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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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THURSDAY, SEPTEMBER 19, 1918.

INDUSTRIAL CHEMISTRY.

II.

(4) *Organic Compounds of Arsenic and Antimony.* By Prof. G. T. Morgan. Pp. xx+376. ("Monographs on Industrial Chemistry.") (London: Longmans, Green, and Co., 1918.) Price 16s. net.

(5) *Plant Products and Chemical Fertilisers.* By S. Hoare Collins. Pp. xvi+236. ("Industrial Chemistry.") (London: Baillière, Tindall, and Cox, 1918.) Price 7s. 6d. net.

(6) *A Text-book of Inorganic Chemistry.* Edited by Dr. J. N. Friend. Vol. v. *Carbon and its Allies.* By Dr. R. M. Caven. Pp. xxi+468. (London: C. Griffin and Co., Ltd., 1917.) Price 15s. net.

THE breadth of chemical industry is well exemplified in the works under notice. The three mentioned in the first review (NATURE, September 12, 1918, p. 21) cover the heavy chemical, the dye, and the edible oil industries, all requiring many millions of capital, employing thousands of workpeople, and affording problems enough for the most exacting critic.

(4) The three volumes now dealt with show equal diversity, and although Prof. Morgan's monograph deals with a much smaller and more highly specialised section of the chemical industry, it is none the less of considerable importance to establish it in this country. The synthetic organic arsenical compounds were found to be of great physiological potency at quite an early date, though real progress dates only from the beginning of the present century; this fact has very much stimulated later research in the field.

The first discovery of an aromatic arsenical drug was made by Béchamp during the years 1860–63. His compound began to be tried in therapeutics about the year 1902. It was termed "atoxyl" on account of its comparatively non-toxic nature, and employed in the treatment of sleeping sickness.

The success attending these pioneering efforts caused Ehrlich in Frankfort and his many student collaborators systematically to investigate the subject, and Ehrlich and Bertheim showed in 1907 that atoxyl is the sodium salt of *p*-arsanilic acid. Ehrlich carried out researches in a laboratory and private hospital endowed for him by George Speyer, the Frankfort banker, and in collaboration, on the industrial side, with the well-known Höchst colour works. The Béchamp reaction was extended from aniline to other bases, and every possible arsenical derivative was tested physiologically; proof of Ehrlich's zeal is afforded by the story that salvarsan, first obtained in 1909, was the 606th compound to be examined by him. Atoxyl and its homologues are derived from quinquevalent arsenic, but Ehrlich noticed that aromatic compounds of tervalent arsenic were much more effective against diseases of protozoic origin. Salvarsan and its sodium methylene sulphinate, known as neosalvarsan, are the substances chiefly used to-day in the arsenical treatment of syphilis, and it is satisfactory that we are no longer dependent upon Germany for these drugs, which are manufactured here by Messrs. Burroughs Wellcome and Co. and by Messrs. May and Baker, and in France by Poulenc Frères, and possibly by others.

A further discovery made by Ehrlich is the property of arsenobenzene to couple with salts of copper, silver, gold, and platinum in such a way that compounds are formed which can be administered intravenously, when the heavy metal exerts a germicidal action, supplementing that of the aromatic arsenical, whilst at the same time the compound is less toxic to the patient than salvarsan. Such a compound is luargol, prepared by Danysz, and used with considerable success in the French Army. Other valuable organic arsenicals are the primary aromatic arsines discovered by two American chemists, Palmer and Dehn.

The foregoing is only the briefest outline of Prof. Morgan's very fascinating introductory chapter; he rightly points the moral of the need for co-ordinated effort in scientific research which is to have a practical bearing.

For the pure chemist organic arsenic compounds have even greater sentimental interest on account of the part they have played in the early development of the theory of radicles. Bunsen's discovery of cacodyl, as Berzelius named it, and Frankland's explanation of its constitution, were important stages in establishing the constitution of carbon compounds generally.

Prof. Morgan has aimed at giving a complete account of the chemistry of these compounds, dealing with the literature up to the end of 1917, and the value of the text is enhanced, as is nowadays the custom, by a comprehensive bibliography. Successive chapters deal with cacodyl, the aliphatic arsenicals, the aromatic arsenicals, atoxyl, salvarsan, neosalvarsan, the primary arsines, luargol, and the aromatic antimonials, with finally a chapter on miscellaneous derivatives. Lithium antimonyl tartrate has been used extensively by Plimmer and others in the treatment of sleeping sickness, but so far the true organo-antimonials have not been found to equal the arsenical drugs of the salvarsan type.

(5) Agriculture can scarcely be termed a chemical industry, but that side of it which deals with fertilisers is essentially applied chemistry, and justifies its inclusion in this series. Mr. Collins starts from the point of view that the raw materials of agriculture are often the waste products of the other industries, whilst the produce of agriculture again forms the raw material for other industries. His volume covers the cycle from factory to fertiliser, from fertiliser to field, and from field to factory again; it is another of Dr. Rideal's monographs on industrial chemistry.

The opening sections deal briefly with the nature, use, and advantages of the nitrogen, phosphorus, and potash groups of fertilisers. Under the heading of "Mixed Fertilisers" the many questions arising out of farmyard manure and its storage are discussed—the manure heap is still the most unscientific part of the farm—also the vexed subject of the utilisation of sewage.

Part ii. deals with soils and their properties, and the author is able in relatively few words to give a comprehensive account of this vast subject, in which the application of science has made such strides, though it remains more than ever true that the cultivator of the soil himself must determine in every case the dividing line between what is practicable and what is not. The sections on special soil improvers and soil reclamation are most suggestive.

Under the heading "Crops" an outline of photosynthesis is given, followed by sections on the formation of carbohydrates, oil, nitrogenous bodies, and miscellaneous substances, such as tea, coffee, rubber, and fruit. These are all well done, and give a great deal of information in a limited space, much of which is not so generally known to chemists as is perhaps desirable. A point of interest in connection with the increasing production of oil-cake in this country is the opposition of cattle to take readily to new-fashioned food.

Perhaps the most interesting section is that entitled "The Production of Meat." The grazing animal is a machine for converting food of low value to human beings into high-grade food, and there is much to be learnt before this process is fully understood and efficiently controlled. The variety of simple forms of combined nitrogen is large, but whereas some of them are plentiful, others are scarce, and possibly their supply to the animal has to be considered. At present no practical way of obtaining a clear idea of the value of the different proteins in the foods has been discovered. Similarly the production of fats in this country is one of the greatest needs for the future, particularly in times when sea transport is restricted. The climate is unsuitable for the production of vegetable fats, and far greater attention will have to be paid to the pig from this point of view. In discussing future development the financial aspects and the labour question are not forgotten.

Enough has been said to indicate that Mr. Collins has produced a book which is both novel and suggestive, and it deserves to be very widely read.

(6) Without the solid foundation of fact, chemical theories of any kind would not lead far, and it is therefore appropriate to include here a mention of the newest volume of Dr. Friend's "Text-book of Inorganic Chemistry"—namely, that entitled "Carbon and its Allies," by Dr. Caven. Inorganic chemistry to-day is vastly more interesting than a generation ago, when physical chemistry was all but unknown, and the increasing technical importance of many of the less common elements has also added to their interest to the chemist. The elements dealt with are carbon, silicon, titanium, zirconium, thorium, germanium, tin, and lead. For carbon 150 pages of the text are required, which allow of detailed consideration of the allotropic forms, of coal, the simple hydrocarbons, coal-gas, and carbon dioxide. The section dealing with the last is particularly full, and may be quoted as typical of the thoroughness with which the book has been prepared.

The chemistry of silicon has made notable advances during the last few years, largely owing to the researches of British workers on the problems of its relation to carbon, which will be found to be fully considered.

An interesting section is that concerning the constitution of the silicates, which are more definite in composition than the acid itself. The hexite-pentite theory of the Aschs is briefly replained. The author might have made fuller reference to the present industrial uses of silica and of the alkali silicates, the latter especially having very wide application. Titanium is in the main a scientific curiosity, practical interest being limited to its use in steel. The same applies to zirconium, but now that the subject of refractory materials is receiving greater attention we may expect to hear more of it. Thorium is of importance from two points of view—namely, on account of its radio-activity and the use of its oxide in the manufacture of incandescent gas mantles. Both subjects receive very full treatment, and the chapter is one of the most valuable in the book.

Dr. Caven is to be congratulated on having done his work well, and his book will be found to be a storehouse of useful knowledge by all desiring information about the metals mentioned. It is well arranged and clearly printed, both of which facts add much to its usefulness.

E. F. ARMSTRONG.

A THEORIST'S OUTLOOK.

Essays in Scientific Synthesis. By E. Rignano. Pp. 254. (London: G. Allen and Unwin, Ltd., 1918.) Price 7*s.* 6*d.* net.

THE editor of the well-known international journal of science, *Scientia*, has done well to give Englishmen, whom he regards as "not attracted by broad generalisations," an opportunity of appreciating in their own language some of the stimulating essays that come from his untiring pen. They deal, indeed, with generalisations of the loftiest scope, but those who cannot follow the author up all the peaks which he seeks to climb will be rewarded by many an interesting view of the solid ground of facts below. The bond uniting the eight essays is that they express the synthetic spirit, and that they are animated by the object "of demonstrating the utility in the biological, psychological, and sociological fields of the theorist, who, without having specialised in any particular branch or subdivision of science, may nevertheless bring into those spheres that synthetic and unifying vision which is brought by the theorist-mathematician, with so much success, into the physico-chemical field of science." We are not sure that "theorist" is the proper title for the generalising thinker like Herbert Spencer, or that Dr. Rignano sufficiently realises the dangers of the synthetician's ambition, but we agree with his protest against the narrow view that all experimentation must be done in a laboratory. What the author really stands for is, that complementary to the work of the experimentalist is the work of the quiet thinker who has had sufficient discipline in scientific method on one hand, and in metaphysical analysis on the other. For this function the book before us is an apologia, and, while it naturally illustrates the risks of the adventure, it also clearly demonstrates its rewards. The second essay gives a luminous exposition of the synthetic value of the evolution-theory. "No other theory, perhaps, has succeeded in bringing into one general survey so many disparate phenomena, and in co-ordinating in one complete complex the numerous individual theories which hold their own in widely differing branches of science, and which, at first sight, seem to have nothing in common." We wish, however, that the author had said something about the fallacy so frequently involved in applying the same word "evolution" to historical sequences which have little in common except that they are processes of becoming.

The central part of the book is undeniably difficult, but it is, as an attempt at least, of great importance. It gives an outline of a mnemic theory of life, which the author has previously expounded in his work on "centro-epigenesis." Let us try to state the main idea without too much of its special terminology. It is quite certain that a relatively simple living creature without any nerve-centres can somehow enregister the results of its experience so that subsequent actions are influenced. That is a relatively simple "mnemic" phenomenon. A set of cells that have taken to some novel metabolic routine, such as secreting an anti-body to some toxin, may keep up the habit long after the original stimulus has ceased to operate. That is another illustration of "mnemic" phenomena. There is some sort of functional inertia in individual organisms—a tendency which in its most fundamental expression is simply to persist in a given phase of moving equilibrium (the word "stationary" used in the translation does not suggest the right idea). Now if the germinal substance is made up of "specific potential elements" which act as accumulators of particular modes of energy—"representative currents," as it is said—it may also be that in the course of the individual development of the offspring there is an activation of these and an irradiation from the centre outwards so that a formative influence is exerted. "The substance of which each of these specific potential elements is composed, which is capable of giving as discharge a single well-determined specific nervous current, is still one and the same substance which this nervous current, when it acts as a 'charging' current, can in its turn form and deposit." In this is found the explanation of the transmission of acquired characters (supposing that to be a fact) and of the recapitulation of phylogenetic stages in ontogeny. It appears to us that the specific form of Dr. Rignano's theory is not in grips with the facts, but to those who believe that experience counts in racial evolution in some other way than either Lamarck or Darwin recognised, every adventure in mnemic theory will be welcome. As to the nervous energy referred to, with its fundamental property of specific accumulation, it is said to obey the general laws of energetics, but is regarded as a monopoly of living organisms. In other words, there is a specific vital energy, as the late Prof. Assheton also maintained.

Organisms strive and cry, they exhibit endeavour and initiative, they are swayed by "affective tendencies." The author seeks to show that these are fundamentally referable to the tendency to maintain physiological integrity or equilibrium. Inborn affectivities with a mnemic basis express themselves in habitual actions, and new habits form new affectivities of the most varied nature. If "habit is second nature," then, inversely, "nature" is nothing but "first habit"—a deliverance that would have pleased Samuel Butler. The author recognises, of course, the complications that are added in organisms with fine brains and strong emotions, that secondary affectivities may come to overrule the primary ones, and so on; but all the apparent "finalism" of life rests on the mnemic property of living substance, which is admitted to be beyond chemical and physical formulation.

