the manner undertaken of late years by the British Association, and to help to direct towards common and important ends the powers of scientific investigation in our universities and colleges.

The special and technical societies provide the facilities required for the reading of papers. A paper on physics, chemistry, or engineering as a rule receives better discussion and criticism if read at the Physical, Chemical, or Engineering Societies than at the Royal Society, and the discussion on a paper, if proper time and notice are given, is often quite as valuable as the paper itself. Although the individualistic method of research in which each scientific worker takes up whatever kind of research he pleases has produced good results in the past and is in agreement with our national characteristics, it is a serious question whether we shall not have to put limits to it in the future. The problems which await solution require in many cases combined or co-operative research. One of the most useful improvements in the proceedings of our learned societies would be the devotion of more time to well-organised and predetermined subjects of debate with the object of advancing knowledge at the boundaries of cognate sciences.

This applies to the purely scientific problems, as well as to the problems of industrial research. It must be remembered that, after this war is over, in a military sense we shall immediately commence another war of a different kind, in which the weapons will not be bullets and shells, but our national powers of invention, scientific research, commercial organisation, manufacturing capabilities, and education, and these will be pitted against those of a highly organised Germany determined to win back in commerce by any and every means, fair or foul, that which has been lost in war.

That commercial and industrial war will be waged by our enemies with the same ruthlessness and neglect of all scruples as their military operations. We have said good-bye now and for ever to those easy-going amateur British methods which have held us in the past. What we require is to obtain a higher percentage efficiency in all our operations. We have to attain larger and better results in education, scientific research, and industrial work to increase our national output in every way.

We have been buying dyes, chemicals, optical instruments, and drugs from Germany, glass from Austria, arc light carbons, electric machinery, and a hundred other things we have no need to buy, and the reason is that we have been shirking the effort and research necessary to make them as cheaply or as well at home. But the England with a national debt of 2000–3000 millions sterling will be a different kind of place to live in from the England of the year before last, and we shall have to adapt ourselves to the new conditions by new methods of work.

One of the most important of these, I venture to think, is the extension of co-operative research, both scientific and industrial. In the case of industrial work manufacturers are afraid of making their wants and difficulties known lest the mere statement of them should enable a British rival to find a solution and get ahead. It is necessary to appreciate, however, that rivalry between British manufacturers is not nearly such a serious matter as the competition of Germany with all of them will become, and that British manufacturers will have to stand shoulder to shoulder to meet the common foe. German firms do not hesitate to pool their knowledge if it enables Germany to get ahead of other nations, and British trades will therefore have to meet this organisation by one of a similar kind. In the same manner I have long been convinced that far greater advances might be made in purely scientific research in many departments of knowledge if we were to adopt more extensively the custom of associated work. I mean by this the formation of committees of workers, not too large for expeditious decisions, but charged with the duty of investigating certain formulated problems. It is in this respect that our learned societies might do so much more than they do. The proceedings of these societies are mostly a record of isolated, disconnected pieces of work of very different scientific value. But if properly organised discussion were brought to bear on the question, it would be possible to induce investigators of reputation and ability to associate themselves more in conjoint work to the great advantage of our common knowledge. The learned societies should therefore fulfil to the adult and experienced investigator the same function which the professor or teacher should fulfil to his research students, viz., supply them with suggestions for lines of research to stimulate thought and invention.

It is quite certain that we shall have to organise in this way to a far higher degree than we have yet done what may be called the strategy of research, and that the learned societies should act in some capacity like the great general staff of an army towards the subordinate generals and corps commanders. We require therefore to get on to the councils of our learned and technical societies and into their presidential chairs not merely men eminent for their private researches, but men of large ideas with organising abilities and inspirational power. If we do not do this, then, although by a lavish sacrifice of life and treasure we may win, as we are determined to do, in the military and naval operations, we shall in the long run be hopelessly defeated in that slower but none the less deadly scientific and commercial competition which will follow upon the cessation of actual hostilities.

THE BRITISH ASSOCIATION.

SECTION D.

ZOOLOGY.

OPENING ADDRESS[1] BY PROF. E. A. MINCHIN, M.A., HON. PH.D., F.R.S., PRESIDENT OF THE SECTION.

The Evolution of the Cell.

I PROPOSE in this address to deal with an aspect of cytology which appears to me not to have received as yet the attention which it deserves, namely, the evolution of the cell and of its complex organisation as revealed by the investigation of cytologists. Up to the present time, the labours of professed cytologists have been directed almost entirely towards the study of the cell in its most perfect form as it occurs in the Metazoa and the higher plants. Many cytologists appear, indeed, to regard the cell, as they know it in the Metazoa and Metaphyta, as the beginning of all things, the primordial unit in the evolution of living beings. For my part I would as soon postulate the special creation of man as believe that the metazoan cell, with its elaborate organisation and its extraordinarily perfected method of nuclear division by karyokinesis, represents the starting-point of the evolution of life. So long, however, as the attention of cytologists is confined to the study of the cells building up the bodies of the higher animals and plants, they are not brought face to face with the stages of evolution of the cell, but are confronted only with the cell as a finished and perfected product of evolution, that is to say, with cells which, although they may show infinite variation in subordinate points of structure and activity, are nevertheless so fundamentally of one type that their plan of structure and mode of reproduction by division can be described in general terms once and for all in the first chapter of a biological text-book or in the opening lecture of a course of elementary biology.

One of the most striking features of the general trend of biological investigation during the last two decades has been the attention paid to the Protista, that vast assemblage of living beings invisible, with few exceptions, to the unassisted human vision, and in some cases minute beyond the range of the most powerful microscopes of to-day. The study of the Protista has yielded results of the utmost importance for general scientific knowledge and theory. The morphological characteristic of the Protista, speaking generally, is that the body of the individual does not attain to a higher degree of organisation than that of the single cell. The exploitation, if I may use the term, of the Protista, though still in its initial stages, has already shown that it is amongst these organisms that we have to seek for the forms which indicate the evolution of the cell, both those lines of descent which lead on to the cell as seen in the Metazoa and Metaphyta, as well as other lines leading in directions altogether divergent from the typical cell of the text-book. We find in the Protista every possible condition of structural differentiation and elaboration, from cells as highly organised as those of Metazoa, or even in some cases much more so, back to types of structure to which the term cell can only be applied by stretching its meaning to the breaking-point.

It is impossible any longer to regard the cell as seen in the Metazoa and as defined in the text-books as the starting-point of organic evolution. It must be recognised that this type of cell has a long history of evolution behind it, which must be traced out, so far as the data permit. The construction of phylogenies and evolutionary series is, of course, purely speculative, since these theories relate to events which have taken place in a remote past, and which can only be inferred dimly and vaguely from such fragments of wreckage as are to be found stranded on the sands of the time in which we live. All attempts, therefore, to trace the evolution of the Protista must be considered as purely tentative at present. If I venture upon any such attempt, it is to be regarded as indicating a firm belief on my part that the evolution of the cell has taken place amongst the Protista, and that its stages can be traced there, rather than as a dogmatic statement that the evolution has taken place in just the manner which seems to me most probable.

Before, however, I can proceed to deal with my main subject, it is absolutely necessary that I should define clearly the sense in which I propose to use certain terms, more especially the words "cell," "nucleus," "chromatin," "protoplasm," and "cyto-

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[1] Abridged by the author.

plasm." Unless I do so, my position is certain to be misunderstood, as, indeed, it has been already by some of my critics.

The term cell was applied originally to the protoplasmic corpuscles building up the bodies of the Metazoa and Metaphyta, each such corpuscle consisting of a minute individualised mass of the living substance and containing a nucleus. Hence a complete cell is made up of two principal parts or regions, the nucleus and the remainder of the protoplasmic body, termed the cytoplasm. By some authors the term protoplasm is restricted to the cytoplasmic portion of the cell, and protoplasm is then contrasted with nucleus; but it is more convenient to consider the whole cell as composed of protoplasm divided into two regions, nucleus and cytoplasm.

