THURSDAY, JANUARY 17, 1918.

## MANUALS FOR THE CHEMICAL LABORATORY.

(1) *Standard Methods of Chemical Analysis.* Edited by Wilfred W. Scott and others. Pp. xxxi+864. (New York: D. Van Nostrand Company; London: Crosby Lockwood and Son, 1917.) Price 30*s.* net.

(2) *The Theory and Use of Indicators: An Account of the Chemical Equilibria of Acids, Alkalies, and Indicators in Aqueous Solution, with Applications.* By Dr. E. B. R. Prideaux. Pp. vii+375. (London: Constable and Co., Ltd., 1917.) Price 12*s.* 6*d.* net.

(3) *Technical Handbook of Oils, Fats, and Waxes.* By P. J. Fryer and F. E. Weston. Vol. i., *Chemical and General.* Pp. viii+279. (Cambridge Technical Series.) (Cambridge: At the University Press, 1917.) Price 9*s.* net.

(1) FOR the analyst whose work embraces a wide range of problems it is comforting to have at hand a book which can be trusted to indicate forthwith the best, or at least the usual, methods of solving such problems. It obviates an undue expenditure of time on the searching of files and indexes, and facilitates the comparing of one process with another, which is usually a necessary preliminary to attacking the task in hand, if that task is a new one.

To a large extent the volume under notice is a work which would be classed as a "laboratory comfort" of the kind indicated. It is a very good selection of "standard methods." The "chemical analysis," however, for which these standard methods are given is largely confined to inorganic substances. True, there is a part devoted to special subjects, which includes sections on the analysis of some organic products, such as oils, fats, waxes, and coals; but in the main the work is concerned with inorganic analysis.

Beginning with "aluminium" and ending with "zirconium," the elements are taken in order, and under each heading are given, first, the chief physical data, namely, the atomic weight, specific gravity, melting point, boiling point, and the oxides formed by the element. Next, the characteristic chemical reactions for identifying the substance are given, and then follows a selection of methods for its quantitative determination. These include gravimetric, volumetric, and electrolytic processes, of which a judicious choice has been made. Any preliminary treatment required by the substance is described under directions for the "preparation and solution" of the sample and its separation from interfering substances.

Many of the newer processes are included, such as the estimation of nickel by means of alpha-benzildioxime and by dimethylglyoxime, and the determination of sulphates with benzidine hydrochloride. A method for the determination of carbon in steel by direct combustion is given, by which, it is claimed, accurate results can be obtained in ten minutes: the improvement lies in supplying a rapid current of oxygen, instead of a slow one as formerly. A welcome feature of the work is the inclusion of the principal "rare" elements amongst those dealt with. In the special part the analysis of alloys, cements, coal, gas, paint, and water, and the assaying of gold and silver are described, as well as the examination of oils, etc., already mentioned.

In general, the treatment of the subject-matter is lucid and concise; "lengthy exposition, theoretical dissertation, and experimental data," the authors say, have been purposely avoided. Only a few press errors have been noticed, but two distinguished names in chemistry have lost their final "e," and appear as "Scheel" (p. 30) and "Thorp" (p. 458). The book will be found very useful as a convenient summary of modern analytical methods within the limits indicated.

(2) Dr. Prideaux's book is mainly one for the advanced student and the investigator. Its purpose is to present a connected survey of the subject of chemical "indicators," *i.e.* the substances used for showing by their changes of colour the occurrence or progress of certain chemical reactions. Much has happened in this region of chemical inquiry since the time when the Romans used red wine as an indicator in testing the "hardness" of drinking water. Even down to a relatively short time ago the number of indicators in general use was but small, *e.g.* litmus, logwood, cochineal, and a few other substances. With the development of synthetic organic chemistry, however, many more indicators have been brought into use—nitro-derivatives, phthalein compounds, aminophenol-methane products, and so on. More important still, the mechanism of the changes whereby the colours of these compounds are produced or altered has been carefully investigated, both chemically, from the point of view of molecular structure, and physically, from that of electrolytic equilibrium in the solution. The author gives an account of the results, and of present views on the subject, including the allied matters of light absorption and theories of colour. Many references are supplied, and workers in this field of research will find the book of considerable utility. For general use its value would be enhanced by the inclusion of an elementary introductory chapter.