We have left too little of our allotted space for the remaining chapters. In answer to the ambitious question, "What is consciousness?" the author maintains that a psychic state is not in itself conscious or unconscious, but becomes one or the other only in relation to some other psychic state. As to the *rôle* of religion, it is argued that its social functions are gradually waning away, having been replaced by other influences. For the individual, however, it is likely to remain, in some form or other, as an expression of man's unconquerable desire to push beyond the frontiers of science and in a stretching out of his hands to relieve his surcharged emotion. Against the fatalistic dogma of "historic materialism" which exaggerates the "inevitable march" of economic processes, the author argues cogently that even in the recognition of the struggle between classes there is on the part of extreme Marxists a welcome contradiction in terms, for the agency of free men with ideas and ideals is thus admitted to be a factor that counts. In spite of its exaggerations, however, the fundamental idea of "historic materialism" has had an important synthetic function in binding together the previously disconnected disciplines of economics, law, and history. The book ends with a dispassionate discussion of Socialism and its future and with a note of hopefulness in recognising the, in part compulsory and in part spontaneous, enlargement and sensitising of the social conscience. We hope to see a continuation of these valuable essays in scientific synthesis, and we would take this opportunity of wishing the author success in his disinterested editorship of *Scientia*, which is an indubitable factor towards true pacifism.

MATHEMATICAL BOOKS.

(1) *Theory of Maxima and Minima.* By Prof. Harris Hancock. Pp. xiv + 193. (Boston (Mass.), London, etc.: Ginn and Co., 1917.) Price 10s. 6d. net.

(2) *Analytic Geometry and Calculus.* By Profs. F. S. Woods and F. H. Bailey. Pp. xi + 516. (Boston (Mass.), London, etc.: Ginn and Co., 1917.) Price 10s. 6d. net.

(1) THE theory of maxima and minima contains pitfalls into which have fallen such well-known mathematicians as Lagrange, Bertrand, Serret, and Todhunter. A peculiar interest, therefore, is attached to the subject, and the reader will find Prof. Hancock's book well worth his study. Except that there is no reference to calculus of variations, the author has succeeded in covering the ground fairly thoroughly, and that without allowing the argument to be anywhere tedious. He gives many references, and a few quite interesting examples.

After a short investigation of maxima and minima of functions of a single variable, he gives in some detail the methods of Scheeffer and von Dantscher, which introduced rigour into the discussion of functions of two or three variables. The theory here is intimately connected with the theory of quadratic forms and singularities of higher plane curves. The author seems not to have read such books as Bromwich's "Quadratic Forms," Hilton's "Linear Substitutions," or Muth's "Elementartheilar," which would have enabled him in places to simplify his treatment of quadratic forms. In tracing a plane curve near a singularity, the author should have made use of Newton's diagram. He should also have avoided such a phrase as "cusps of the first and second kind," which implies that the cusps in question are comparable, whereas the latter is a singularity of much higher complexity than the former.

The chapter on relative maxima and minima is especially interesting. The discussion usually given in the text-books is very scanty, and the fuller treatment here given is very welcome. A valuable point is made in §§ 98–107. The usual proof that the maximum triangle inscribed in a given circle is equilateral runs as follows: "If not, suppose ABC to be the greatest triangle. If $AB \neq AC$, let D bisect the arc BAC. Then the triangle $BDC > BAC$, etc." Is this argument admissible? The reader may compare the following reasoning, due to an Italian author: "Unity is the greatest integer. For, if not, suppose n ($\neq 1$) the greatest. Then $n^2 > n$, etc." The proofs run parallel, but the tacit assumption (a greatest triangle or integer exists) is lawful in one case and not in the other.

(2) This work is a revision and abridgment of the authors' two-volume "Course in Mathematics for Students of Engineering and Applied Science," and is intended to occupy a two years' course for an average college class. The book does not give the impression of being especially suited to the needs of students of applied science, except for the fact that examples are included on finding centre of gravity, centre of pressure, and so on. In the main the book is apparently simply a course on pure mathematics designed for the American undergraduate. As such it may be commended as quite clear and readable, and it is furnished with some 2000 well-chosen examples. Naturally it is possible to criticise certain portions on the ground of absence of rigidity. But probably the authors have hit the happy mean between a slovenliness which demoralises the beginner and a precision which terrifies him.

It is interesting to contrast the American and English ideas of a suitable syllabus for the first two years of a "pass" mathematical course. The Americans include the co-ordinate geometry of straight line and plane; but the rest of the syllabus consists almost entirely of the calculus and elementary differential equations. Even the circle and conic receive no more than a passing mention; and very little algebra is inserted, such subjects as determinants and the theory of equations being deferred for subsequent study. Contrast this with a certain English B.A. course, which demands no calculus whatever, but requires the "simple properties of conic sections, including a discussion of the general equation of the second degree and the methods of projection"! The book under review may give the student a somewhat false idea of the importance of the conic (it is mentioned casually along with the witch, the cissoid, and the strophoid), and he may find partial differentiation studied by means of three-dimensional co-ordinate geometry a little too hard for him. But, nevertheless, English teachers have very much to learn from their allies. H. H.

OUR BOOKSHELF.

The Botany of Iceland. Edited by Dr. L. Kolderup Rosenvinge and Dr. Eug. Warming. Part ii. 3. Ernst Østrup: "Marine Diatoms from the Coasts of Iceland." 4. Aug. Hesselbo: "The Bryophyta of Iceland." Pp. 348–675. (Copenhagen: J. Frimodt; London: J. Wheldon and Co., 1918.) Price 11s. net.

THIS part completes vol. i. of "The Botany of Iceland," the first part of which was issued in two sections, one on "The Marine Algal Vegetation," by H. Jónsson, in 1912, and a second on "The Physical Geography of the Island," in 1914.

The list of marine diatoms from the coasts of Iceland comprises 209 species and varieties; seven species and a number of varieties are here described as new. Mr. Østrup gives a tabular list showing the universal distribution of the forms, as well as their distribution on the different parts of the coasts of Iceland from which it appears that this coastal flora has a predominant European character, but that about one-half of the European species may also occur in colder seas; and, further, that diatom-life is most abundant on the south-west coast. The author also gives a synopsis showing the association of the genera and species of diatoms with the various genera of seaweeds.

The greater part of the book (p. 395 to the end) is occupied with a detailed study of the moss flora of the island, based mainly on Mr. Hesselbo's own collections and investigations. This comprises a systematic list with full notes on the distribution of the species mentioned, and including ninety-three liverworts, twenty sphagna, and 326 true mosses. A full account of the Bryophyte communities follows; first the lowland formations, and secondly the vegetation of mountain heights. Mosses play a very important part in the plant-covering of Iceland, occurring either as an essential component of practically all the plant associations, and often in far greater numbers as regards species and individuals than do the higher plants; or as distinct Bryophyte associations from which other plants are entirely absent, or in which they occur only as a subordinate component. The lowland formations are classified as littoral, hydrophilous or wet-soil, mesophilous, xerophilous (heaths), the vegetation of the rocks, and the vegetation of the lava-fields. The hydrophilous afford the greatest variety, the formations varying with the character of the water or soil; especially interesting are those of the hot springs, which the author describes in some detail. A number of successful photographic reproductions illustrate the prominence of the mosses in the Iceland flora.

The Main Currents of Zoology. By Prof. W. A. Locy. Pp. vii+216. (New York: Henry Holt and Co., 1918.)

THE aim of this book is to explain to the student and to the general reader what have been the main movements in the development of zoology. In the nineteenth century, with which the author begins, the outstanding biological advances were the discovery of protoplasm, the formulation of the cell-theory, the establishment of the doctrine of evolution, the rise of bacteriology, and the beginning of the experimental study of heredity. After interesting chapters on taxonomy and Linnæus, on comparative anatomy and Cuvier, on embryology and von Baer, on physiology and Claude Bernard, the author indicates what seem to him to be the five chief pathways—structural zoology, systematic zoology, general physiology, experimental zoology, and philosophical zoology. This does not seem very satisfactory, for "systematic zoology" is taken to include classification (which belongs to morphology), ecology and study of habits (which belong to physiology); and "experimental zoology" is, as Prof. Locy says, "more a method of general application than a subdivision."

A chapter on insects illustrates a very characteristic modern current, the study of the carriers of important disease-producing organisms, such as those causing malaria and sleeping sickness. Then follows a terse but very clear exposition of theories of evolution. A chapter is devoted to a consideration of the discoveries leading to vaccination and to the use of anæsthetics, with emphasis on W. T. G. Morton's work (1846) in connection with ether. "The ten foremost men of zoological history" are (after Aristotle) Harvey, Malpighi, Linnæus, Cuvier, von Baer, Johannes Müller, Pasteur, Darwin, Max Schultze, and Mendel. The study ends with an estimate of the contributions to zoology made by different nations, and with an emphasis on the international character of science.

There is a copious, well-arranged bibliography, and students will also welcome the series of photographs of great zoologists. Prof. Locy is beyond question right that the educational value of a science is greatly enhanced if the historical setting is made clear, and towards that end his book will be found thoroughly effective.

J. A. T.

A Primer of Engineering Science. By E. S. Andrews. Part i., "First Steps in Applied Mechanics." Part ii., "First Steps in Heat and Heat Engines." Pp. ix+95+67. (London: James Selwyn and Co., 1918.) Price 3*s*. 9*d*. net.

BOTH parts of this book are bound in one volume. Part i. contains chapters dealing with forces, moments, work, power, energy, machines, various types of mechanism, friction, stress and strain. The matter in this part is taken from the author's "Introduction to Applied Mechanics," which was reviewed in NATURE of January 20, 1916. The experimental work described in this part is weak. Six experiments in all are described; the first three only are numbered. Judging from the use made of spring balances in two of the experiments, these appliances have no weight. Part ii. is new, and consists of five chapters dealing with types of heat engines, measurement of heat energy, properties of steam, expansion, indicator diagrams, and the transmission of heat. There are a summary of the contents at the end of each chapter, and also some exercises to be worked by the student. Ten experiments are described in this part. No table of the properties of steam is given; a graph is included, but stops at 100 lb. per square inch; since it is reproduced to a small scale, accurate readings cannot be taken from it. There is evidence of haste in the compilation. On p. 2 the piston ring is described as a "junk" ring; Fig. 6 (*c*) on p. 9 is wrongly arranged; it is stated on p. 39 that Boyle discovered his law in 1862; on p. 50 a diagram traced by an indicator is described as "a diagram of resultant force or effort upon a body." Some of the diagrams are badly reproduced, this being owing to the quality of paper used. Considering the book as a whole, the young student will find some parts interesting and helpful; other parts are treated unsuitably, and a considerable amount of supplementary matter will have to be supplied by his teacher.

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.*]

A Shower of Sand-eels.

About 3 o'clock on the afternoon of Saturday, August 24 last, the allotment-holders of a small area in Hendon, a southern suburb of Sunderland, were sheltering in their sheds during a heavy thunder-shower, when they observed that small fish were being rained to the ground. The fish were precipitated on three adjoining roads and on the allotment-gardens enclosed by the roads; the rain swept them from the roads into the gutters and from the roofs of the sheds into the spouts.

The phenomenon was recorded in the local newspapers, the fish being described as "sile." I was away at the time, but, seeing the account, I wrote to Dr. Harrison, and thanks to him, and especially to Mr. H. S. Wallace, I obtained a sample of the fish, and I was able yesterday (September 5) to visit the place in the company of the latter gentleman.

From those who saw the occurrence we derived full information, which left no doubt as to the genuineness of what had been stated, and this we were able to put to the test, for a further sample was obtained from a rain-barrel which could have got its supply only from the spout of the shed to which it was connected. The precipitation of the fish, we were told, lasted about ten minutes, and the area involved Commercial Road, Canon Cocker Street, the portion of Ashley Street lying between these streets, and the adjoining gardens. The area measured approximately 60 yards by 30 yards, and was thus about one-third of an acre. It is not easy to say how many fish fell, but from the accounts it may be gathered they were numerous; there were apparently several hundreds.

There can be no question, therefore, that at the time stated a large number of small fish were showered over about one-third of an acre during a heavy rain accompanied by thunder; we were informed that no lightning was observed, and that the wind was variable.

All the examples which came into my hands from different parts of the ground and from the rain-barrel prove to be the lesser sand-eel (*Ammodytes tobianus*). They all, moreover, are about 3 in. in length, or 7·5 cm. to 7·9 cm. They are not "sile," a name usually given to the very small young of the herring. But the sand-eels are sea-fish, and it is evident that the sand-eels showered to the ground at Hendon were derived from the sea.

On sandy beaches around our coasts the lesser sand-eel is very common. As its name implies, it burrows into the sand, but in the bays it may often be seen not far from the surface swimming about in immense shoals—shoals which are characterised by the members being all about the same size.

The place where the sand-eels in question were deposited lies about one-quarter of a mile from the seashore, but it is probable that the minimum distance of transport was at least half a mile.

The only explanation which appears to satisfy the conditions, therefore, is that a shoal of sand-eels was drawn up by a waterspout which formed in the bay to the south-east of Sunderland, and was carried by an easterly breeze to Hendon, where the fish were released and deposited. It is significant that the area of deposition was so restricted, and that no other area was affected. The origin and the deposition were therefore local.