We come now to the consideration of the body termed the nucleus, which undoubtedly possesses an importance in the life and functions of the cell far greater than would be inferred from the name given to it. I have described in general terms the typical nucleus of the text-books, as found commonly in the cells that build up the bodies of ordinary animals and plants. The minutiæ of the details of structure and arrangement of the constituent parts may vary infinitely, but the type remains fairly constant. When we come, however, to the nuclei of the Protista, such pronounced modifications and variations of the type are met with that a description in general terms is no longer possible. I will direct attention now only to one point. In the protist cell the chromatin is not necessarily confined to the nucleus, but may occur also as extranuclear grains and fragments, termed chromidia, scattered through the protoplasmic body; and the chromatin may be found only in the chromidial condition, a definite nucleus being temporarily or permanently absent.

The essential part of the nucleus is the chromatin, and the other structural constituents of the nucleus, namely, membrane, framework, and plastin or nucleolar bodies, are to be regarded as accessory components built up round, or added to, the primary nuclear material, the chromatin. Even with regard to the nuclei of Metazoa it is maintained by Vejdovsky that at each cell-generation the entire nucleus of the daughter-cell is produced from the chromosomes alone of the mother-cell. The simplest body which can be recognised as a nucleus, distinct from the chromidia scattered without order or arrangement throughout the protoplasmic body, is a mass of chromatin or a clump of chromatin-grains supported on a framework and lodged in a special vacuole in the cytoplasm.

This brings me to a point which I wish to emphasise most strongly, namely, that the conception of a true cell-nucleus is essentially a structural conception. A nucleus is not merely an aggregation of chromatin; it is not simply a central core of some chemical substance or material differing in nature from the remainder of the protoplasm. The concepts "nucleus" and "chromatin" differ as do those of "table" and "wood." Although chromatin is the one universal and necessary constituent entering into the composition of the cell-nucleus, a simple mass of chromatin is not a nucleus. A true nucleus is a cell-organ, of greater or less structural complexity, which has been elaborated progressively in the course of the evolution of the cell; it is as much an organ of the cell as the brain is an organ of the human body. As a definite cell-organ, it performs in the life and economy of the cell definite functions. As an organ of the cell, however, it has no homologue or analogue in the body of the multicellular animals or plants; there is no organ of the human body, taken as a whole, similar or comparable to the nucleus of the cell.

The foregoing brief consideration of the nucleus leads me now to discuss in more detail the nature and properties of the essential nuclear substance, the so-called chromatin. To define, or characterise adequately, this substance is a difficult task. The name chromatin is derived from the fact that this substance has a peculiar affinity for certain dyes or stains, so that when a cell is treated with the appropriate colouring reagents—with so-called nuclear stains—the chromatin in the nucleus stands out sharply, by reason of being coloured in a different manner from the rest of the cell. In consequence, the statement is frequently made, in a loose manner and without reflection, that chromatin is recognised by its staining reactions, but in reality this is far from being true. When a preparation of an ordinary cell is made by the methods of technique commonly in use, the chromatin is recognised and identified by its position in a definite body with characteristic structure and relations to the cell as a whole, namely, the nucleus, and this is equally true whether the chromatin has been stained or not. Any so-called chromatin-stain colours many bodies which may occur in a cell besides the chromatin, and it may be necessary to try a great many different stains before a combination is found which will differentiate a given cytoplasmic enclosure from a true chromatin-grain by its colour-reactions. The so-called volutin-grains, for example, which are found commonly in the cytoplasm of many protists, are identified by the fact that they have a stronger affinity for "chromatin-stains" than chromatin itself.

What, then, is the true criterion of the chromatin-substance of living organisms? From the chemical point of view the essential substance of the cell-nucleus would appear to be characterised by a complexity of molecular structure far exceeding that of any other proteins, as well as by certain definite peculiarities. Especially characteristic of chromatin is its richness in phosphorus-compounds, and it stands apart also from other cell-elements in its solvent reactions, for example, resistance to peptic digestion. How far these features are common, however, to all samples of chromatin in all types of living organisms universally, cannot, I think, be stated definitely at present; at any rate, it is not feasible for a cytologist of these days to identify a granule in a living organism or cell as chromatin solely by its chemical reactions, although it is quite possible that at some future time purely chemical tests will be decisive upon this point—a consummation devoutly to be wished.

The only criterion of chromatin that is convincing to the present-day biologist is the test of its behaviour, that is to say, its relations to the life, activity, and development of the organism. I may best express my meaning by an objective example. If I make a preparation of *Arcella vulgaris* by suitable methods, I see the two conspicuous nuclei and also a ring of granules lying in the cytoplasm, stained in the same manner as the chromatin of the nuclei. Are these extranuclear granules to be regarded also as chromatin? Yes, most decidedly, because many laborious and detailed investigations have shown that from this ring of granules in Arcella nuclei can arise, usually termed "secondary" nuclei for no other reason than that they arise *de novo* from the extranuclear chromatin and quite independently of the "primary" nuclei. The secondary nuclei are, however, true nuclei in every respect, as shown by their structure, behaviour, and relations to the life-history of the organism; they may fuse as nuclei of gametes (pronuclei) in the sexual act, and they become, with or without such fusion, the primary nuclei of future generations of Arcella; they then divide by karyokinesis, when the organism reproduces itself in the ordinary way by fission, and are replaced in their turn by new secondary nuclei at certain crises in the life-history. In view of these facts, it can be asserted without hesitation that the ring of staining granules in Arcella is composed of, or at least contains, true chromatin-grains, extranuclear chromatin for which R. Hertwig's term chromidia is now used universally.

Having now defined or explained, as well as I am able, the terms of which I am about to make use, I return to my main theme, the cell and its evolution. To summarise the points already discussed, a typical cell is a mass of protoplasm differentiated into two principal parts or regions, the cytoplasm and the nucleus, or, it may be, two or more nuclei. The cytoplasm may or may not contain chromatin-grains in addition to other enclosures, and may possess cell-organs of various kinds. The nucleus, highly variable in minute structure, possesses one invariable constituent, the chromatin-material in the form of grains and masses of various sizes.

The cell, therefore, in its complete and typical form, is an organism of very considerable complexity of structure and multiplicity of parts. The truth of this proposition is sufficiently obvious even from simple inspection of the structural details revealed by the microscope in cells in the so-called "resting condition," but still more so from a study of their activities and functions. The vital processes exhibited by the cell indicate a complexity of organisation and a minuteness in the details of its mechanism which transcend our comprehension and baffle the human imagination, to the same extent as do the immensities of the stellar universe. If such language seems hyperbolic, it is but necessary to reflect on some of the established discoveries of cytology, such as the extraordinary degree of complication attained in the process of division of the nucleus by karyokinesis, or the bewildering series of events that take place in the nuclei of germ-cells in the processes of maturation and fertilisation. Such examples of cell-activity give us, as it were, a glimpse into the workshop of life and teach us that the subtlety and intricacy of the cell-microcosm can scarcely be exaggerated.

On the assumption that an organism so complex and potent was not created suddenly, perfect and complete as it stands, but arose, like all other organisms, by progressive evolution and elaboration of some simpler form and type of structure, it is legitimate to inquire which of the various parts of the cell are the older and more primitive and which are more recent acquisitions in the course of evolution. The evolution of the cell may be discussed as a morphological problem of the same order as that of the phylogeny of any other class or phylum of living beings, and by the same methods of inquiry.

The problem of cell-evolution may be attacked, beginning with the consideration of the primary structural differentiation of the typical cell, the distinction of nucleus, or rather chromatin, and cytoplasm.

Since no concrete foundation can be found for the view that cytoplasm and chromatin have a common origin in the evolution of living things, we are brought back to the view that one of them must have preceded the other in phylogeny.

For my part, I am unable to accept any theory of the evolution of the earliest forms of living beings which assumes the existence of forms of life composed entirely of cytoplasm without chromatin. All the results of modern investigations into the structure, physiology, and behaviour of cells, on the one hand, and of the various types of organisms grouped under the Protista, on the other hand—the combined results, that is to say, of cytology and protistology—appear to me to indicate that the chromatin-elements represent the primary and original living units or individuals, and that the cytoplasm represents a secondary product. I will summarise briefly the grounds that have led me to this conviction, and will attempt to justify the faith that I hold; but first I wish to discuss briefly certain preliminary considerations which seem to me of great importance in this connection.