(3) Messrs. Fryer and Weston's work is intended to be a conspectus of the chemistry and general scientific principles involved in the manufacture of oils, fats, and waxes. This industry is essentially a chemical one, and a knowledge of the fundamental principles of chemistry, both theoretical and practical, is indispensable for a really intelligent conception of the nature of the processes involved. The authors' experience is that, whilst technical men in the industry generally have a wide knowledge of the practical issues of the subject, this knowledge exists side by side with much ignorance of the basic principles underlying such issues. They, therefore, endeavour to explain, as simply as the theme permits, the theoretical basis on which the technical processes rest. No doubt

it is true, as they remark, that compared with that of many other industries the chemistry of the oils, fats, and waxes is remarkable for its simplicity; but unless the reader has already had some grounding in organic chemistry he will probably conclude, from the pages of formulæ put before him in the earlier part of the work, that it is not such a very simple matter after all.

This apart, the book is a serviceable one for the purpose in view. Practical analytical work is left to be expounded in a companion treatise: the present volume explains the chemical processes and terms used in connection with the fixed oils and their congeners, and gives the physical and chemical data characterising the various products; but it is not intended to be a guide and counsellor for the experimenter. For example, the meaning of "viscosity" is shown, and the values of this constant are given, but detailed directions for actually determining the viscosity are not included; presumably these are reserved for the companion volume.

The interpretation of analytical data, not the way to obtain them, is the key-note of the book. A large amount of information is given in a systematic manner and in a very handy form. The diagrammatic representations of chemical and physical constants are a special feature, which should prove convenient for speedily identifying an unknown oil or fat—in fact, the present writer has already found them useful. C. S.

## INCREASE OF AGRICULTURAL OUTPUT.

(1) *British Grasses and their Employment in Agriculture.* By S. F. Armstrong. Pp. vii+199. (Cambridge: At the University Press, 1917.) Price 6*s.* net.

(2) *Manuring for Higher Crop Production.* By Dr. E. J. Russell. Second edition. Pp. vi+94. (Cambridge: At the University Press, 1917.) Price 3*s.* 6*d.* net.

(1) THE task of increasing home-grown food-supplies has steadily forced itself to the front as one of the key-problems upon the solution of which the issue of the war primarily depends. The essential features of the problem are by this time familiar even to the lay public, in so far, at any rate, as they involve the ploughing up of grassland and the planting of corn or potatoes. It is not sufficiently realised, however, even by the farmer himself, that this represents only one part of the contribution which can be effectively made to the desired increase of food production. The total agricultural area of the United Kingdom is roughly forty-seven million acres, of which some twenty-seven million acres are under permanent grass, whilst of the remaining area about six and a half million acres rank temporarily as grassland, being occupied at the moment by rotation grasses and clovers, forming a transition crop in the arable rotation. It is obvious that the utmost efforts in bringing land under the plough can make only relatively small inroads upon this immense acreage of grassland, so that we must continue to depend upon grassland for a very substantial contribution to national food supplies. Moreover, in proportion as the area of arable land increases and that of grassland shrinks, the greater becomes the necessity for devoting attention to the improvement of the latter, in order that adequate grazing for live-stock may be provided by the reduced area.

It requires little acquaintance with farming to realise that a great deal of the existing grassland is of very inferior quality, and it is common knowledge amongst agriculturists that a large proportion of it could be considerably improved. Mr. Armstrong estimates that fully 20 per cent., or not fewer than 5,000,000 acres, of so-called grassland is so infested with weeds and inferior grasses as to represent comparatively worthless herbage. What this means in terms of food production is illustrated by estimates submitted to the British Association in 1915 by Mr. T. H. Middleton, which showed that poor grazing land as it exists to-day produces less than one-fifth of the meat obtainable from the same area of average pasture and little more than one-tenth of the produce of the best grassland.

The improvement of poor grassland must proceed along two broad lines. The first requirement is the establishment of healthy soil conditions by means of drainage, liming, and manuring, and only when these have been secured can the other half of the problem, the establishment of a herbage of the more nutritious grasses and forage plants, be successfully dealt with. A knowledge of the characteristics of the different forage plants and their relation to varying soil conditions is obviously an essential part of the improver's equipment. The subject, for which Mr. Armstrong uses the unattractive name of "Agricultural Agrostology," has received a considerable share of the attention of the agricultural botanist, and Mr. Armstrong has now endeavoured to present it in a form adapted primarily for the agricultural student, but not too technical to be of use to the practical farmer, the seed merchant, and the rural schoolmaster. The major portion of the book is concerned with the botanical characteristics of the various species of grasses, special attention being devoted to those species which are most abundant or of greatest economic importance in the British Isles. The treatment of this part of the subject in the main follows conventional lines, but prominence is given to points that have a special interest for the student of agriculture.