We were informed that the fish were all dead, and, indeed, stiff and hard, when picked up immediately after the occurrence. This serves to detract from the possibilities of distribution being influenced by such an occurrence, but it is possible that other species would be able to withstand such an aerial method of dispersion. It is more than probable that the vortical movement of a waterspout would transport plankton. This was naturally not observed in this case, and the small creatures, including eggs and young stages, would likely be carried over a wider area.

A. Meek.

Dove Marine Laboratory, Cullercoats, September 4.

THE WATER-POWERS OF THE BRITISH EMPIRE.

For a number of years Nature has been, on the subject of water-power in Great Britain, a *vox clamantis*. It has pointed out that while other countries—notably the United States, France, Italy, Switzerland, and even Canada—have possessed hydrographic services, there has been no co-ordinated effort—indeed, one might almost say, no effort of any kind—in this country to procure the information essential to the determination of its water-power resources and their extent and availability. It is true that a merely superficial review is sufficient to show that those resources cannot possibly vie with the vast stores of power locked up in the Alps, the Pyrenees, and the Rockies. Neither, in consequence of the plenitude of our coalfields, has there hitherto been any occasion to trouble in the least about additional, or alternative, sources of power supply. But the war, or rather its unexpected protraction, has of late completely changed the national outlook. The reckless prodigality with which our stores of solid fuel have hitherto been depleted can no longer be countenanced, and the certainty of ultimate exhaustion has to be faced before increasing scarcity causes prices to mount to unremunerative heights. The nation is learning economy, not only in food and clothing, but also in regard to its natural resources and mineral endowments. A salutary experience has been gained, and, though somewhat late in the day, it is satisfactory to know that the position is at last beginning to be fully realised and appreciated.

The Water-Power Committee of the Conjoint Board of Scientific Societies, in their preliminary report, which was abridged in Nature of September 5, p. 16, has taken a wide and comprehensive view of its functions. The committee has, the report states, "endeavoured to collect all the available relevant information" respecting the amount and distribution of water-power in the British Empire. Turning over the twenty-eight pages of the report, it must be affirmed that the information thus forthcoming is lamentably scant and imperfect. Throughout the length and breadth of the Empire two countries only—Canada and New Zealand—have recognised the fundamental importance of systematic investigation. Initiatory efforts on a small scale have, indeed, been made in Tasmania, New South Wales, and South Africa, but as regards the rest of the Empire there is an entire lack of data upon which to form any trustworthy estimate whatever. No wonder that the committee confesses to a feeling of disappointment and concern.

A very commendable effort was made, in January last, by Mr. A. Newlands, a member of the committee, to direct public attention to the matter, and the statistics which he then put forward in a paper read before the Royal Society of Arts, though admittedly incomplete, serve the useful purpose of furnishing a basis for preliminary estimates in regard to the United Kingdom. As the information was summarised in NATURE of May 9, there is no occasion to dilate upon it here. The committee's comment is that "while the possible water-powers of the United Kingdom are comparatively small, yet, occurring as they do at no great distance from industrial regions, they are relatively valuable, and every effort should be made by close investigation to ascertain their commercial value at an early date."

The outstanding fact, however, about natural supplies of water-power is that their efficient and economic development depends upon the acquisition of extensive data, involving prolonged and laborious observation. It is not sufficient to take a few gauge readings, or to record variations in level over several months, or a year or two. If the investigation is to be of real practical value it must extend over a long series of years. And herein lies the difficulty of dealing, instanter, with a situation which by long neglect has been allowed to become acute. Not until hydrometric studies have completely determined the range of conditions from maximum flood to minimum flow can the design of headworks be safely taken in hand. So, even if observations be commenced to-morrow, a lengthy interval of time, as things are reckoned in these rapid days, must elapse before they are complete enough for action to be taken on them.

In these circumstances it is obvious that where the outcome is at all problematical, or the commercial advantages not strikingly attractive, there will be a reluctance on the part of private individuals to undertake the necessary research work. Scientific bodies, however willing to assist, are certainly not equipped with funds for the purpose. It is natural, therefore, to look to the State to finance such undertakings, the more so as the water-powers, when defined and available, should be exploited, not for individual or merely local benefit, but for the advantage of the whole community.

The committee's report advocates the principle of State initiative. It recommends that the British Government should bring to the notice of the Indian and Dominion Governments the necessity for a systematic investigation of all reasonably promising sources of water-power, and where such an inquiry would be beyond the capabilities of any governing body, the report recommends that it be dealt with by an Imperial Water-Power Board, the constitution of which should be of a widely representative character. Finally, it suggests that "since it is unlikely that private capital will be available for many years for hydraulic development on any large scale, powers should be obtained for the State to assist or to undertake such development if thought advisable."

These are the main conclusions of the report, with the general trend of which we venture to think public sentiment and technical opinion will entirely concur. It now remains to be seen whether any action on the part of the Government will follow. Continued neglect of the matter can only be attended by consequences not merely inimical to immediate national interests, but also economically prejudicial to the welfare of succeeding generations. BRYSSON CUNNINGHAM.

PHYSICAL AND CHEMICAL CONSTANTS.[1]

THE valuable publication before us makes one realise that the country is waking up, if slowly. It is very significant that only in the fourth year of the war a Government Department should be sufficiently alive and receptive to agree to issue a book of constants such as this, bearing as it does on a problem indissolubly bound up with the future of the race.

Both Germany and ourselves have been giving the closest attention to the commercial development of the various processes for the fixation of nitrogen. It was well known that Germany was ahead of us, and the Munitions Inventions Research Laboratory accordingly concentrated on the problem. Its staff soon realised that a detailed compilation of the physical and chemical constants involved was a virtual necessity. Hence the present publication, which is to be regarded as a first instalment of constants compiled by Dr. Todd and his colleagues under the direction of Dr. J. A. Harker, F.R.S., whose name is a guarantee, were one needed, of the soundness of the physics and chemistry of the publication before us, and for which we have nothing but praise.

Considerable skill has obviously been exercised in employing the material to the fullest advantage, more especially in those cases where a scrutiny of the literature served only to show that the data available were meagre. Careful acknowledgment is paid to the several well-known existing books of constants, happily now no longer confined to the German tongue.

But the present work is not to be regarded as a mere compilation of constants. It is a good deal more than that. There are many points in it of considerable technical importance which are very fully discussed, to which the attention of the practical man interested in such problems should be directed.

Half the book is divided into graphs, very clearly executed on a scale sufficiently generous to permit of their accurate and rapid use. In many of these virtually the full area of the page (11 in. by 8 in.) is employed.

[1] "Physical and Chemical Data of Nitrogen Compounds." Pp. 96 Ministry of Munitions, Munitions Inventions Department, Nitrogen Products Committee.

The book is divided into five sections (with their associated graphs): general gas data, ammonia data, nitric acid data, hydrogen purification data, and miscellaneous data.

It will suffice to say that in no other publication have we found so adequate and up-to-date a summary of results. One wishes that other branches of physics and chemistry could be treated in a similarly comprehensive manner, and the whole issued as the British answer to "Landolt." It would be large, and doubtless expensive, but imagine its utility! And we need not despair, for we have now got an English Baedeker—blue—and that is only a beginning.

It is not clear from the copy before us to what extent the publication will be available to the general public, or how it may be obtained, or what its cost will be to the would-be purchaser. We trust that there will be no difficulties on these scores, for, both for its own worth and as an earnest of many more good things of the same kind, the present volume deserves a wide circulation.

BIOLOGY AND WAR.[1]

PROF. RAYMOND PEARL makes in the lecture before us an interesting examination of the biological philosophy of war. The primary implements are not mechanisms, but biological entities —men. The primary problems of war are biological problems—why do men fight, what kinds of men make the best fighters, what conditions conduce to the most effective fighting, and what are the probable consequences of the fight to the winner and the loser? "In general, why men deliberately plan wars is because they are different biologically, in structure, habits, mental outlook, thought, or other ways, and wish to preserve intact their differentiations." The group differences have an emotional context of passion, and the modern physiologists have shown us "why rage is more generally followed by fighting than by judicial arbitration." As to the belief, held with particular tenacity in Germany, that warfare is in line with the process of nature selection which has made on the whole for progressive evolution, it must be pointed out that "nowhere in nature does natural selection, as indicated by modern careful study of the subject, operate with anything like that mechanistic precision which the German political philosophy postulates; . . . much less does natural selection operate in a rigid and mechanical manner with reference to human affairs; . . . military results are not, in fact, measured in terms of biological survival." "The plain fact in the matter is that the proudly ruthless philosophy of Treitschke and Bernhardi is not only immorally cruel, but also immortally stupid."

As to the widespread fear that this war will have a serious dysgenic effect by the elimination of so many exceedingly desirable types, Prof. Pearl points out that the racial qualities are continued in the females, that many fighters have left progeny before they fell, that a large proportion of the total male population is not involved in the war, and so on. Nevertheless, it seems to us that Prof. Pearl is very optimistic in concluding that "any putative, deleterious, selective effect" of the present war "on the races concerned will be insignificantly slight." Most readers of NATURE will, we believe, know personally of several highly distinguished and markedly original men, whose deaths on the field have left the race, whatever statisticians may say, very definitely the poorer. These unique patterns may recur perhaps; for the present they are gone; and we know not how to replace them.

[1] A lecture given before the Washington Academy of Sciences on May 9, 1918. Journ. Washington Acad. Sci., vol. viii. (1918), No. 11, pp. 341–60.

NOTES.

THE council of the South African Association for the Advancement of Science has resolved to institute a Sir David Gill memorial fund, to accumulate for a number of years until an amount has been raised adequate for some purpose to be decided upon. Mr. R. T. A. Innes, Union Observatory, Johannesburg, has consented to act as the secretary and treasurer of the fund, and intending subscribers are invited to communicate with him.

PROF. H. C. H. CARPENTER, the president of the Institute of Metals, has been nominated to fill the office for a further year.

DR. H. S. HELE-SHAW, F.R.S., and Signor Marconi have been elected honorary fellows of the Society of Engineers (Inc.).

SIR JOHN MARSHALL, Director-General of Archæology in India, has, in consequence of illness, been granted leave of absence, during which his deputy will be Dr. Spooner, Superintendent of Archæology, Eastern Circle.

A COMMITTEE on explosives investigations has been selected by the U.S. National Research Council at the request of the American Secretary of War and the Secretary of the Navy. The committee consists of Dr. C. E. Munroe, of the George Washington University (chairman); Mr. L. L. Summers, of the War Industries Board; Lt.-Col. W. C. Spruance, jun., of the Ordnance Department of the Army; and Lt.-Commdr. T. S. Wilkinson, of the Ordnance Department of the Navy.

DR. J. N. ROSE, a curator of the division of plants, the U.S. National Museum, has gone on a botanical expedition to Ecuador on behalf of the National Herbarium, the U.S. Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium.

DR. OLAF ANDERSON, petrologist at the U.S. Geophysical Laboratory, has resigned his position, having been appointed Government geologist and director of an experimental silicate laboratory at Christiania.

ON September 3 there died in a nursing home in London, only three months after her "Life of Sophia Jex-Blake" had been published, Dr. Margaret Todd, the authoress. Dr. Todd was known to many readers as "Graham Travers," under which *nom de plume* her five novels were written. Dr. Todd, born in 1859, was educated at Edinburgh, Glasgow, and Berlin, graduated in medicine (M.D. Brux.), and was associated in her medical work with Dr. Jex-Blake, the pioneer of the "lady medicals" movement in Edinburgh. Their friendship led to Dr. Todd's becoming Dr. Jex-Blake's executrix and her biographer. To this latter task Dr. Todd brought a triple qualification, the colleague's, the friend's, and the novelist's. Like Mrs. Gaskell's "Life of Charlotte Brontë," it is a woman's life of a woman, is written by a novelist, and reads with all the interest of a novel. Dr. Jex-Blake's biographer depicts her truthfully, a strong, not altogether likeable, personality, strangely emerging from the setting of a patrician English country home, in sharp contrast to the roughness and bitter rancour she endured in Edinburgh. There, supported by such men as Prof. Masson and a small band of staunch friends, she waged war against "a dying tyranny," won the day, and thereby opened a road for those who came after, among them Dr. Elsie Inglis, and others serving to-day with the Scottish Women's Hospitals. Dr. Margaret Todd's last work is an addition to biographical literature, and will help to keep the road-makers unforgotten.

DR. CARL PETERS, the German African explorer, died last week at the age of sixty-two. His first mission to Africa in 1884 was unofficial, and, in fact, discouraged by his Government, but Dr. Peters succeeded in signing a treaty with chiefs on the mainland opposite Zanzibar and laying the foundations of German East Africa. In 1888–90 he made an expedition up the Tana River by Mount Kenia to Lake Baringo, Victoria Nyanza, and back to Zanzibar through Usukuma and Ugoga. Dr. Peters's avowed object was to search for Emin Pasha, but he was more concerned in making treaties with Uganda chiefs. In this, however, he was forestalled by the British. His expedition covered a great deal of ground, and the way was marked by terrorism and brutality, where previous explorers had penetrated with little difficulty. In 1891 Dr. Peters returned to Africa, and in 1892 was one of the commissioners for delimiting the Anglo-German boundary in East Africa. Soon after he was recalled to Germany. In 1899–1901, and again in 1905, he travelled in the Anglo-Portuguese frontier lands in the Zambesi region, and made many important discoveries. This was probably Dr. Peters's best work, though his published results were marred by hasty conclusions and ill-founded judgments on the origin of the Zimbabwe ruins and the extent of early Portuguese work in Africa. Dr. Peters was the author of several works on Africa, including "The Eldorado of the Ancients," published in 1902.