It is common amongst biologists to speak of "living substance," this phrase being preceded by either the definite or the indefinite article—by either "the" or "a." If we pause to consider the meaning of the phrase, it is to be presumed that those who make use of it employ the term "substance" in the usual sense to denote a form of matter to which some specific chemical significance can be attached, which could conceivably be defined more or less strictly by a chemist, perhaps even reduced to a chemical formula of some type. But the addition of the adjective "living" negatives any such interpretation of the term "substance," since it is the fundamental and essential property of any living being that the material of which it is composed is in a state of continual molecular change and that its component substance or substances are inconstant in molecular constitution from moment to moment. When the body of a living organism has passed into a state of fixity of substance, it has ceased, temporarily or permanently, to behave as a living body; its fires are banked or extinguished. The phrase "living substance" savours, therefore, of a *contradictio in adjecto*; if it is "living" it cannot be a "substance," and if it is a "substance" it cannot be "living."

As a matter of fact, the biologist, when dealing with purely biological problems, knows nothing of a living substance or substances; he is confronted solely by living individuals, which constitute his primary conceptions, and the terms "life" and "living substance" are pure abstractions. Every living being presents itself to us as a sharply limited individual, distinct from other individuals and constituting what may be termed briefly a microcosmic unit, inasmuch as it is a unity which is far from being uniform in substance or homogeneous in composition, but which, on the contrary, is characterised by being made up of an almost infinite multiplicity of heterogeneous and mutually interacting parts. We recognise further that these living individuals possess invariably specific characteristics; two given living individuals may be so much alike that we regard them as of the same kind or "species," or they may differ so sharply that we are forced to distinguish between them specifically. Living beings are as much characterised by this peculiarity of specific individuality as by any other property or faculty which can be stated to be an attribute of life in general, and this is true equally of the simplest or the most complex organisms; at least we know of no form of life, however simple or minute, in which the combined features of individuality and specificity are not exhibited to the fullest extent.

The essential and distinctive characteristic of a living body of any kind whatsoever is that it exhibits while it lives permanence and continuity of individuality or personality, as manifested in specific behaviour, combined with incessant change and lability of substance; and further, that in reproducing its kind, it transmits its specific characteristics, with, however, that tendency to variability which permits of progressive adaptation and gradual evolutionary change. It is the distinctively vital property of specific individuality combined with "stuff-change" (if I may be allowed to paraphrase a Teutonic idiom) which marks the dividing line between biochemistry and biology. The former science deals with substances which can be separated from living bodies, and for the chemist specific properties are associated with fixity of substance; but the material with which the biologist is occupied consists of innumerable living unit-individuals exhibiting specific characteristics without fixity of substance. There is no reason to suppose that the properties of a given chemical substance vary in the slightest degree in space or time; but variability and adaptability are characteristic features of all living beings. The biochemist renders inestimable services in elucidating the physico-chemical mechanisms of living organisms; but the problem of individuality and specific behaviour, as manifested by living things, is beyond the scope of his science, at least at present. Such problems are essentially of distinctively vital nature, and their treatment cannot be brought satisfactorily into relation at the present time with the physico-chemical interactions of the substances composing the living body. It may be that this is but a temporary limitation of human knowledge prevailing in a certain historical epoch, and that in the future the chemist will be able to correlate the individuality of living beings with their chemico-physical properties, and so explain to us how living beings first came into existence; how, that is to say, a combination of chemical substances, each owing its characteristic properties to a definite molecular composition, can produce a living individual in which specific peculiarities are associated with matter in a state of flux. But it is altogether outside the scope and aim of this address to discuss whether the boundary between biochemistry and biology can be bridged over, and if so, in what way. I merely wish to emphasise strongly that if a biologist wishes to deal with a purely biological problem, such as evolution or heredity, for example, in a concrete and objective manner, he must do so in terms of living specific individual units. It is for that reason that I shall speak, not of the chromatin-substance, but of chromatinic elements, particles or units, and I hope that I shall make clear the importance of this distinction.

To return now to our chromatin; I regard the chromatinic elements as being those constituents which are of primary importance in the life and evolution of living organisms mainly for the following reasons: the experimental evidence of the preponderating physiological *rôle* played by the nucleus in the life of the cell; the extraordinary individualisation of the chromatin-particles seen universally in living organisms, and manifested to a degree which raises the chromatinic units to the rank of living individuals exhibiting specific behaviour, rather than that of mere substances responsible for certain chemico-physical reactions in the life of the organism; and last, but by no means least, the permanence and, if I may use the term, the immortality of the chromatinic particles in the life-cycle of organisms generally. I will now deal with these points in order.

The results obtained by physiological experiments with regard to the functions of the nuclear and cytoplasmic constituents of the cell are now well known and are cited in all the text-books. It is not necessary, therefore, that I should discuss them in detail. I content myself with quoting a competent and impartial summary of the results obtained:—

"A fragment of a cell deprived of its nucleus may live for a considerable time and manifest the power of co-ordinated movements without perceptible impairment. Such a mass of protoplasm is, however, devoid of the powers of assimilation, growth, and repair, and sooner or later dies. In other words, those functions that involve destructive metabolism may continue for a time in the absence of the nucleus; those that involve constructive metabolism cease with its removal. There is, therefore, strong reason to believe that the nucleus plays an essential part in the constructive metabolism of the cell, and through this is especially concerned with the formative processes involved in growth and development. For these and many other reasons . . . the nucleus is generally regarded as a controlling centre of cell-activity, and hence a primary factor in growth, development, and the transmission of specific qualities from cell to cell, and so from one generation to another.[2]

I have mentioned already in my introductory remarks that the only trustworthy test of chromatin is its behaviour, and the whole of modern cytological investigation bears witness to the fact that the chromatinic particles exhibit the characteristic property of living things generally, namely, individualisation combined with specific behaviour. In every cell-generation in the bodies of ordinary animals and plants the chromatin-elements make their appearance in the form of a group of chromosomes, not only constant in number for each species, but often exhibiting such definite characteristics of size and form, that particular, individual chromosomes can be recognised and identified in each group throughout the whole life-cycle. Each chromosome is to be regarded as an aggregate composed of a series of minute chromatinic granules or chromioles, a point which I shall discuss further presently.

Even more remarkable than the relation of the chromosomes to cell-reproduction is their behaviour in relation to sexual phenomena. In the life-cycles of Metazoa the sexual act consists of the fusion of male and female pronuclei, each containing a definite and specific number of chromosomes, the same number usually, though not always, in each pronucleus. It has been established in many cases, and it is perhaps universally true, that in the act of fertilisation the male and female chromosomes remain perfectly distinct and separate in the synkaryon or nucleus formed by the union of the two pronuclei, and, moreover, that they continue to maintain and to propagate their distinct individuality in every subsequent cell-generation of the multicellular organism produced as a result of the sexual act. In this way, every cell of the body contains in its nucleus distinct chromatinic elements which are derived from both male and female parents and which maintain unimpaired their distinct and specific individuality through the entire life-cycle. This distinctness is apparent at least in the germ-cell-cycle of the organism, but may be obscured by secondary changes in the nuclei of the specialised tissue-cells.

Only in the very last stage of the life-cycle do the group of male and female chromosomes modify their behaviour in a most striking manner. In the final generation of oogonia or spermatogonia, from which arise the oocytes and spermatocytes which in their turn produce the gamete-cells, it is observed that the male and female chromosomes make a last appearance in their full number, and then fuse in pairs, so as to reduce the number of chromosomes to half that previously present.

As Vejdovsky has pointed out, there can be no more striking evidence of the specific individuality of the chromosomes than their fusion or copulation in relation to the sexual act. Is there any other constant element or constituent of living organisms exhibiting to anything like the same degree the essentially vital characteristics of individuality manifested in specific behaviour? If there is, it remains to be discovered.