THE publication of the *Monthly Register* of the American Society for Practical Astronomy has been suspended for the duration of the war. The society itself has postponed all further activity for the same period, and no new members are being elected. When the work of the society is resumed the organisation will be as at the close of 1917, the membership consisting of those who were upon the books at that time.

WITH the issue of the *Journal of Anatomy* for October, the publication of the periodical, which is the official organ of the Anatomical Society of Great Britain and Ireland, is to be transferred to the Cambridge University Press, Fetter Lane, E.C.4. Contributions should be sent, as hitherto, to Prof. Keith, acting editor, Royal College of Surgeons, Lincoln's Inn Fields, W.C.2. We wish the journal, which was established in 1867, continued and increasing success.

AMONG the forthcoming free public lectures to be delivered at Gresham College, Basinghall Street, are the following:—Geometry, W. H. Wagstaff, October 8 to 11; Astronomy, A. R. Hinks, November 5 to 8; Physic, Sir R. Armstrong-Jones, November 12 to 15; and Music, Sir F. Bridge, November 19 to 22.

WE welcome the establishment of a new scientific publication, the *American Journal of Physical Anthropology,* with Dr. Ales Hrdlička as editor, supported by a large staff of eminent American anthropologists. The first number, issued for January–March, 1918, contains some important contributions. Mr. G. S. Miller publishes an elaborate study of the famous jaw discovered at Piltdown in 1912. This specimen has been the subject of much controversy, some British anthropologists maintaining that it formed part of the admittedly human cranium close to which it was discovered, while others regarded it as the jaw of a chimpanzee accidentally washed into proximity with a human skull. The latter view is supported in this paper. The combined characters of the jaw, molars, and skull were made the basis of a genus Eoanthropus, of the family Hominidæ. But Mr. Miller asserts that "while the brain-case is human in structure, the jaw and teeth have not yet been shown to present any character diagnostic of man; the recognised features in which they resemble human jaws and teeth are merely those which men and apes possess in common. . . . As the result of recent study the generic features of the jaw and teeth have not been shown to differ from those of living African chimpanzees." The question has probably not reached its conclusion. But the investigation will be assisted by the comprehensive study of the facts and a bibliography of the literature provided by Mr. Miller.

IN the September issue of *Man* Sir H. C. Read discusses a remarkable carved ivory object from Benin, which has recently been presented to the British Museum by Mr. Louis Clarke. At first sight this example scarcely suggests African art, but the representation of a human head wearing a hat connects it with other specimens of Benin art. It is difficult to conceive the precise object of a cover of this peculiar shape. It may have been used as the cover of a vessel, and offerings of some kind may have been dropped into a lower receptacle through the hole in the centre. But no exactly parallel specimen appears to exist in other collections of Benin art, and the object of its construction so far remains a mystery.

IN *Sudan Notes and Records* (vol. i., No. 3, July, 1918) Mr. W. Nicholls describes a remarkable marriage custom in the Sennar province, which is known as "stealing the fire." On the final night of the festivities the bridegroom goes to the bride's house escorted by a band of youths bearing torches. These torches can be lit only by fire taken from the bride's house, and this the relatives of the bride take every possible method to prevent. Some of the bridegroom's friends creep in secretly at night, or a body of them forces its way into the house to carry off the fire. The editor quotes as parallels the custom recorded by Sir James Frazer ("The Golden Bough," "The Magic Art," vol. ii., pp. 216, 230), in which fire is used as a fertility charm in marriage ritual. But this is not an exact parallel, and, assuming that the charm is in the interest of the bride, it does not account for the resistance made by her friends when the bridegroom's party endeavours to procure fire from her home hearth.

THE report for 1917 of the inspectors under the Act restricting experiments on animals has just been published; it can be got from H.M. Stationery Office or through any bookseller, price 2*d*. The total number of experiments in England and Scotland was 55,542, being 10,501 fewer than in 1916; the total number of experiments in Ireland was 832. About 97 per cent. of all experiments were inoculations, or other proceedings performed without anæsthetics. The decrease in the number of experiments goes with the fact that many of our pathologists and bacteriologists are working in one or other of the theatres of war. Indeed, the war is writ large all over this report. Of the twenty new places registered under the Act, fourteen are military hospitals and laboratories, mostly for Canada and New Zealand. Owing to the shortage of men for the work, women are helping; of the 695 licensees, 43 were women. The number of licensees is discounted by the fact that no fewer than 402 of the 695 made no use of their licences during 1917.

REPORTS have recently been received from various quarters of the occurrence in rooms of myriads of little black flies. These not only swarm upon the window-panes, but have also been found in drawers, under carpets, and even behind the glass of framed pictures. Specimens that have been submitted to the Natural History Museum, South Kensington, prove to be *Pteromalus deplanatus*, Nees, a species belonging to the parasitic Hymenopterous family Chalcididæ. There appears to be some uncertainty as to the host-insect that gives rise to such swarms of the parasite. The latter is recorded to have been bred from insects of various orders, *e.g.* a moth (*Tortrix xylosteana*), a beetle (*Ceuthorrhynchus asperulus*), and a Cynipid gall (*Teras terminalis*), but none of these hosts is likely to be the source of origin of such swarms of the parasite indoors; it is probable that in such circumstances it has emerged from one of the wood-boring furniture beetles (*Anobium striatum* or *Xestobium tessellatum*), though there is no definite record of such an origin. Should this prove to be the fact, the Pteromalus, though, perhaps, regarded by the householder as a nuisance, is evidently from its numbers a useful and efficient check upon the insidious and destructive pest of indoor woodwork, whether furniture, wainscotting and panelling, or beams and floor-boards. Information of the definite association of the Pteromalus with one of these wood-boring beetles would be welcomed by the Natural History Museum.

MR. CLOUDESLEY BRERETON writes to us in regard to the origin of water-snails and leeches in a small artificial pool in a London garden. The basin, a few square feet in size, was made about three years ago, and one or two water-lilies were placed in it. Two years later some water-snails appeared, and this year three leeches. There is no pool of any sort in adjacent gardens. The water comes from the main. Where have the animals come from? (*a*) They may have been introduced in a young phase along with the water-lilies. The spawn of Limnæa and some other fresh-water snails is deposited on the under-surface of water-plants, and the eggs of some fresh-water leeches are similarly attached. (*b*) They may have been introduced along with the main water—the snails in their larval state, the leeches either when very small or later. On two occasions we have obtained from a house-tap in a large town leeches about 2 in. long. (*c*) Even in transitory rain-water pools the sudden appearance of fresh-water molluscs has been repeatedly observed, and we do not know that any circumstantial explanation has been given. It is probable that water-birds, such as wagtails, may occasionally serve as distributors. Darwin wrote in the "Origin of Species" of just-hatched shells clinging to a duck's foot, and Sir Charles Lyell told him of a water-beetle (Dytiscus) which carried an Ancylus, a fresh-water snail like a minute limpet. Mr. Brereton's observation, which has its counterpart in the experience of others, deserves further investigation.

ENTOMOLOGISTS are still in doubt as to the stage of the life-history in which the common house-fly normally passes the winter. A paper on the subject has been lately published in the *Journal of Agricultural Research* (vol. xiii., No. 3) by R. H. Hutchison, who concludes, from observations and experiments made in Washington, that larvæ and pupæ survive the cold season in and under large manure-heaps, and that breeding may go on through the winter if flies gain access to heated buildings, and find there both food and material suitable for egg-laying.

THE stone-flies (Perlidæ) have hitherto been considered as of no economic importance except that they serve as bait for anglers. A paper by E. J. Newcomer (*Journ. Agric. Research,* vol. xiii., No. 1) is therefore noteworthy, since it records damage to orchard foliage by some species of Tæniopteryx.

THE "Summary of Progress of the Geological Survey of Great Britain for 1917" (H.M. Stationery Office, 1918, price 2*s.*) contains a number of valuable facts relating to the modes of occurrence and probable reserves of iron-ores in Great Britain. Mr. Lamplugh's account of the oolitic ore of Jurassic age revealed by the Dover coal-borings is especially noteworthy, a reserve of about 100,000,000 tons being indicated. Dr. R. Campbell describes Scotch occurrences of potash-felspar.

THE issue of the *American Journal of Science* for July, 1918, contains 416 pages, and commemorates the one hundredth anniversary of the foundation of the journal. The progress of the sciences since 1818 is described in eleven chapters, and the entire cost of the issue has been defrayed from the Silliman memorial fund. In his review of the history of the journal, Prof. E. S. Dana gives a facsimile of the covering title of vol. i., No. 1, which shows that its scope included "agriculture and the ornamental as well as useful arts." The essay on "The Progress of Historical Geology in North America," by Charles Schuchert, contains important remarks on stratigraphy, and the following classification is proposed for the older Palæozoic systems:—Taconic (Olenellus beds), Cambrian, Champlain (Emmons, 1842) or Ordovician, Silurian. The author does not seem aware of Lapworth's support and revival of the term Taconic in 1891. Joseph Barrell, in a philosophic article, reviews the growth of our knowledge of earth-structure; and R. S. Lull deals with vertebrate palæontology, a subject to which the United States have made such paramount contributions. H. L. Wells and H. W. Foote, in the article on chemistry, furnish a table of the elements on Mendeléeff's scheme, in which recent discoveries are included. Attention is directed by the authors to the remarkable compartment in Group III., in which fourteen metals of the rare earths are summarised as "lanthanum 139·0 to lutecium 174·0," the full list being added below. The century's progress in physics is reviewed by L. Page; but W. R. Coe deals only with American developments in zoology. The capture of Louis Agassiz for the United States in 1846 is recorded with warm appreciation.

MR. J. T. JUTSON (Proc. Roy. Soc. Victoria, vol. xxx., part 2, 1918, p. 165) furnishes striking examples of the influence of the crystallisation of soluble salts in promoting rock-weathering in sub-arid regions. He acknowledges his indebtedness to Prof. J. Walther, who directed attention to the subject during the visit of the British Association to Australia in 1914. Level rock floors are developed around lakes, where moisture, containing for the most part sodium chloride, is drawn up by capillarity. The solidifying of the salt disintegrates the rock, and

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wind removes the *débris*. Caves are eaten out in this way under the marginal cliffs, which recede by a process of dry undermining. A paper by Dr. Bather in the *Geological Magazine* for 1917 is referred to.

A PUBLICATION of importance to zoologists and geologists on "The Foraminifera of the Atlantic Ocean" is begun by Mr. J. A. Cushman in Bulletin No. 104 of the United States National Museum (Smithsonian Institution, Washington, 1918). The Astrorhizidæ are here dealt with, and the evidence of selective ability in these primitive forms is of perennial and philosophic interest. Haliphysema, with its crown of sponge-spicules, is figured after Brady; but photographs are given of *Psammosphaera parva*, which habitually builds into its spherical test one large spicule, projecting boldly at each end. Mr. Cushman writes of another species as possessing "even greater ingenuity."

ONE of the greatest earthquakes of the last ten years was registered on September 3. At West Bromwich the range of movement amounted to 10 in.; the writing pointers were frequently swept off the paper, and were once completely dismounted, the total duration of the oscillations being four or five hours. The origin of the earthquake is estimated to be in the North Pacific, at a distance of 5600 miles, and probably in the Aleutian Islands, which belong to one of the great unstable regions of the globe.

MR. C. H. GLASCODINE, of Abingdon Gardens, W., has sent us an account of a remarkable hailstorm in King Island, Tasmania, on June 21 last, received from his nephew, Mr. E. J. Glascodine, from which we extract the following:—"The hailstones were like starfish, *i.e.* with a roughly spherical core and fingers out in all directions, not only on one plane: more like one of those most useful-looking old-time war weapons, spikes protruding from a sphere of iron in all directions mounted on a handle by a short chain! But in the case of the hailstones the spike was much longer, the largest part of the whole. One or two I measured were more than three inches across from point to point, and several were above two inches in two directions: the centre was comparatively small, from ½ in. to ¾ in. in diameter, roughly. They were not heavy, and were clear ice, not opaque as hail usually is, and at the same time each 'stone' appeared to be an agglomeration of ordinary small hailstones. Though the ground was more or less covered with ice, which lay for two hours, and only a proportion of the hailstones were of extra large size and this unusual shape, the thermometer (on veranda) did not fall below 48° F. All soft, succulent leaves of plants, such as arum lilies and rhubarb, turnip-tops, and such like, were shredded, torn in strips."

IN an article in the September issue of *Scientia* Dr. A. Riccò, of the Astrophysical Observatory of the University of Catania, summarises our knowledge of the constitution of the sun. So far as the interior is concerned, there is still much to learn. The high temperature and pressure which exist there are so much above those attainable in a laboratory that we are unable to ascertain what their effects on the properties of matter are likely to be. There seems little doubt that the temperature of the interior exceeds 7000° C., and is well above the critical temperatures of the substances of which the sun is composed. As a consequence, those substances should be in the gaseous state; but under the enormous pressure to which they are subjected their molecules are so close together that the properties of the gases must be similar to those of liquids, or even solids, as known from laboratory experiments.

IN a paper presented to the Franklin Institute in March, which appears in the August issue of the Journal of the institute, Mr. F. W. Sperr, jun., chief chemist to the Koppers Co., of Pittsburgh, dealt with the relations between the principal characteristics of American cokes and the sources of the coal from which they are produced. In the course of his address he pointed out that more than one-half of the sixty million tons of coke produced per annum in America at the present time is made in the old "beehive" oven, which wastes the ammonia, benzene, naphthalene, toluene, and other by-products the modern oven conserves, and, in addition, will only produce good coke for metallurgical purposes from a much more restricted range of coals than the modern oven. He estimates the annual loss to the country from this cause to be 19,000,000*l*.

THE American Ceramic Society, which has been in existence nearly twenty years, and has hitherto issued its Transactions in the form of annual volumes, has decided instead to publish a monthly journal, the first number of which has just come to hand. The official description of it as "a monthly journal devoted to the arts and sciences related to the silicate industries" serves as a reminder that the authoritative definition of the term "ceramic" in America covers a much wider range than is commonly accepted elsewhere. Possibly this more extensive field may supply at the same time a reason for publication at shorter intervals, and a sufficient amount of suitable matter to maintain the standard aimed at. It is interesting to note that of the committees through which the U.S. National Research Council works, three are concerned with subjects coming within the scope of the American Ceramic Society's activities. An appreciative notice of Prof. E. Orton, jun., who has been secretary of the society since its foundation, is included. Among the technical papers in this first number are:—"Special Pots for the Melting of Optical Glass," by Bleininger; "The Effect of Gravitation upon the Drying of Ceramic Ware," by Washburn; and "Notes on the Hydration of Anhydrite and Dead-burned Gypsum," by Gill. We wish the American Ceramic Society success in its new venture.

READERS of NATURE may be weary of the iteration with which their attention has been directed to the extraordinarily liberal scale on which the American Government subsidises the provision of agricultural education and research, but an article in the current *Fortnightly Review* contains some striking figures which deserve notice. For example, the expenditure of the United States Department of Agriculture has risen from 234,000*l*. in 1890 to upwards of 5,000,000*l*. in 1916—a figure which may be contrasted with the 300,000*l*. odd expended by the English Board of Agriculture in the latter year. Another striking figure is derived from the report of the Division of Publications. The aggregate printed matter issued in one year exceeded 25 million copies of nearly 2000 separate publications, all of which were issued at a nominal price. Another novel form of activity noticed is the employment of "agents in the field" to supply advice gratuitously to the southern coloured agriculturists. Of these 450 were employed. Again, what are known as "corn clubs" for boys have been started. The membership of these exceeds 46,000, and all have been specially instructed in the growing of maize. A sum of 8000*l*. was distributed in prizes for good work. A further respect in which the U.S. Government is far ahead of the British is in relation to the control of food products, especially in respect of adulteration and preservatives, and of this department a characteristic feature is the

"Poison Squad," a band of young men who have volunteered to submit themselves to experiment with suspected foods. The writer of the *Review* article, however, carries his admiration of American administration too far, perhaps, when he says that "the American Government's offices are staffed, not with dull, bureaucratic automatons, not with human derelicts and petrifacts, but with keen, open-minded, and striving business men." This is the same form of psychosis which led before the war to the adulation of German institutions and methods. There is, however, another tribute paid to the American with which more complete agreement can be expressed. "America's chief success," says the writer, "is largely due to the fact that education is the chief industry of the nation." We agree; the American has an intense belief in the value of education and in an aristocracy of brains rather than of wealth. In this respect England has much to learn.

Recalled to Life, a quarterly review devoted to all that is being done for the disabled sailor and soldier, now appears with a new name, *Reveille*, and a new editor, Mr. John Galsworthy in place of Lord Charnwood (H.M.S.O., 2*s*. 6*d*. net). In the issue for August Col. Sir Robert Jones gives a graphic account of the work now being carried out by surgeons in the special military hospitals where disabled men are treated. Experience has shown that the principles which have to be applied in military orthopædic cases are those which were successfully applied in peacetime to children who had suffered from infantile paralysis. Before the war very few surgeons saw more than occasional cases of wounded or divided nerves. Now every convoy from France brings many such cases. The technique of the suturing of nerves has become one of the important points in operative practice. Operations, such as the grafting of bone, the transplantation of tendons, and the plastic reformation of the face or of stumps, which were regarded as surgical curiosities in peacetime, have now become matters of everyday experience. The chief lesson that the military surgeon has learned from recent experience is that the re-education of nerves, muscles, and joints which have been reformed by operation is by far the most important and tedious part of successful treatment. "Muscles," says Sir Robert Jones, "can be made to learn to do things they never did before; bones can be arranged, and the cells will build them up to meet new emergencies; nerve-cells will learn to send messages to the muscles in their new work, and a new limb, as it were, will be created."

ACCORDING to the *Zeitschrift für angewandte Chemie* for July 2 last, an association of German manufacturers of finely ground dyes, recently formed in Berlin, has been joined by nearly all the firms interested. In addition to watching the economic interests of its members, the new association will act as a central medium for the distribution of raw materials both now and during the transition period.

A LARGE deposit of graphite at Skaland, in Norway, and under the control of the Metallurgists A./S. of Bergen, has been prospected, and now proves to be sufficiently extensive to supply the Norwegian market for some years to come. Any desired quality of product can be made from the crudest material up to one of 97 per cent. purity. Electrostatic separation is adopted. According to U.S. Commercial Reports (May 23, 1918), it is proposed to erect a plant capable of meeting the home demand.

AN engineer in Haugesund (Sweden) is at present engaged on an invention in connection with the smelting of molybdenum at a large works near, at which (according to *Verdens Gang*, June 30) it is hoped to refine fifty tons of molybdenum per annum.

DR. HEINRICH TRAUN AND SONS, of Hamburg, have issued a four-page leaflet giving particulars of "Faturan," an insulating material manufactured by them. It is a condensation product of phenol and formaldehyde. It is non-hydroscopic, and scarcely affected by heat. A high insulation is maintained owing to the absence of surface sulphur. Its tensile strength is 2·5 to 3 kg. per mm.^{2}, and its specific gravity 1·2 to 1·3 in normal qualities.

MESSRS. HENRY FROWDE AND HODDER AND STOUGHTON have in the press for publication in the series of Oxford Medical Publications "The Early Treatment of War Wounds," by Col. H. M. W. Gray, illustrated, and "War Neuroses and Shell Shock," by Brevet Lt.-Col. F. W. Mott, illustrated. They also announce a new edition of "Surgical Diseases of the Gall-bladder, Bile Ducts, and Liver: Their Pathology, Diagnosis, and Treatment" (including Jacksonian prize essay), by H. J. Waring, illustrated.

OUR ASTRONOMICAL COLUMN.

AUGUST AND SEPTEMBER METEORS.—Mr. Denning writes that between August 28 and September 12 he observed 153 meteors, and determined a number of radiant points of minor showers. The chief of these were as under:—

1918	Radiant ° °	No. of meteors
August 28–September 8 ...	0 − 2	8
August 28–September 8 ...	265+63	7
September 2–12	318+48	10
August 29–September 8 ...	326+78	6
August 28–September 12 ...	332+ 5	8
August 30–September 8 ...	333+57	9
August 31–September 12 ...	337−10	7
August 29–September 1 ...	352+76	8

The Cygnids, No. 3 on the list, were very definitely marked, and that radiant, like several of the others, remains visible during a long period.

On September 8 two large fireballs were seen by Mrs. Wilson at Totteridge at 7h. 20m. and 10h. 14m. G.M.T. The latter was estimated to be four times as brilliant as Venus, and it broke into three pieces in the latter part of its flight. It had a long course of 170 miles, from 10 miles south of Dunkirk to the North Sea about 40 miles north-east of Cromer. Its height was from 64 to 29 miles, velocity 14 miles per second, and the radiant point was at 324°−25° in Capricornus.

NOVA MONOCEROTIS.—A detailed account of the spectrum of Nova Monocerotis, as observed on February 25 and March 1, 15, and 27, has been given by Dr. G. F. Paddock (Lick Obs. Bull., No. 313). The following bright lines were observed in addition to those of hydrogen:—4363, 4640, 4686, 4959, 5007, 5526±, 5677±, 5756±, all being described as faint except the first two and the fifth. As in other novæ, the lines were broad and complex, and each emission band had a faint central absorption band. The bands of hydrogen and 4640 were nearly symmetrical, while the nebulium lines were brightest on the violet sides of the absorption bands. There were no narrow lines suitable for determinations of radial velocity, but the central absorption bands appear to have occupied nearly their normal positions. It is evident that the star had reached the nebular stage in the usual sequence of spectra when these observations were made. At the time of discovery by Wolf on February 4, the magnitude of the nova was 8·5, but previous photographs in the Harvard collection showed that the maximum had already been passed.

THE SPECTROSCOPIC BINARY BOSS 46.—Following the discovery of the variable velocity of this star at Mount Wilson in 1914, Messrs. W. S. Adams and G. Strömberg have made extensive observations, and features of special interest have been revealed (*Astrophys. Journ.*, vol. xlvii., p. 329). The star belongs to the class of spectroscopic binaries in which the calcium lines give values of the radial velocity differing widely from those indicated by other lines. The period is 3·5225 days, and the velocity shown by the hydrogen and helium lines has the remarkably large range of 450 km. per second. The calcium lines have been found to show a variation having the same period, but with the comparatively small range of 20 km. A velocity of −45 km. for the system is indicated by the lines of hydrogen and helium, and of −23·5 km. by the calcium lines. These results seem to favour the view that the vapour producing the calcium lines is not in the form of a detached cloud in space, but is involved in the binary system itself. The differing velocities for the system deduced from the two sets of lines are probably not to be wholly interpreted on the basis of velocity. The visual magnitude of the star is 6·0, and the spectral type B 3 p.

THE INVASION OF TRENCHES BY RATS.

PROF. P. CHAVIGNY has contributed to the *Revue Générale des Sciences* for July 15 and 30 two very interesting and useful articles on the invasion of trenches by rats. Soon after trench warfare began the trenches were invaded by immense numbers of rats, which caused great damage and almost intolerable annoyance at night. Various measures, such as the use of poisons, infective virus, traps, terriers, etc., were taken to destroy the rats, but with very poor success; and it is shown that this was due to a lack of knowledge of the natural history and habits of the animals concerned.

The rat which invades trenches is nearly always the ordinary brown or Norway rat (*Mus decumanus*), but in the case of dry trenches the black rat (*M. rattus*) may be present. These rats sleep in places of retreat or holes during the day; it is at night that they cause all the trouble. The intelligence which they display in overcoming obstacles and avoiding traps, poison, etc., is extraordinary; and it is evident that they possess some means of communicating their knowledge to one another, since any particular means of killing them soon becomes of little use. Prof. Chavigny lays special stress on the fact that they live on exactly the same food as man, and cooked in the same way. Of raw food they can make scarcely any use. For instance, they simply starve if given raw barley. They will gnaw and destroy almost anything that their teeth can penetrate, but what they actually live upon is simply the ordinary human food which they are able to reach, and particularly the remnants from meals. A rat consumes about 30 to 50 grams of food daily, and starvation kills it in about forty-eight hours. It neither lays up stores of food nor hibernates in winter.

As ordinary brown and black rats will not breed in captivity, most of our knowledge as to their rate of reproduction is derived from observations on the albino variety, which breeds readily in captivity. The period of gestation is twenty-one days, and the minimum time between two litters from the same female is sixty-two days. She may have as many as five litters in a year. A litter consists of about ten. A female at the age of two and a half to three months is capable of producing a litter. The young are very efficiently tended, so that scarcely any die. A simple calculation gives the surprising result that a single pair of rats is capable of producing twenty million descendants within three years.

Reproduction ceases during cold weather, and rats cannot reproduce themselves at all in cold climates. In temperate climates reproduction is at a standstill during the winter. The most important factor limiting reproduction is, however, the supply of nutriment. A female receiving only sufficient food to keep her in good condition does not reproduce at all, whereas with superabundance of food reproduction proceeds at its maximum rate.

In his second paper Prof. Chavigny describes and discusses the various methods used for destroying rats, and shows that the disappointing results obtained are due to neglect of the fact that multiplication of rats is simply the result of scattering human food within their reach. The essential step in controlling the rat invasions is to prevent the scattering about of remnants of food. For this purpose it is recommended that, where possible, all waste food should be collected and used for pigs. Where this is not possible the waste food should be thrown into pits and covered with earth before nightfall. Prof. Chavigny proposes also that placards should be posted up saying that "he who sows fragments of food will reap a harvest of rats."