I come now to the question of the permanence and immortality, in the biological sense of the word, of the chromatinic particles, which may be summarily stated as follows: the chromatinic particles are the only

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[2] E. B. Wilson, "The Cell," second edition, 1911, pp. 30, 31.

constituents of the cell which maintain persistently and uninterruptedly their existence throughout the whole life-cycle of living organisms universally.

I hope I shall not be misunderstood when I enunciate this apparently sweeping and breathless generalisation. I am perfectly aware that in the life-cycle of any given species of organism there may be many cell-constituents besides the chromatin-particles that are propagated continuously through the whole life-cycle; but cell-elements which appear as constant parts of the organisation of the cell throughout the life-cycle in one type of organism may be wanting altogether in other types. With the exception of the chromatin-particles there is no cell-constituent that can be claimed to persist throughout the life-cycles of organisms universally. It may be that this is only the result of our incomplete knowledge at the present time. I am prepared, however, to challenge anyone to name or to discover any cell-constituent, other than the chromatinic particles, which are present throughout the life-cycle, not merely of some particular organism, but of organisms universally.

To recapitulate my argument in the briefest form; the chromatinic constituents of the cell contrast with all the other constituents in at least three points: physiological predominance, especially in constructive metabolism; specific individualisation; and permanence in the sense of potential biological immortality. Any of these three points, taken by itself, is sufficient to confer a peculiar distinction, to say the least, on the chromatin-bodies; but taken in combination they appear to me to furnish overwhelming evidence for regarding the chromatin-elements as the primary and essential constituents of living organisms, and as representing that part of a living body of any kind which can be followed by the imagination, in the reverse direction of the propagative series, back to the very starting-point of the evolution of living beings.

In the attempt to form an idea as to what the earliest type of living being was like, in the first place, and as to how the earliest steps in its evolution and differentiation came about, in the second place, we have to exercise the constructive faculty of the imagination guided by such few data as we possess. It is not to be expected, therefore, that agreement can be hoped for in such speculations; it would indeed be very undesirable, in the interests of science, that there should be no conflict of opinion in theories which, by their very nature, are beyond any possibility of direct verification at the present time. The views put forward by any man do but represent the visions conjured up by his imagination, based upon the slender foundation of his personal knowledge, more or less limited, or intuition, more or less fallacious, of an infinite world of natural phenomena. Consequently such views may be expected to diverge as widely as do temperaments. If, therefore, I venture upon such speculations, I do so with a sense of personal responsibility and as one wishing to stimulate discussion rather than to lay down dogma.

To me, therefore, the train of argument that I have set forth with regard to the nature of the chromatinic constituents of living organisms appears to lead to the conclusion that the earliest living beings were minute, possibly ultramicroscopic particles which were of the nature of chromatin. How far the application of the term chromatin to the hypothetical primordial form of life is justified from the point of view of substance, that is to say in a biochemical sense, must be left uncertain. In using the term chromatin I must be understood to do so in a strictly biological sense, meaning thereby that these earliest living things were biological units or individuals which were the ancestors, in a continuous propagative series, of the chromatinic grains and particles known to us at the present day as universally-occurring constituents of living organisms. Such a conception postulates no fixity of chemical nature; on the contrary, it implies that as substance the primitive chromatin was highly inconstant, infinitely variable, and capable of specific differentiation in many divergent directions.

For these hypothetical primitive organisms we may use Mereschkowsky's term biococci. They must have been free-living organisms capable of building up their living bodies by synthesis of simple chemical compounds. We have as yet no evidence of the existence of biococci at the present time as free-living organisms; the nearest approach to any such type of living being seems to be furnished by the organisms known collectively as Chlamydozoa, which up to the present have been found to occur only as pathogenic parasites. In view, however, of the minuteness and invisibility of these organisms, it is clear that they could attract attention only by the effects they produce in their environments. Consequently the human mind is most likely to become aware in the first instance of those forms which are the cause of disturbance in the human body. If free-living forms of biococci exist, as is very possible and even probable, it is evident that very delicate and accurate methods of investigation would be required to detect their presence.

If it be permissible to draw conclusions with regard to the nature of the hypothetical biococci from the somewhat dubious, but concrete, data furnished by the Chlamydozoa, the following tentative statements may be postulated concerning them. They were (or are) minute organisms, each a speck or globule of a substance similar in its reactions to chromatin. Their substance could be described as homogeneous with greater approach to accuracy than in the case of any other living organism, but it is clear that no living body that is carrying on constructive and destructive metabolism could remain for a moment perfectly homogeneous or constant in chemical composition. Their bodies were not limited by a rigid envelope or capsule. Reproduction was effected by binary fission, the body dividing into two with a dumbbell-shaped figure. Their mode of life was vegetative—that is to say, they reacted upon their environmental medium by means of ferments secreted by their own body-substance. The earliest forms must have possessed the power of building up their protein-molecules from the simplest inorganic compounds; but different types of biococci, characterised each by specific reactions and idiosyncrasies, must have become differentiated very rapidly in the process of evolution and adaptation to divergent conditions of life.

Consideration of the existing types and forms of living organisms shows that from the primitive biococcal type the evolution of living things must have diverged in at least two principal directions. Two new types of organisms arose, one of which continued to specialise further in the vegetative mode of life, in all its innumerable variations, characteristic of the biococci, while the other type developed an entirely new habit of life—namely, a predatory existence. I will consider these two types separately.

(1) In the vegetative type the first step was that the body became surrounded by a rigid envelope. Thus came into existence the bacterial type of organism, the simplest form of which would be a Micrococcus, a minute globule of chromatin surrounded by a firm envelope. From this familiar type an infinity of forms arise by processes of divergent evolution and adaptation. I will not attempt, however, to follow up the evolution of the bacterial type further, or to discuss what other types of living organisms may be affiliated with it, as I have no claims to an expert knowledge of these organisms.

(2) In the evolution from the biococcus of the pre-

datory type of organism, the data at our disposal appear to me to indicate very clearly the nature of the changes that took place, as well as the final result of these changes, but leave us in the dark with regard to some of the actual details of the process. The chief event was the formation, round the biococci, of an enveloping matrix of protoplasm for which the term periplasm (Lankester) is most suitable. The periplasm was an extension of the living substance which was distinct in its constitution and properties from the original chromatinic substance of the biococcus. The newly formed matrix was probably from the first a semi-fluid substance of alveolar structure and possessed two important capabilities as the result of its physical structure; it could perform streaming movements of various kinds, more especially amœboid movement; and it was able to form vacuoles internally. The final result of these changes was a new type of organism which, compared with the original biococci, was of considerable size, and consisted of a droplet of alveolar, amœboid periplasm in which were imbedded a number of biococci. Whether this periplasm made its first appearance around single individual biococci, or whether it was from the first associated with the formation of zooglœa-like colonies of biococci, must be left an open question.

Thus arose in the beginning the brand of Cain, the prototype of the animal—that is to say, a class of organism which was no longer able to build up its substance from inorganic materials in the former peaceful manner, but which nourished itself by capturing, devouring, and digesting other living organisms. The streaming movements of the periplasm enabled it to flow round and engulph other creatures; the vacuole-formation in the periplasm enabled it to digest and absorb the substance of its prey by the help of ferments secreted by the biococci. By means of these ferments the ingested organisms were killed and utilised as food, their substance being first broken down into simpler chemical constituents and then built up again into the protein-substances composing the body of the captor.

A stage of evolution is now reached which I propose to call the pseudo-moneral or cytodal stage, since the place of these organisms in the general evolution of life corresponds very nearly to Haeckel's conception of the Monera as a stage in the evolution of organisms, though not at all to his notions with regard to their composition and structure. The bodies of these organisms did not consist of a homogeneous albuminous "plasson," but of a periplasm corresponding to the cytoplasm of the cell, containing a number of biococci or chromatin-grains. In the life-cycles of Protozoa, especially of Rhizopods, it is not at all infrequent to find developmental phases which reproduce exactly the picture of the pseudo-moneral stage of evolution, phases in which the nucleus or nuclei have disappeared, having broken up into a number of chromatin-grains or chromidia scattered through the cytoplasm.