THE PROPERTIES OF COPPER.

THE U.S. Bureau of Standards has recently issued a circular (No. 73) entitled "Copper." It appears that the Bureau is constantly in receipt of requests for detailed or general information concerning the properties, statistics, etc., of metals and alloys. Such information is rarely to be found in systematic form. Generally the different sources of such information are difficult of access, and their accuracy is not always certain. Much information of this kind that is quoted is valueless, either for the reason that the data upon which it is based are incorrect or because they have not been properly interpreted in quoting. Accordingly, the Bureau is planning to issue from time to time circulars on individual metals or alloys with the idea of grouping in them all the most trustworthy information that is available, either from its own tests and investigations or from published records contained in the literature.

These circulars are intended to deal primarily with the physical and mechanical properties of the metal or alloy; all other factors, except a few statistics of production, such as methods of manufacture, impurities, etc., are discussed only in relation to these properties. Copper has been chosen as the first metal for this treatment, partly because much of the accurate information regarding it has been obtained at the Bureau, and partly because our knowledge of its properties is more complete than that of any other metal. Moreover, the commercial forms of copper are characterised by a high degree of purity, *e.g.* the electrolytic wire bar manufactured in the United States of America contains on an average 99·96 per cent. of this metal, and the Lake wire bar 99·89 per cent. The highest quality brands of English (furnace-refined) copper contain about 99·75 per cent.

Circular No. 73 contains the best established values of various physical and mechanical characteristics of pure and commercial grades of copper, principally at the ordinary temperature. Variations of these properties with changes of temperature are also discussed. There is a useful technological section dealing with casting, deoxidation, working, welding, hardening, electro-deposition, and heat-treatment, followed by another discussing the effects of impurities on the physical properties of the metal, and concluding with a brief account of its "diseases." A complete bibliography and typical specifications are included. The information is mainly put in the form of tables and curves, and the latter have been reproduced in such dimensions that accurate interpolation of values on them is possible by the use of a rule graduated in decimal parts of a centimetre. The probable degree of accuracy of data is indicated, or implied, by the number of significant figures in the values given.

It is somewhat surprising to note that pure copper which has been cast and rolled and afterwards annealed at 500° C. to normalise it does not have its ultimate tensile strength stated more closely than 35,000±5000 lb. per sq. in., when it is remembered that after this treatment there is less variation between different samples than in any other condition. Such copper has no detectable elastic or proportional limit; *i.e.* annealed copper takes a permanent set with the slightest loads. On the other hand, when it is cold worked, rolled, or drawn, it does acquire a limit of proportionality, depending on the degree of work. Experiments at the Bureau have shown that modern hard-drawn copper wire is equally affected by drawing throughout the section, and that no hard or exterior skin exists. This has been corroborated by Peirce. The publication is a most useful one. H. C. H. C.

INTERFEROMETER DETERMINATION OF REFRACTIVE INDICES.

PROF. CARL BARUS has recently developed and extended certain of the methods described by him in 1916 in connection with the spectroscopic resolution of interferences obtained with interferometers of all classes from the simplest to the most complicated type.[1] Cases of special interest arise in which the interfering spectra are reversed or inverted relatively to each other.

Obviously, such methods may have a number of valuable physical applications, and among several examples to which Prof. Barus has given attention is the possibility of the determination of refractivity irrespective of form by immersion methods. In the method developed for this measurement (chap. iv., part ii.) the interferences produced by white light in a slightly modified type of Michelson interferometer are viewed with a telescope and prism-grating. Elliptical interferences are seen in the spectrum, which may be moved relatively to spectral lines by a micrometric change of path in one of the beams. A trough containing a liquid of adjustable refractive index, in which the solid under test may be immersed, is placed in this beam, and attempts are made to recognise equality in refractive index of solid and liquid by the fixity of fringes on immersion. Naturally, the fringes in the spectrum are distorted owing to unavoidable differences of dispersion, but it is disappointing that the method should have failed to give a sensitive indication of equality. It has, however, long been recognised that interference methods in most cases are inconvenient for direct refractometry; in reality, the recognition of the point of equality is the crux of the matter, for other more simple and direct methods are available for the measurement itself. In this connection an expedient used by the present writer in attacking the problem (Trans. Optical Soc., December, 1916)—that of varying refractive index in the liquid by differential evaporation while homogeneity is secured by mechanical stirring—might possibly lead to success. The fringes could then be observed continuously and the necessity for separate steps avoided.

The detection of *variations* of refractive index in unworked glass is one of the most important problems for modern optics. These variations, which are due to irregularity of composition, frequently affect the fifth decimal place, but cannot at present be detected until optically worked surfaces have been given to a specimen. It seems possible that the difficulty may be overcome by an interferometer-immersion method. It is too often assumed, however, that interferometer methods are of great delicacy in comparison with "definition" tests or the Töpler knife-edge test. Remembering Lord Rayleigh's rule, that disturbances should meet in an image with not more than a quarter wave-length difference of phase, it may be realised that the formation of a well-defined image is a fairly severe test of the homogeneity of the media of the system, having granted sufficient freedom from aberrations due to the form of the surfaces. If, in addition, the direct image is screened so that only the effects of irregularity are perceived, the test may apparently be made as sensitive as is desired by increasing the intensity of the source of light.

In conclusion, it may be remarked that the method of spectral interferences, although appearing to be exceedingly useful, has not yet been studied so exhaustively in this or other connections as to enable a final judgment to be passed upon it. L. C. M.

[1] "The Interferometry of Reversed and Non-reversed Spectra." By Carl Barus. Parts i. and ii. (Publications of the Carnegie Institution of Washington, 1916 and 1917.)

FERN NOTES FROM PRINCE BONAPARTE'S HERBARIUM.

UNDER the title "Notes Ptéridologiques"[1] Prince Roland Bonaparte is issuing at irregular intervals fascicles of a publication dealing primarily with the fern collections in his private herbarium in Paris. The herbarium already contains about 300,000 specimens coming from all parts of the world. These have been derived partly by purchase or exchange from public or private herbaria or from individuals, and partly from Prince Bonaparte's own correspondents or from collectors and travellers with whom he is in touch. Thus many of the collections are represented in other herbaria, and the publication of the names of specimens which have hitherto been undetermined will be of service to other workers in the field of pteridology, while a systematic account of new collections will add to our knowledge of the ferns and of their geographical distribution. Prince Bonaparte is also pleased to receive on loan collections for determination, and will publish lists of the species.

The general arrangement is geographical, and each collection is treated separately under the heading of the continent from which it has been derived. The systematic arrangement and nomenclature adopted are those of Christensen's Index. A list of desiderata is printed at the beginning of each fascicle.

In an introductory note the older practice of relying solely on external characters for the determination of genera and species is adversely criticised. In the future more use must be made of anatomical characters; thus the scales and hairs, which are becoming increasingly important for systematic distinctions, may appear alike when viewed superficially, but on microscopic examination will reveal well-marked characters useful for specific delimitation. These characters, with those of nervation, will be found more trustworthy than those derived from the indusium, a transitory structure.

These little brochures should prove of considerable value to botanists who are interested in the systematic study of the ferns. We note that the Prince does not follow the rule of giving a brief Latin diagnosis of the new species, though there is often a good description

[1] Paris: Imprimé pour l'auteur.

in French. There is, however, nothing to be said in favour of publishing lists of new species with no description or reference to such, as is done, for example, in the case of a number of Spruce's specimens from tropical South America. The fascicles are separately paged, and an index to each would facilitate reference.

SCIENTIFIC RESEARCH AND NATIONAL PROSPERITY.[1]

MANY, no doubt, do not comprehend what functions the research chemist can exercise in South Africa, and what scope the country can offer for his labours. Following the United States principle of the best men in the best posts, where, they ask, can we place him so that the country may, through his instrumentality, reap the greatest advantage? To answer such questions one needs, first of all, to consider how scientific research—and therefore, inferentially, chemical research—may be distributed. As a matter of convenience a threefold grouping is adopted—university research, industrial research, and national research. Adopting the definitions given by Mr. C. E. Skinner a few months ago at a meeting of the American Institute of Electrical Engineers, we may say that university research includes the pure scientific research, which naturally finds its home in the university, and all other research done there for the purpose of training men. Industrial research comprises all that done by or for industrial concerns with the purpose of advancing industry. National research is that carried on by the Government for the purpose of benefiting the people as a whole. Now it is plain that between these three types of research there can be no sharp lines of demarcation, but university research is often the stepping-stone to industrial advancement, while national research is repeatedly industrial in its objects.

Mr. Skinner rightly holds that the primary function of the university in research should be the training of research men, and that universities should be equipped to turn out research men just as they are now equipped to turn out men with academic and engineering degrees. Prof. G. G. Henderson has laid down the principle that the training of the chemist, so far as that training can be given in a teaching institution, must be regarded as incomplete unless it includes some research work.[2]

The demand for research in almost every field is growing with a rapidity wholly unprecedented, and to the universities alone can we look for men able and ready to take their places in the strenuous effort that is bound to be put forth on every side. We have just inaugurated a triple university system: Prof. Crawford, in his presidential address to this association at Maritzburg, asked, and sought to answer, what South Africa expects from its universities, and referred, in particular, to the need of encouraging the study of science and of furthering research. In developing this theme he asked us to remember that the highest form of research is not made to order, and that there is more in genius than industry and opportunity. It would benefit us to bear this in mind and, in juxtaposition with Prof. Crawford's words, to place a sentence from Mr. Skinner's address:—

"If it takes a genius to recognise a genius yet undeveloped, and properly to stimulate and direct that genius, how necessary it is that we place men of genius at the head of the research departments of our universities!"

It comes to this, then, that we should see to it that our universities are well equipped with scientific research workers, and it is pre-eminently desirable that a system of research professorships should be instituted, the chairs to be occupied by men of enthusiasm, men who will inspire a like zeal and devotion amongst those of the younger generation whom they gather around them, men of personality and character, who will kindle in the breasts of the research students feelings of admiration and respect for them and their work.

"In training research men," says Mr. Skinner again, "the university will naturally become the custodian and the promoter of pure scientific research." Here is the fountain-head whence we shall ultimately draw our men for industrial research and for national research; how important is it, then, that the source of all our supplies should be of crystal purity! Whatever more utilitarian form of research one may afterwards take up, research in pure science is invaluable in the earlier part of the research student's career, for it will give him a zest and a stimulus that will remain with him throughout, enrich his scientific imagination, and adorn all his later work.

At the same time, university research may lead to the most utilitarian results; some of the most important dyes, artificial alizarin, the phthaleins, indigo, and such drugs as phenacetin, antipyrin, and aspirin, were all discovered in university chemical laboratories.

Now why have we so few persons doing research work in South Africa? Is it in part because no research geniuses are born, or is it that we fail to recognise them, and neglect to provide them with the essential facilities?—youths, maybe, on whose humble birth fair Science frowned not, flowers born to blush unseen and waste their sweetness on the desert air, mute, inglorious Miltons whose genius remained latent because we took no trouble to draw it out?

Dr. P. G. Nutting about a year ago said that some writers have spoken of the investigator as a rare individual, to be sifted out from educational institutions with great care for a particular line of work. My personal opinion is that a large percentage of the men students are fitted for research work if properly started along the right line.

What we in South Africa lack—next to the facilities for research—is not so much the research students as the men to start them on right lines. I think that Principal Beattie, at the inauguration of the University of Cape Town three months ago, sounded the correct note in observing that the youth of South Africa did not lack enthusiasm or ability for research, but they lacked opportunity, and, he added, much depended on the men they had as professors. That is the secret of it all. In this dread war South Africans have more than once exhibited a physical courage and a pertinacity equal to anything that Australia or New Zealand could show; why should not South Africa, then, produce a Bragg or a Rutherford as well as Australia and New Zealand, seeing that intellectual courage and pertinacity are two indispensable qualities in a successful research worker? The position is analogous to that which war has developed in Europe and America: there the opportunity has made the man. An American chemist said that "the German General Staff has learned, if others have not, that German chemical achievement, which is great indeed, is no sign that equal ability does not exist elsewhere. The Allies and America improvised a munitions industry in two years to match their machine of forty years' preparation"; and then he

[1] From the presidential address delivered by Dr. C. F. Juritz before the South African Association for the Advancement of Science at Johannesburg on July 8.

[2] Report British Association, Newcastle-upon-Tyne, 1916, p. 374.

went on to make a remark which we may well take to heart:—"War could force us to do nothing we did not possess capacity for before."

"The potential research worker," says the editor of the United States *Experiment Station Record*, "is probably less born than made"; and Dr. Nutting thus clothes the same thought in different language:—"Fertility of mind is not so much an inborn quality of the mind itself as of the training and association which that mind has had."[3]

Hence it is our solemn duty as a young nation to provide abundant facilities at each of our three universities for the making of our future research workers.