The next stage in evolution was the organisation of the chromatin-grains (biococci) into a definite cell-nucleus. This is a process which can be observed actually taking place in many Protozoa in which "secondary" nuclei arise from chromidia. With the formation of the nucleus the cytode or pseudo-moneral stage has become a true cell of the simplest type, for which I propose the term *protocyte*. It is now the starting-point of an infinite series of further complications and elaborations in many directions. With all the diverse modifications of the cell the nucleus remains comparatively uniform. It may, indeed, vary infinitely in details of structure, but in principle it remains a concentration or aggregation of numerous grains of chromatin supported on some sort of framework over which the grains are scattered or clumped in various ways, supplemented usually by plastin or nucleolar substance either as a cementing ground-substance or as discrete grains, and the whole marked off sharply from the surrounding cytoplasm, with or without a definite limiting membrane. There is, however, one point in which the nucleus exhibits a progressive evolution of the most important kind. I refer to the gradual elaboration and perfection of the reproductive mechanism, the process whereby, when the cell reproduces itself by fission, the chromatin-elements are distributed between the two daughter-cells.

The chromatin-constituents of the cell are regarded, on the view maintained here, as a number of minute granules, each representing a primitive independent living individual or biococcus. To each such granule must be attributed the fundamental properties of living organisms in general; in the first place metabolism, expressed in continual molecular change, in assimilation and in growth, with consequent reproduction; in the second place specific individuality. As the result of the first of these properties the chromatin-granules, often perhaps ultra-microscopic, may be larger or smaller at different times, and they multiply by dividing each into two daughter-granules. As a result of the second property, chromatin-granules in one and the same cell may exhibit qualitative differences and may diverge widely from one another in their reactions and effects on the vital activities of the cell. The chromatin-granules may be either in the form of scattered chromidia or lodged in a definite nucleus. When in the former condition, I have proposed the term chromidiosome for the ultimate chromatinic individual unit; on the other hand, the term chromiole is commonly in use for the minute chromatin-grains of the nucleus.

In the phase of evolution that I have termed the pseudomoneral or cytodal phase, in which the organism was a droplet of periplasm containing scattered biococci or chromidiosomes, metabolism would result in an increase in the size of the cytode-body as a whole, accompanied by multiplication of the chromidiosomes. Individualisation of the cytodes would tend to the acquisition of a specific size—that is to say, to a limitation of the growth—with the result that when certain maximum dimensions were attained the whole cytode would divide into two or more smaller masses amongst which the chromidiosomes would be partitioned.

In the next stage of evolution, the protocyte with a definite nucleus, it is highly probable that at each division of the cell-body, whether into two or more parts, the primitive method of division of the nucleus was that which I have termed elsewhere "chromidial fragmentation"; that is to say, the nucleus broke up and became resolved into a clump of chromidiosomes, which separated into daughter-clumps from which the daughter-nuclei were reconstituted. Instances of nuclear divisions by chromidial fragmentation are of common occurrence among the Protozoa, and represent probably the most primitive and direct mode of nuclear division.

It is clear, however, that if the chromatin-grains are to be credited with specific individuality and qualitative differences amongst themselves, this method of nuclear division presents grave imperfections and disadvantages, since even the quantitative partition of the chromatin is inexact, while the qualitative partition is entirely fortuitous.

It is not surprising, therefore, to find that the process of nuclear division undergoes a progressive elaboration of mechanism which has the result of ensuring that the twin sister-granules of chromatin produced by division of a single granule shall be distributed between the two daughter-cells, so that for every chromatin-grain obtained by one daughter-cell an exact counterpart is obtained by the other; in other words, of ensuring an exact qualitative, as well as quantitative, partition of the chromatin-particles. In its perfect form this type of nuclear division is known as karyokinesis or mitosis, and all stages in its progressive development are to be found in the Protozoa.

In the evolution of nuclear division by karyokinesis two distinct processes are being developed and perfected in a parallel manner, but more or less independently; first, the method of the partition and distribution of the chromatin-grains between the two daughter-nuclei; secondly, the mechanism whereby the actual division of the nucleus and the separation of the two daughter-nuclei are effected in the cell-division. I have dealt elsewhere with the evolution of the mechanism of karyokinesis as exemplified by the numerous and varied types of the process found amongst the Protozoa, and I need not discuss the matter further here, but the behaviour of the chromatin-grains may be dealt with briefly. The main feature in the process of the exact quantitative and qualitative distribution of the daughter-chromatin between the daughter-nuclei is the aggregation of the chromatin-grains or chromioles into definite, highly individualised structures known as chromosomes. In the most perfected forms of the process of chromosome-formation the chromioles become united into a linear series termed by Vejdovsky a chromoneme, which is supported upon a non-chromatinic basis or axis.

The actual division of the chromatin takes place by the longitudinal splitting of the chromoneme—in other words, by simultaneous division into two of each of the chromioles of which the thread is composed. In this way every chromiole which was contained in the original chromoneme is represented by a daughter-chromiole in each of the two daughter-chromonemes. It follows that the familiar process of the splitting of the chromosomes in karyokinesis is a mechanism which brings about in the most simple, sure and direct manner an exact quantitative and qualitative partition of the chromatin-grains between the two daughter-nuclei.

The chromatin-cycle of a cell in which the process of division by karyokinesis takes place in its most perfectly developed form, may, therefore, be conceived as follows. The nucleus in its resting state contains a definite number of companies or brigades of chromatinic units (chromioles), each brigade spread over a certain extent of the nuclear framework forming a karyomere. As a preparation to division each separate brigade of chromioles falls into line as the chromoneme, forming with its supporting substance the chromosome; there are formed, therefore, just so many chromosomes as there were karyomeres in the nucleus. In this disciplined and orderly array each chromiole undergoes its division into two daughter-chromioles, so that each file or chromoneme of chromioles splits into two files. At the reconstitution of the daughter-nuclei each daughter-chromosome gives rise to a karyomere again, the chromioles falling out of the ranks and disposing themselves in an apparently irregular manner on the newly built framework of the daughter-nucleus to constitute their own particular karyomere. Thus karyokinesis differs only from the most primitive method of division by chromidial fragmentation in that what was originally a haphazard method of distribution has become a disciplined and orderly manœuvre, performed with the precision of the parade-ground, but in a space far less than that of a nutshell.

In the nuclear division of Protozoa, without going into detail, it may be stated broadly that all stages are to be found of the gradual evolution of the tactical problem which constitutes karyokinesis.

I have dealt briefly with the problem of the evolution of karyokinesis because the process of nuclear division is, in my opinion, of enormous importance in the general evolution of living organisms. I have expressed elsewhere the opinion that the very existence of multicellular organisms composed of definite tissues is impossible until the process of karyokinesis has been established and perfected. For tissue-formation it is essential that all the cells which build up any given tissue should be similar, practically to the point of identity, in their qualities; and if it is the chromatin-elements of the cell which determine its qualities and behaviour, then the exact qualitative division of the chromatin, as effected in karyokinesis, is indispensable as a preliminary to the production of identically similar daughter-cells by division of a parent-cell. Hence it becomes intelligible why, amongst Metazoa, we find the occurrence of nuclear division by karyokinesis in its most perfect form to be the rule, and "direct" division of the nucleus to be the rare exception, while, on the other hand, in the Protista, and especially in the Protozoa, we find every possible stage in the gradual evolution of the exact partition of the chromatin in the process of nuclear division, from chromidial fragmentation or the most typical amitosis up to processes of karyokinesis as perfect as those of the Metazoa.

I have confined myself to the evolution of the cell as this organism is seen in its typical form in the bodies of the multicellular organisms, starting from the simplest conceivable type of living being, so far as present knowledge enables us to conceive it. But there is not the slightest reason to suppose that the evolution of the Protista took place only in the direction of the typical cell of the cytologist. Besides the main current leading up to the typical cell, there were certainly other currents tending in other directions and leading to types of structure very unlike the cells composing the bodies of multicellular organisms.