We pass on to speak of industrial research, which always has some utilitarian end in view, whereas the purpose of pure scientific research is more exclusively philosophic—the discovery of truth. The investigator in pure science has been likened to the explorer who discovers new continents, or islands, or lands before unknown; the investigator in industrial research to the pioneer who surveys the newly discovered land in order to locate its mineral resources, to determine its forest areas, and to ascertain the position of its arable land.[4]

I quote these remarks with all circumspection, for, after all, there are no sharp boundaries between research in pure science and in applied or industrial science, and Huxley was right when he wrote that "what people called 'applied science' is nothing but the application of pure science to particular problems." The fact is that applied science is impossible until a foundation of pure science has been laid to build it on. You cannot apply a science which is not there to apply, and, as Sir William Tinney has said, until men began to interrogate Nature for the sake of learning her ways, and without concentrating their attention on the expectation of useful applications of such knowledge, little or no progress was made.

Industrial chemistry has been defined as that branch of chemical science which uses all the rest of chemistry and much engineering for the furtherance of production of chemical substances, or the use of chemical means or methods for manufacturing any material of commerce; and hence industrial research for the most part differs widely from university research. True, there are instances to the contrary; thus Michigan University has at Ann Arbor a tank for testing ship resistance, and Illinois University has a laboratory for investigations on a full-size locomotive engine; but industrial research is, for the most part, impracticable for universities, and, as often as not, needs to be carried out under large-scale conditions, as it were *in situ*, and by persons already possessing practical experience in the various phases of the problem under investigation. At the same time there should be much closer co-operation between the university and industrial research. Industry should recognise that it must depend primarily upon the universities for its trained research men, and co-operate to the fullest possible extent to the end that properly trained men be turned out.

Do you realise what this last sentence involves—you who are connected with the big industries? It involves that industry should recognise that, from a purely selfish motive, if from no other, its interest lies in endowing research chairs at the universities, and in seeing that they are occupied by men of genius. The very nature of industrial research implies that there must be a constant accession to the ranks of its workers of persons trained in pure scientific research.

[3] NATURE, vol. c., p. 157, 1917.

[4] Col. J. J. Carty: Presidential address, Proc. Amer. Inst. Elec. Engineers, vol. xxxv. [10], p. 1415, 1916.

If such accession be intermitted, or if the increase of knowledge by means of pure scientific research be hampered, industrial research will inevitably be limited in corresponding degree.

The Government has acted wisely and well in endeavouring to establish a system of industries in this country; do we want these industries to fizzle out, or to go through years of laborious struggling? If we wish to minimise preventable disadvantages of that kind, let us do without delay whatever we can to foster research, so that the men to conduct it may become available as soon as they are needed.

National research approaches more nearly to the industrial than to the university type. It is often undertaken for the advantage of industry in general, but its outlook is considerably broader than that above embraced within the scope of industrial research, restricted, as the latter is, to the requirements of individual industries. In South Africa the cry for industrial research has become more imperative of late, and the Industries Advisory Board, as well as the Scientific and Technical Committee appointed on the initiative of the Minister of Mines and Industries, has gone some distance both in educating the public to the need of this type of research and in giving an impetus in the required direction. Mainly, however, the agencies used were of two classes: the laboratories of the university colleges, and those of certain Government Departments, together with the respective officers of those institutions.

There are two fundamental principles on which I must now lay stress; they are expressed in the words co-operation and co-ordination—co-operation between workers in different branches of science, co-ordination amongst those who work in the same branch in order that the maximum of benefit may be attained. So interdependent, in fact, so interlaced are the three types of research to which I have briefly alluded that it should be patent as the sun at noon that the closest co-operation between them all is essential. It is to be feared that this is not yet so clearly realised as it should be. The waste of time and energy that has risen from overlapping, which in turn has resulted from lack of collaboration, is incredibly great. It has stifled work of value in the past to an extent that is certainly not realised; it has thrown back for many years branches of investigation in which ere now incalculable progress might have been made and untold pecuniary advantages reaped. Would that the dire necessity of this searching war could stir up the South African nation to a correct appreciation of the facts!

About a year ago the president of the Society of Chemical Industry, in his address at Birmingham, insisted on the absolute necessity for the engineer and the chemist to "get into double harness as quickly as possible" and work sympathetically together for the progress of chemical industry. In South Africa, too, this necessity has been manifested, but I am glad to say that we have had more than manifestation; we have had realisation and we have had operation. For example, when, some months ago, the fertiliser scarcity arose, I was deputed to investigate the potentialities of unutilised raw materials in the Union, and found, amongst other things, that there were several thousand tons of good material going to waste in various places in connection with such institutions as slaughterhouses and crayfish canneries for lack of by-products plant to deal with it. When I had completed my tour of inspection and furnished my report, the engineers were charged to follow on, and set to work to make good the deficiency in plant, with the result that a respectable quantity of fertilisers will now be produced from the refuse that hitherto has been going to waste.

May I just repeat here—because they are still applicable to-day—a few remarks which I made in my presidential address to the Cape Chemical Society six years ago?—

"As an industrial science chemistry never operates in isolation. When we concern ourselves with the chemistry of the country's vegetable products it is the science of botany that has to afford additional aid; if it is general agriculture that we are dealing with, the chemist may also have to work in co-operation with the zoologist, entomologist, or mycologist. Often, in connection with the investigation of the country's mineral products and of its agricultural soils, consultation with the geologist is required. In any case, there is this one outstanding fact that these various scientific offices need to be in closest touch with each other in order to promote the smoothest working of the entire machine of investigation as an organised whole.

"This close contact between science and science is of great importance, but it is still more important that contact between the various workers *in one and the same science* should be as intimate as proper co-ordination and organisation can make it. During its annual convention, towards the close of 1910, the American Society of Agronomy was very largely occupied with the standardising of methods for conducting experiments. It was then shown again and again that a large amount of experimental work done in the United States had led to results which could not be compared with each other, were difficult to interpret in a trustworthy way, and were liable to lead to wrong conclusions because there had been no agreement as to method amongst the various institutions involved in the work. We do not wish to have these mistakes repeated in South Africa; our desire is rather to profit by the experience of other lands, but unless we look well to our steps we stand to repeat some of those very mistakes in an aggravated form. Therefore, lest we should go on a wrong track with regard to this matter of investigation and research, two principles should remain deeply graven on our minds: these are co-ordination of effort and unity of plan."

Some of us have read what Mr. H. G. Wells describes as ideal in his "Modern Utopia":—

"In Utopia a great multitude of selected men, chosen volunteers, will be collaborating on this new step in man's struggle with the elements. . . . Every university in the world will be urgently working for priority in this aspect of the problem or that. Reports of experiments, as full and as prompt as the telegraphic reports of cricket in our more sportive atmosphere, will go about the world."

Clearly, co-operation and co-ordination cannot become effective without efficient organisation. We were afforded a splendid illustration of what may thus be effected in the case of a private corporation on the occasion of the Stellenbosch meeting a year ago, when we visited the dynamite factory at Somerset West, and listened to the historical account given by the general manager. Established at the beginning of the present century for the purpose of supplying dynamite to the Kimberley mines, the sphere of operations had so extended that during the twelve months immediately preceding our visit the works had exported to the Commonwealth of Australia more than 100,000*l.* worth of explosive manufactured in South Africa, in addition to supplying our own needs. From that manufacture other industries developed one by one, and the works now include plant for the manufacture of sulphuric, hydrochloric, and nitric acids and of copper sulphate and the nitrates of barium and lead, while others are under consideration. Farmers have been supplied with the sulphur which they need for sheep-dipping and vine-spraying, while 20,000 gallons monthly of a lime-sulphur solution for sheep-dipping have been turned out. The works bid fair to develop into a general chemical factory after the war. Thus far the private concern; what we need in the way of a Government establishment is an institute for research in pure and applied chemistry—such a national chemical laboratory as Prof. Henderson has been longing to see established in England, but England is not yet sufficiently responsive. "We don't conduct research," says Mr. H. G. Wells; "we simply let it happen." Ah, that is where England differs from South Africa; we *don't* let it happen. Sometimes we make ourselves believe that we do, and then we let other things happen to interfere with it. Why, I have been pleading these twenty-four years for a properly organised system of chemical, physical, and biological research with respect to our agricultural soils, and it has not come yet.

The way in which a nation can organise itself and its resources for war has impressed a world. Other nations are talking about organising themselves for the commercial struggle that will ensue upon the termination of the present strife, but mere talking about reconstruction will not enable us to face the future serenely. "We all talk about the weather," said Mark Twain, "but nothing is done!" Why is it that England, France, Australia, New Zealand, and Canada are mobilising their scientific men for research? Dr. G. E. Hale, chairman of the Department of Science and Research of the United States Council of National Defence, says that it is because, "looking ahead, it was seen that the conclusion of peace would be followed by a trade war with Germany, in which no industry not perfected by scientific research could hope to succeed."

Can South Africa compete industrially with a country that has shown us what organisation can achieve, if we starve the very soul of industrial prosperity—pure and applied scientific research carried out in the laboratory?

Mr. W. C. Dampier Whetham, in his recently published book on "The War and the Nation," devoted a section to the organisation of British industry and commerce, in regard to which a reviewer says that "three years of war have done more than a century of peace to impress upon the public mind the indispensability of scientific research to national prosperity." The result has been that the Imperial Government has called into being a department for the express purpose of organising and directing research, and has placed considerable sums of money at this Department's disposal. But perhaps the most important outcome is that "the leaders of British industries have begun to acquire the habit of working together in order to conduct associated researches."[5]

Now let me emphasise the point that there is not one of these industries for which the chemist is not essential at one stage or another. An interesting address given some months ago by the president of the American Cyanamide Company[6] shows how universal the need of the chemist is. Two thousand grades of glassware are required for a vast variety of purposes; for this the skilled glass-maker must work under chemical control. The iron and steel of our cutlery, the extraction of silver, gold, and, in fact, of all metals from the ores, need the chemist at every step; the clothing we wear, the dyes that colour it, and more particularly synthetic dyes, the host of other uses to which cotton is put, the use of cellulose in the form of artificial silk as a new textile material, all are interwoven with the resources of the chemist. The

[5] Journ. Roy. Soc. Arts, vol. lxv., p. 755, 1917.
[6] *Chem. News*, vol. cxvi., pp. 157-59, 1917.

preparation and preservation of our foods, and the securing of their purity, both depend on chemical control. The manufacture of synthetic drugs, such as antipyrin, phenacetin, sulphonal, veronal, novocaine, aspirin, and salvarsan; the introduction of synthetic perfumes like heliotropin; of synthetic flavours like vanillin; of synthetic rubber and synthetic camphor; the quality of the fuel we use; the efficiency of the fertilisers we put into the soil; the extraction and utilisation of the various animal and vegetable oils, and the conversion of some of them into solid fats by catalytic agency, and so into soaps or candles, with glycerin as a by-product; the production of liquid fuels—every one of these would be impossible without chemical aid.

There are a few facts regarding the chemist which I want every South African, and particularly those in high positions, to realise. First of all, get rid of the idea that he is a druggist or pharmacist, any more than he is a baker or plumber, or belongs to any other avocation in which chemistry takes a share. And then grasp the fact that there is scarcely an avocation on the face of this earth into which chemistry does not enter, or wherein the chemist would not be of some use. One does not need to tell Johannesburg that it has to thank the chemist for its prosperity, for without him many of the mines would long have ceased to work. The other great industry of South Africa, agriculture, is at the mercy of the chemist in respect of the manufacture of fertilisers, and many agricultural products owe to him the processes employed in their preparation. Chemical operations are fundamental to every branch of the dairy industry; the making of jam, the drying of fruit, the tinned vessels in which many of these articles are preserved, are all subservient to the chemist. Without him the economical production of metals of any kind could not take place; there would be no locomotive engines, no assurance that the water which these engines need will not corrode their boiler-tubes, no testing of the coal which converts that water into steam, no provision of steel rails to run the locomotives on, or, to go further, no steel armour for our battleships, and no alloys for shrapnel, aeroplanes, or submarines. It is also the chemist's work to control the driving-power of ships of war and merchandise alike, whether that driving-power be coal, oil, or electricity, for the materials employed by the electrician must all, in the first place, be scrutinised by the chemist.

All explosives are essentially chemical in their make-up, and, in fact, the whole Army, as well as the Navy, is dependent on the chemist all along the line, inasmuch as he has to vouch for the purity of all their supplies of food and drink, even well-water; and not only their natural purity, but also their freedom from fraudulent adulteration or deliberate poisoning. The various gases so much used in the present war are all the productions of the chemist, and so are the means adopted to secure immunity from those gases. It is the chemist who controls the Army's drugs, disinfectants, and anæsthetics. The colouring of the material used for clothing not only the military and naval Services, but the whole civil population as well, is subject to the careful scrutiny of the chemist. His functions also include the manufacture of the leather which provides an army with boots; without him that leather cannot be tanned, as the entire wattle and other tanning industries are conducted under his advice. The finished leather, too, is investigated by him lest fraudulent practices should have participated in its manufacture.