In this address I have set forth my conceptions of the nature of the simplest forms of life and of the course taken by the earliest stages of evolution, striving all through to treat the problem from a strictly objective point of view, and avoiding as far as possible the purely speculative and metaphysical questions which beset like pitfalls the path of those who attack the problem of life and vitalism. I have, therefore, refrained as far as possible from discussing such indefinable abstractions as "living substance" or "life," phrases to which no clear meaning can be attached.

How far my personal ideas may correspond to objective truth I could not, of course, pretend to judge. If I might be permitted to attempt an impartial criticism of my own scheme, I think it might be claimed that the various forms and types of organisms in my evolutionary series, namely, the simple cell or protocyte, the cytode or pseudomoneral stage, the micrococcus, even the biococcus, are founded on concrete evidence, and can be regarded as types actually existent in the present or past. On the other hand, the *rôle* assigned by me to each type in the pageant of evolution is naturally open to dispute. For example, I agree with those who derive the bacteria as primitive, truly non-cellular organisms, directly from the biococcus through an ancestral form, and not at all with those who would regard the bacteria as degenerate or highly specialised cells. But the crux of my scheme is the homology postulated between the biococcus and the chromatinic particle

—chromidiosome or chromiole—of true cells. In support of this view, of which I am not the originator, I have set forth the reasons which have convinced me that the extraordinary powers and activities exhibited by the chromatin in ordinary cells are such as can only be explained on the hypothesis that the ultimate chromatinic units are to be regarded as independent living beings, as much so as the cells composing the bodies of multicellular organisms; and, so far as I am concerned, I must leave the matter to the judgment of my fellow-biologists.

I may point out, in conclusion, that general discussions of this kind may be useful in other ways than as attempts to discover truth or as a striving towards a verity which is indefinable and perhaps unattainable. Even if my scheme of evolution be but a midsummer night's fantasy, I claim for it that it co-ordinates a number of isolated and scattered phenomena into an orderly and, I think, intelligible sequence, and exhibits them in a relationship which at least enables the mind to obtain a perspective and comprehensive view of them. Rival theories will be more, or less, useful than mine, according as they succeed in correlating more, or fewer, of the accumulated data of experience. If in this address I succeed in arousing interest and reflection, and in stimulating inquiry and controversy, it will have fulfilled its purpose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—A portrait of Prof. Lapworth (by Mr. B. Munns) has been presented to the University by Mr. W. Waters Butler.

Dr. Elgood Turner has been appointed demonstrator in anatomy for women students in succession to Dr. Violet Coghill, who has resigned.

Dr. Mary Clarke has been appointed lecturer in hygiene to the students of the Training College for Women.

Mr. B. Lloyd has been appointed demonstrator in anatomy for the session.

GLASGOW.—Prof. John Ferguson has resigned the Regius chair of chemistry, to which he was appointed in 1874. He had previously for nine and a half years been a junior teacher in the department. He has therefore been a member of the staff for more than fifty years. During his tenure of office the chemical laboratories of the University have been greatly enlarged, and separate departments of organic chemistry, metallurgical chemistry, and physical chemistry have been instituted under the charge of special lecturers. Among Prof. Ferguson's former pupils are many distinguished chemists, including Prof. Millar Thomson, Sir William Ramsay, Sir J. J. Dobbie, Carrick Anderson, Profs. Henderson, Boyd, Long, and Parker, and Dr. A. W. Stewart.

LEEDS.—The Vice-Chancellor has received the following message from the King:—"His Majesty feels that the assistance of the universities is a great asset to the cause for which we are fighting, as science plays such a prominent part in modern warfare."

LONDON.—A course in dynamical meteorology with practical work will be given at the Meteorological Office, South Kensington, on Fridays, at 3 p.m., during the second term by Sir Napier Shaw, director of the Meteorological Office and University reader in meteorology. The fortnightly meetings at the Meteorological Office for discussion of important contributions to current meteorology in colonial or foreign journals will be resumed at 5 p.m. on Monday, October 25, and will be continued on alternate Mondays until March 27, 1916, with the exception of December 20th and January 3. Students wishing to attend should communicate with the reader at the Meteorological Office. The lectures are addressed to advanced students of the University and to others interested in the subject. Admission free, by ticket, to be obtained on application at the Meteorological Office.

A COPY of the September issue of the *Reading University College Review* has been received. It contains a revised list of the names of present members of the staff, past and present students, and present servants of the college who are serving with his Majesty's Forces, or in the French Army. The college may well be proud of its roll of honour. Mr. W. E. G. Atkinson, who was formerly a lecturer of the Department of Agriculture, has been killed in action in the Dardanelles, and Mr. T. G. Malpas, demonstrator in the physics laboratory, has been wounded. The review also contains a list of recent original contributions to science by members of the staff.

THE various courses of instruction to be given at the North of Scotland College of Agriculture during the present session are set out in detail in the current calendar of the college. The courses are designed to prepare students for the degree of B.Sc. in agriculture in the University of Aberdeen, the university diploma in agriculture, the national diplomas in agriculture and dairying, the degree of B.Sc. in forestry, and the certificate in forestry granted by the Highland and Agricultural Society of Scotland. All courses are open to women as well as to men. With the aid of a grant from the Development Commission, a research department has been instituted. In accordance with the conditions under which the grant is received from the Commission, this department is managed by a joint committee representing the governors and the University Court. We notice the governors have acquired a college farm. Experiments and demonstrations will be carried out. Experimental plots, an experimental and demonstration garden, and a horticultural department, are in course of construction. It is also intended to carry on feeding and other experiments upon stock. The farm is conveniently situated about five miles from Aberdeen. It is proposed to institute a school of rural domestic economy for girls. There is a large mansion house on the college farm estate which will be equipped as a residence for the girls attending the school, and in which classes will be carried on.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 4.—M. Ed. Perrier in the chair.—J. **Boussinesq**: The correct calculation of the influence of climatic inequality on the velocity of increase of terrestrial temperatures with depth from the surface.—H. **Douvillé**: The orbitoids of the peninsula of California. A study of material arising from the geological explorations of Arnold Heim. Some specimens belong to the genus Orthophragmina, and it is the first time these have been discovered in this region. Some rare Foraminifera include specimens of *Amphistegina Niasi*.—E. E. **Barnard**: Some supposed movements in stars near the cluster Messier 11 = N.G.C. 6705. The observation of J. Comas Solá on movements of stars in the neighbourhood of this cluster do not appear to be well founded. They were based on the stereoscopic examination of photographs taken at an interval of three years. The author has examined photographs of the same region separated by an interval of twenty-two years, making use of a Zeiss stereo-comparator, but no movement of the stars in question can be observed.—J. Comas **Solá**: The approximate positions of a small planet, apparently new.—C. **Camichel**: Hammering in water pipes entirely free from air. Experimental determinations of the velocity of wave transmission in an 80 mm. iron pipe, 154 metres long, and of the pressures produced by sudden closing of a tap in the main.—Alb. **Colson**: The heat disengaged by a solid body passing to the state of saturated or dilute solutions. Details of experimental studies by a new method on the heats of solution of common salt.—B. **Bogitch**: The reciprocal solubility of copper and lead. Copper and lead form a double layer when the amount of copper exceeds 34·5 per cent., and is below 87 per cent. This double layer can only exist between the temperature of solidification of the upper layer (940° C.) and 975° C.—Arnold **Heim**: The geology of the southern part of lower California.—MM. **Debierne** and **Regaud**: The use of the condensed radium emanation in closed tubes in the place of radium compounds, and the estimation (in millicuries of emanation destroyed) of the energy used up in radio-active applications in general. An account of the advantages, from the points of view of economy and ease of application, of condensed radium emanation for biological purposes.

New South Wales.

Linnean Society, August 25.—Mr. A. G. Hamilton, president, in the chair.—R. J. **Tillyard**: The physiology of the rectal gills in the larvæ of anisopterid dragonflies. The minute structure of the rectal gill was studied to find evidence for a solution of the difficult problem of the physiology of respiration in these organs. Seven separate elements are recognisable in the gills. The argument excludes four of these, leaving only three, viz., the cuticle, the epithelial syncytium of the gill, and its tracheal capillary loops, as the agents of respiration. These are suited for respiration by diffusion of gas from the rectal water-supply through the cuticle and syncytium into the capillaries. The old objection to this diffusion theory, viz., that it can be understood easily when once started, but that there is no explanation of how it could begin in the newly-hatched nymph, is disposed of by observations on the process of hatching, which prove that the tracheal gas is not derived in the first instance from the rectal water-supply, but from some unknown source in the anterior end of the larval body.—T. G. **Sloane**: Studies in Australian entomology. No. XVII.—New genera and species of Carabidæ. This instalment treats of the tribes Pamborini, Migadopini, Broscini, Cuneipectini, Nomiini, Pterostichini, Platynini, Oodini, Harpalini, and Lebiini. Four genera and thirty-two species are described as new; among the most noteworthy being—a new species of Pamborus, a new genus of the Antarctic tribe Migadopini, an additional species of the genus Cuneipectus (the type of a tribe confined to western Australia), and a species of Phorticosomus, which has the submentum bearing two horn-like processes, a character known only in the allied genus Dioctes from the Steppes east of the Caspian Sea.—O. B. **Lower**: Descriptions of new Australian Lepidoptera. Twenty-one species, referable to the Geometridæ, Monocteniadæ, Selidosemidæ, Limacodidæ, Ocneriadæ, Zeuzeridæ, Pyraustidæ, Œcophoridæ, and Xyloryctidæ, are described as new; with one exception, all are from Pinnaroo, South Australia, or from Broken Hill, N.S.W., or from both localities.

Cape Town.

Royal Society of South Africa, August 18.—Dr. L. Péringuey, president, in the chair.—J. W. **Bews**: The growth forms of Natal plants. The author gives a detailed description of his work on the growth forms of Natal plants. The investigation of the growth forms of plants in relation to their environment is being recognised as a very important, if not the most important, branch of plant ecology. The study of the various plant communities and their determination by the environmental factors presents a more general aspect of the subject, and has hitherto perhaps on the whole received more attention from plant ecologists, though, of course, it includes a certain amount of the study of the separate growth forms. It is, however, in the more detailed study of the "epharmony" of the species of plants that a deeper insight is gained into the cause and effect relationship existing between the environment and plant life.—I. B. Pole **Evans**: The South African rust fungi. I. The species of Puccinia on Compositæ. Descriptions and accompanying notes are given of the species of Puccinia based mainly upon material which the author and his colleagues have collected during the past ten years in South Africa, and which is now represented in the Mycological Herbarium of the Union of South Africa at Pretoria. The material has been collected primarily with the object of elucidating the life-histories of the various rusts which are so destructive to many of our economic crops, and it is hoped that the descriptions of these parasites, of which this is the first instalment, may promote a more widespread interest in this group of plants, and may be the means of adding considerably to our present very imperfect knowledge of these fungi.—J. Steph. v. d. **Lingen**: Heating and cooling apparatus for Röntgen crystallographic work. The apparatus described has been devised by the author in order to facilitate the work of those who wish to carry on research on the determination of the energy of an atom at zero temperature and at very high temperatures. The energy of atoms and its relation to temperature is one of the many problems of modern physics. Since the publication of de Bye's extension of Laue's theory of Röntgen interference, several experiments have been performed with a view to determine, first, the validity of de Bye's theory, and, secondly, the variation of atomic energy due to "heat motion."

BOOKS RECEIVED.

Memoirs of the Geological Survey, England and Wales: The Coals of South Wales, with Special Reference to the Origin and Distribution of Anthracite. By Dr. A. Strahan and Dr. W. Pollard. Second edition. Pp. vi+91. (London: H.M.S.O.; E. Stanford, Ltd.) 2*s.*

Stars of the Southern Skies. By M. A. Orr (Mrs. J. Evershed). Pp. xii+92. (London: Longmans and Co.) 2*s.* net.

An Introduction to Applied Mechanics. By E. S. Andrews. Pp. ix+316. (Cambridge: At the University Press.) 4*s.* 6*d.* net.

Botany. By D. Thoday. Pp. xvi+474. (Cambridge: At the University Press.) 5*s.* 6*d.* net.

In Pastures Green. By P. McArthur. Pp. xi+364. (London: J. M. Dent and Sons, Ltd.) 5*s.* net.

Quantitative Laws in Biological Chemistry. By Dr. S. Arrhenius. Pp. xi+164. (London G. Bell and Sons, Ltd.) 6*s.* net.

Key to Geometry for Schools. By W. G. Borchardt and Rev. A. D. Perrott. Pp. 294. (London: G. Bell and Sons, Ltd.) 8*s.* 6*d.* net.

An Untamed Territory: The Northern Territory of Australia. By E. R. Masson. Pp. xii+181. (London: Macmillan and Co., Ltd.) 6*s.*

Leeds Astronomical Society. Journal and Transactions for the Year 1914. Edited by C. T. Whitmell. Pp. 104. (Leeds: R. Jackson and Son; London: W. Wesley and Son.) 2*s.*

Principles of General Physiology. By Prof. W. M. Bayliss. Pp. xx+850. (London: Longmans and Co.) 21*s.* net.

Vicious Circles in Sociology, and their Treatment. By Dr. J. B. Hurry. Pp. 34. (London: J. and A. Churchill.) 2*s.* net.

The Rugby Course of Elementary Chemistry. By A. P. Highton. Pp. 79. (London: E. Arnold.) 2*s.* 6*d.*

Handy Logarithmic Tables. By Y. Uraguchi. (Tokyo: Y. Uraguchi.) 12 sen, or 3*d.*

On Certain Channels attributed to Overflow Streams from Ice-dammed Lakes. By Prof. T. G. Bonney. Pp. 44. (Cambridge: Bowes and Bowes.) 1*s.* net.

A First Course of Engineering Science. By P. J. Haler and A. H. Stuart. Pp. viii+191. (London: University Tutorial Press, Ltd.) 2*s.* 6*d.*

Experimental Physics. By Prof. H. A. Wilson. Pp. viii+405. (Cambridge: At the University Press.) 10*s.* net.

National Museum of Wales. Descriptive Handbook to the Relief Model of Wales. By W. E. Whitehouse. Pp. 62+plates vii. (Cardiff: The Museum.) 6*d.*

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College. February–June, 1915. Edited by R. M. Milne. Pp. 24 (London: Macmillan and Co., Ltd.) 1*s.* net.

Government of India. Department of Education. Indian Education in 1913–14. Pp. 75+plates. (Calcutta: Supt. Government Printing, India.) Rs. 1.8, or 2*s.* 3*d.*

Elementary Practical Metallurgy for Technical Students and Others. By J. H. Stansbie. Pp. viii+151. (London: J. and A. Churchill.) 3*s.* 6*d.* net.

The Alligator and its Allies. By Prof. A. M. Reese. Pp. xi+358. (New York and London: G. P. Putnam's Sons.) 10*s.* 6*d.* net.

Canada. Department of Mines. Geological Survey. Memoir 74: a List of Canadian Mineral Occurrences. By R. A. A. Johnston. Pp. 275. (Ottawa: Government Printing Bureau.)

Union of South Africa. Province of the Cape of Good Hope. Marine Biological Report, No. ii. for the year ending 30th June, 1914. Pp. 167. (Cape Town: *Cape Times*, Ltd.)

The Spirit of the Soil: or, an Account of Nitrogen Fixation in the Soil by Bacteria and of the Production of Auximones in Bacterized Peat. By G. D. Knox. Pp. xiii+242. (London: Constable and Co., Ltd.) 2*s.* 6*d.* net.

Some Frontiers of To-morrow. By Prof. L. W. Lyde. Pp. viii+120. (London: A. and C. Black, Ltd.) 2*s.* 6*d.*

A History of Babylon. By Prof. L. W. King. Pp. xxiii+340. (London: Chatto and Windus.) 18*s.* net.

Guide to the Australian Ethnological Collection exhibited in the National Museum of Victoria. By Dr. B. Spencer. Second edition. Pp. 128+28 plates. (Melbourne: D. W. Paterson and Co.)