Without the chemist there could be no books, for chemical processes are fundamental to the making of paper, of printing and writing ink, not to mention again the materials wherewith books are bound and the colouring of the binding. The production of illustrations in those books, by whatever means, and also the whole art of photography, must stand or fall with the ability of chemistry to assist them. And then, as I have already said, there is the increasingly large subject of fine and synthetic chemicals, beginning with manufactures like those of starch, glucose, and dextrin, the synthetic dyes which surpass natural products in brilliance and permanence, the synthetic perfumes which far transcend natural odours in potency, the synthetic drugs which have done much to afford relief to the suffering; artificial products—I do not say imitations, for they are often better suited to their applications than the natural products which they replace—artificial products in substitution of rubies, of bone, horn, and ivory, of resins, and of leather, are all the result of chemical research. Again and again the chemist has shown us how to produce the most valuable commodities out of waste and refuse. The refuse of the Bessemer steel-works gave rise to one of our most efficient fertilisers; the refuse of the gas-works provided the world with dyes, drugs, and a marvellously long list of other useful articles; the waste of wool-washeries furnishes us with lanoline. Waste wood, if destructively distilled, and, amongst others, waste wattle-wood, of which large quantities are annually available in Natal, is capable of producing acetone, whereof enormous quantities are now being used for the manufacture of propellants.

So we may rightly claim that the present age is the age of the chemist. The chemist has never before had such opportunity for the application of his knowledge to the betterment of material conditions upon earth, and never has he more effectively applied it to the attainment of this aim. It is also sadly true that never before has he applied his knowledge with such damaging effect as during the present war, but when the war shall have run its course all the chemist's resourcefulness, all his energy, all his persistence will be needed to repair the damage done, and to start exhausted nations upon new lines of industry. On the chemist, more than on anyone else, will this task devolve, and in South Africa in particular he will find abundant work awaiting him. Is he to be there to respond to the call? Then it is for us to educate and train him to the necessary standard; it is for us to provide the means whereby his purpose may be accomplished; it is for us to accord him sympathetic treatment. Do not let us regard him as useful only so long as he is bound down to routine work, and as academic when he is occupied with investigations beyond our limited capacity to understand.

We have heard much during the past four years of the difficulties under which the chemist has been labouring in Britain and America—of the apathetic attitude adopted towards him by Governments, public institutions, and industrial concerns; of the sparing hand wherewith the essentials for the pursuit of his investigations have been doled out to him. I have deemed it very desirable to place before you this evening some of the opinions which have been expressed on these topics north of the Equator, because I am convinced that many of our administrators, politicians, educationists, and commercial men are wholly unaware of the strong remonstrances which have grown to quite a literature during these four years, and are probably under the illusion that in South Africa the chemist has now the opportunity, if he cares to make use of it, to help the Union, with *éclat* to himself, safely through some of the difficulties resulting from the war. I have, in fact, heard such a view seriously expressed; the idea is, of course, perfectly absurd. At the same time it falls to the chemist in particular to do all that in him lies to aid production during this time of crisis, and to assist those directly engaged in the work of production, whether it be the manufactures or agriculture. And those who have it in their power to strengthen the chemist's hands in such a work will themselves be not only aiding the State, but also assisting to bear up the lofty principles for the maintenance of which amongst men Britain and her Allies are contending.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AN effort is being made by the New York University to raise a fund to meet the war emergency conditions. Part of the plan is to secure an endowment of 100,000*l*. for the engineering school in connection with a co-operative scheme of education between the industries and the University. So far the sum of 50,000*l*. has been received.

THE new session of the Sir John Cass Technical Institute, Aldgate, London, commences on September 23. The courses of instruction which have been arranged are directed especially to the technical training of those engaged in trades connected with the chemical, metallurgical, and electrical industries. Full facilities are available for qualified persons who desire to undertake special investigations in connection with these branches of industry. Among the special courses of higher technological instruction which form a distinctive feature of the work of the institute may be mentioned analytical work in fuel and gas analysis, courses on brewing and malting and on the micro-biology of the fermentation industries, and, in the department of metallurgy, courses of an advanced character on gold, silver, and allied metals, on iron and steel, on metallography and pyrometry, and on the heat treatment and mechanical testing of metals and alloys. Detailed information concerning the work of the institute is given in the new syllabus, a copy of which may be obtained on application.

THE summer school of civics and eugenics, which was organised conjointly by the Civic and Moral Education League and the Eugenics Education Society, and held at Oxford from August 10 to 31, was very successful, the programme being comprehensive and attractive, and the courses and meetings well attended. A prominent feature of the school was a civics and eugenics exhibition. The exhibits showed on the civic side the possibilities of regional study with a view to civic service as a part of the school and college work, and on the eugenic side gave illustrations of recent work in heredity and the study of family histories. An exhibit from the National Council of Venereal Diseases was also shown. The following public lectures were delivered :—"The Principles of Coeducation," Miss A. Woods; "The Three Voices of Nature," Prof. J. Arthur Thomson; "The Sociological Bearing of Race-study," Prof. H. J. Fleure; "The Influence of Finance on Social Reconstruction," W. Schooling; "The Eugenic and Social Influence of the War," Prof. Lindsay; "The Training College of the Future," Dr. M. W. Keatinge; "Emigration and Eugenics," C. S. Stock; "The Forward Outlook of Eugenics and Civics," Major L. Darwin and A. Farquharson.

THE Indian Bureau of Education at Delhi has issued the first two of a series of short pamphlets in which it proposes to give some account of developments in Indian education which may suggest themselves as worthy of notice. Both pamphlets deal in the main with the sphere of elementary education. The first treats of drawing and manual instruction in Punjab schools. It shows that the same movement is proceeding in India as at home towards providing facilities for the young to learn by *doing* as by talking, listening, reading, and writing. The schemes of instruction follow those adopted of recent date in this country, and several of our own early mistakes are being avoided. Tools and benches are of European pattern. The problem of training teachers is being attacked with some vigour. The second pamphlet is of more general interest. It tells of the humble beginnings of the education of factory children in India, and also children working in tea plantations and on the colliery estate of the East Indian Railway. Descriptions are given of the work going on in all three classes of schools, ranging from the *crèche* to what in England is now called the junior technical school. Above the stage of the *crèche* and the infant school the instruction is that of the part-timer, as a rule, but there are arrangements for evening continuation schooling for older children and adolescents. The vernacular has, as it should have, a more important place than the teaching of English, and the vital importance of manual instruction is recognised. The value of this enterprise can scarcely be exaggerated, for, apart from the fact that the individual is given the opportunity of rising as clerk or, preferably, as skilled workman, there is the likelihood of greater confidence between employer and employed when direct communication is possible, terms of engagement can be clearly understood, and rates of pay calculated. Difficulties abound, and one's sympathy must go out to the pioneers in an uphill task. Mill-owners in Madras, planters in Darjeeling, the railway company, who have actually introduced compulsory education, and officials deserve encouragement.

A PAMPHLET (price 3*d*.) has been issued by the Association for the Scientific Development of Industry, containing the terms of a remarkable address on "The Place and Importance of Science in Education," delivered before the society at Manchester on February 21 last by Mr. Edw. C. Reed. Mr. Reed alludes with satisfaction to the awakened interest of all classes towards science and scientific questions, largely induced, however, by the events of the war, and warmly pleads, with a variety of vivid illustrations, the claims of scientific knowledge and of scientific methods of imparting it as a fundamental part of our educational system. "The result of our neglect of science," he states, "has revealed itself to us in waste, muddle, and inefficiency in practically every department of our national life," whilst, on the other hand, "wherever we have resolutely endeavoured to make good our past deficiencies the effect has been wholly beneficial." From these postulates he proceeds to argue powerfully for a new method and purpose in our educational system. "For every national purpose brains are of more use than bodies," and "the most mechanical job is the better for a little intelligence." But it is not merely on the ground that a training in science and in scientific methods would make the nation more effective in its industrial and commercial activities that the author pleads so powerfully for the inclusion of scientific aims and training in the curriculum of the schools from the earliest period of child-life, but from the much higher consideration that only in so far as this is done can the real, permanent well-being of the nation, both material and spiritual, and of the individuals comprising it, be achieved, and the thesis is worked out with surprising cogency and supported by a wealth of apt allusion. The pamphlet is accompanied by a diagram showing the place of science in the service of man and its importance in industry.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 26.—M. Emile Roux in the chair.—P. **Appell**: The integration of the simultaneous differential equations verifying the Hermite polynomial $U_{m,n}$.—G. **Bigourdan**: The astronomical station at the Petit Luxembourg. The co-ordinates of the stations of the Collége d'Harcourt.—G. **Charpy** and M. **Godchot**: The formation of coke.—M. **Plancherel**: The unicity of the development of a function in a series of Legendre polynomials.—M. **Auric**: The calculation of the energy accumulated in the sun by contraction since its formation.—C. **Raveau**: Is the principle of equivalence a consequence of Carnot's principle? A criticism of a recent paper by Sir Joseph Larmor.—G. **Reboul**: The influence of the radius of curvature of a body on the formation of hoar-frost. Hoar-frost commences to deposit more rapidly on objects the smaller the radius of curvature.—M. **Collignon**: The propagation of the sound of gunfire to great distances. Annual periodicity.—M. **Chopin**: Apparatus for the measurement of chimney losses and the elements constituting these losses. Starting with the approximate formula giving the heat carried away by flue-gases as directly proportional to the difference of temperature between the outside air and the flue, and inversely proportional to the percentage of carbon dioxide by volume, an apparatus is described which reads off directly the percentage of heat lost. The temperature difference is measured by a thermo-couple in the usual way, and for the other factor use is made of the change in electrical resistance of a solution of caustic soda caused by the absorption of carbon dioxide and the production of sodium carbonate. Each of the factors is thus reduced to a galvanometer reading, and the point of intersection of the two galvanometer needles is read off on a series of curves plotting the percentage heat loss. The apparatus in its present form is not automatic.—H. **Colin** and Mlle. A. **Chaudun**: The law of action of sucrase: the hypothesis of an intermediate combination. The results of six series of experiments are given, from which it is shown that the theory of A. Brown, which assumes a combination between the sugar and the enzyme, is justifiable.—F. **Kerforne**: The iron minerals of Menez-Bel-Air (Côtes-du-Nord).—C. **Viola**: The law of Curie. Curie's law is defined as follows: The normal increases of the faces of a crystal in stable equilibrium are directly proportional to their capillary constants, and some mathematical consequences are developed.—A. **Piédallu**: The industrial application of the colouring matter of the glumes of the sugar sorghum. Details are given of the method of extracting the dye, and of its application with different mordants to dyeing wool, silk, and cotton.—M. **Galippe**: Researches on the resistance to heat of the living elements existing normally in animal and vegetable tissues.—P. **Girard** and R. **Audubert**: The electric charges of micro-organisms and their surface tension.—R. **Paucot**: The measurement of arterial pressure in clinical practice. A criticism of current methods of measurement and suggestion of a new technique.

September 2.—M. Paul Appell in the chair.—E. **Cartan**: Varieties of three dimensions.—P. **Straneo**: The extension to physics of the principles of homogeneity and similitude, and a remarkable relation between the universal constants of a theory.—P. **Weiss**: The characteristic equation of fluids. The equation proposed is of the form

$$\left(p+\frac{a}{v^{\eta}}\right)(v-b)=\zeta RT,$$

where R is the gas constant for perfect gases. This equation with four constants, a, b, η, ζ, represents with precision the properties of a fluid in one of the states corresponding with a family of isochores.—F. **Dienert**: The estimation of nitrites. The proposed method is based on the liberation and estimation of iodine from an acidified solution of potassium iodide by the nitrite in an atmosphere free from oxygen.—P. **Gaubert**: The artificial coloration of spherolites of helicoidal formation (tartrates and bimalates).—H. **Hubert**: The influence of the lithological nature of formations relatively to the distribution of the surface and underground waters north of the Senegal River.—L. **Gentil**: The geology of Andalusia.—M. **Lecointre**: Some recent fossil-bearing strata in the neighbourhood of Casablanca, Western Morocco.—F. **Masmonteil**: The morphology of the antibrachial skeleton.—P. **Godin**: The transformation into pedagogic indications of the data of anthropology on the individual nature of the child of both sexes.—A. **Vernes**: The colorimetric measurement of syphilitic infection.—S. **Voronoff** and Mme. Evelyn **Bostwick**: The intensive acceleration of the budding of wounds by the application of testicular pulp.

BOOKS RECEIVED.

Medicinal Herbs and Poisonous Plants. By Dr. D. Ellis. Pp. xii+180. (London: Blackie and Son, Ltd.) 2s. 6d. net.

The New Science of the Fundamental Physics. By Dr. W. W. Strong. Pp. xii+108. (Mechanicsburg, Pa.: S.I.E.M. Co.) 1.25 dollars.

Present-day Applications of Psychology, with Special Reference to Industry, Education, and Nervous Breakdown. By Dr. C. S. Myers. Pp. 47. (London: Methuen and Co., Ltd.) 1s. net.

War Neuroses. By Dr. J. T. MacCurdy. Pp. ix+132. (Cambridge: At the University Press.) 7s. 6d. net.

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