Edinburgh Mathematical Tracts. No. 1: a Course in Descriptive Geometry and Photogrammetry for the Mathematical Laboratory. By E. L. Ince. Pp. viii+79. No. 2: A Course in Interpolation and Numerical Integration for the Mathematical Laboratory. By D. Gibb. Pp. viii+90. No. 3: Relativity. By Prof. A. W. Conway. Pp. 43. No. 4: a Course in Fourier's Analysis and Periodogram Analysis for the Mathematical Laboratory. By Dr. G. A. Carse and G. Shearer. Pp. viii+66. No. 5: a Course in the Solution of Spherical Triangles for the Mathematical Laboratory. By H. Bell. Pp. viii+66. No. 6: an Introduction to the Theory of Automorphic Functions. By L. R. Ford. Pp. viii+96. (London: G. Bell and Sons, Ltd.) 2*s.* 6*d.* net, 3*s.* 6*d.* net, 2*s.* net, 3*s.* 6*d.* net, 2*s.* 6*d.* net, 3*s.* 6*d.* respectively.

British Museum (Natural History). British Antarctic (*Terra Nova*) Expedition, 1910. Natural History Report. Zoology. Vol. iii. No. 1. Pycnogonida. By Dr. W. T. Calman. Pp. 73. (London: Longmans and Co., and others.) 5*s.*

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Theory of Grinding, with reference to the Selection of Speeds in Plain and Internal Work: J. J. Guest.

TUESDAY, OCTOBER 19.

FARADAY SOCIETY, at 8.—The Transformations of Pure Iron. Discussion to be opened by Dr. A. E. Oxley.—*Papers*: The Transference of Electricity by Colloidal Particles: F. Powis.—(1) The Electrolysis of Nitric, Sulphuric, and Orthophosphoric Acids using a Gold Anode: (2) The Electrolysis of Concentrated Hydrochloric Acids using a Copper Anode: F. H. Jeffery.—The Thermal Decomposition of Hydrogen Peroxide in Aqueous Solution: W. Clayton.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Petroleum Industry of Mexico: P. C. A. Stewart.

WEDNESDAY, OCTOBER 20.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Statement upon the Theory and Phenomena of Purpose and Intelligence exhibited by the Protozoa, illustrated by Selection and Behaviour in the Foraminifera: E. Heron-Allen.

CONTENTS.

PAGE

Letters to the Editor:—

Our Astronomical Column:—

The British Association:—

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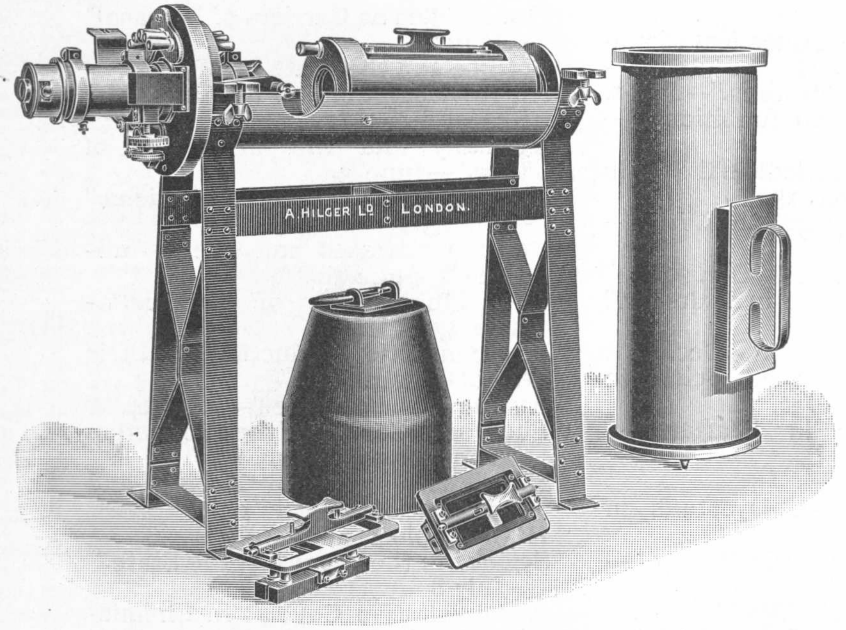

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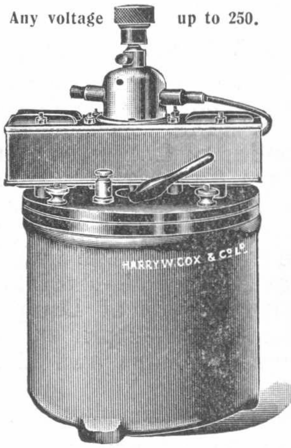

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"The War and British Chemical Industry."—April 1.
"The Position of the Organic Chemical Industry."—April 1.
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"The Supply of Optical Glass."—May 6.
"Asphyxiating Gases in Warfare."—May 6.
"House-Flies as Carriers of Disease."—May 13.
"Science and the State."—May 20.
"An Advisory Council on Industrial Research."—May 20.
"Germany and the Munitions of War."—June 3.
"The Extincteur and its Limitations."—June 3.
"Poisonous Gases and their Antidotes."—June 10.
"The Mobilisation of Science."—June 17.
"The Synthetic Production of Nitric Acid."—June 24.
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"The Use of Cotton for the Production of Explosives."—July 1.
"Problems of Airship Design and Construction."—July 1.
"High Explosives."—July 8.
"Science in the Service of the State."—July 8
"A Consultative Council in Chemistry"—July 8.
"The Use of Cotton for the Production of Explosives."—July 15.
"Munition Metals."—July 15.
"The Products of Coal Distillation." July 15.
"Science and Munitions of War."—July 22.
"Chemical Fire-Extinguishers."—July 22.
"Cotton as a High Explosive."—July 29.
"The War and Chemical Industry." July 29.
"The Government Scheme for the Organisation and Development of Scientific and Industrial Research."—July 29.
"Modern Munitions of War."—July 29.
"The Promotion of Research by the State."—Aug. 5.
"Gauges."—Aug. 12.
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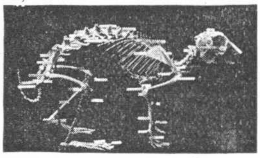

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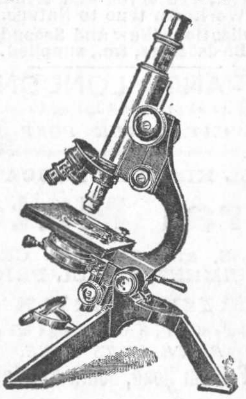

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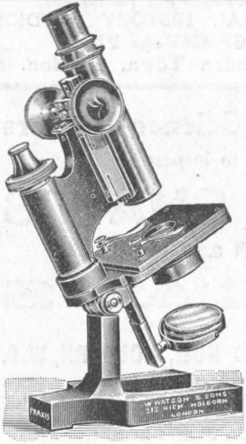

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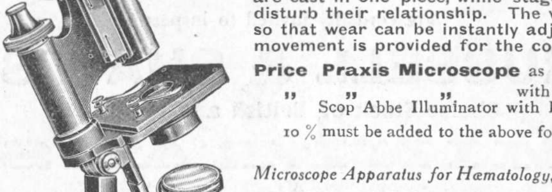
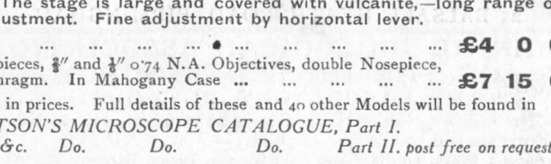


Back View.



Front View.

SPENCER DISSECTING MICROSCOPE, No. 86a.

Plate Glass Stage, mirror to reflect light to object. Hollow Block for Dissecting Instruments and Lenses. With 9x Doublet, **10/6**

Price List on application.

STANDLEY BELCHER & MASON, Ltd.,
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Printed in Great Britain by R. CLAY & SONS, LIMITED, at Brunswick Street, Stamford Street, S.E., and published by MACMILLAN AND CO., LIMITED, at St. Martin's Street, London, W.C., and THE MACMILLAN CO., 66 Fifth Avenue, New York.—THURSDAY, October 14, 1915.