The latter portion of the book deals with the practical problems presented by the grasses in farm economy. The agricultural value of grasses, the valuation of grass-seeds, and the compounding of seed-mixtures receive adequate treatment, whilst a final chapter on the general treatment of grassland gives a brief summary of existing information on a subject which demands much further investigation.

(2) In the improvement of grassland, as in the increase of production on arable land, manuring plays a part of vital importance, and it is in the highest degree desirable that the farmer at this juncture should receive trustworthy guidance in the effective use of manures for all his crops. For

such guidance one looks to Rothamsted, and the rapidity with which a second edition of Dr. Russell's little treatise on manuring has been called for is the best evidence of the success with which he has discharged his obligation. In the briefest compass he gives the clearest possible guidance to the practice of manuring, illustrated throughout by what is probably the most complete summary extant of the results of manurial experiments carried out in this country. The previous edition has been considerably amplified and a very brief chapter added on the breaking up of grassland.

## SIR CLEMENTS MARKHAM.

*The Life of Sir Clements R. Markham, K.C.B., F.R.S.* By Admiral Sir A. H. Markham. Pp. xi+384. (London: John Murray, 1917.) Price 15*s*. net.

IT is not often that the story of a notable life is told by a biographer who is at once sympathetic and impartial. Admiral Sir Albert Markham, the author of the work under review, is not merely closely related to the subject of the memoir, but was his warm and constant friend. Yet he tells his story with the straight simplicity which seems specially to distinguish naval writers, and he leaves his readers to form their own conclusions. Therein lies the greatest charm of the book, for we can well construct for ourselves from the incidents of a life overflowing with energy and achievement the character of a man who enriched the world by many of those "footprints on the sands of time" which serve as indications and guides in the path of generations to come.

The opening chapters of the book are devoted to the career of young Clements whilst he served as cadet and midshipman in the Royal Navy. Incidentally, there is much interesting history of the gradual extension of our geographical knowledge of the Pacific towards the end of last century, and a very clear conception is given of life in a wooden-sided sailing-ship of the latest and smartest class which preceded the introduction of steam, just about the time when steam was beginning to assert a preponderating influence on naval construction. All this is told with the loving interest of a blue-water sailor, and it is easy to gather from the story how the foundations were then laid of that deep admiration and reverence for the Royal Navy which towards the end of Sir Clements Markham's career amounted almost to infatuation. In the sailor boy, too, we can mark the germs of the mature character of the man. Full of generous impulse, which landed him now and then in serious difficulty (as when he rushed headlong, without even the preliminary knock at the door, into the sacred precincts of his captain's cabin to protest against the flogging of a man who had been twice convicted of drunkenness), he finally decided to forsake a career of adventure which he really loved for the prosaic prospects of a life on land, because of a mistaken notion that discipline and fair play could not be reconciled. His persistent adherence to that decision, from which no persuasions of his family and many friends could shake him, was quite characteristic of his subsequent attitude in circumstances which occurred not infrequently when his opinions on more important matters were questioned by those who worked with him in the interests of scientific geography. The word "obstinate" has occasionally been whispered of him; but it is not always easy to say where the line is to be drawn between the firmness which may be essential to the successful issue of an important scheme and the unyielding attitude of the autocrat.

Undoubtedly Sir Clements was able, by reason of his determination and his forceful character, to carry through schemes for exploration in regions of the world where no economic gain could be expected in return for great expenditure, and the whole object of research was purely scientific, which would never have matured in the hands of a more feeble advocate. There are some thrilling accounts of Arctic adventure in the book, which is, perhaps, most interesting in these earlier chapters devoted to the moulding of the Markham character.

The author succeeds in carrying our sympathies with his subject from his earliest years of adventure in the fields of exploration and literature (the young Clements wrote a book on astronomy and physical geography at the age of thirteen!) until the pitiful tragedy of his death occurred, without ever drawing on any idealistic resources of his own. Full justice is done to the noble qualities of the man. His warm-hearted enthusiasm for the supremacy of his country in the wide field of exploration, and his devotion to historical and geographical literature which resulted in the publication of much valuable information which might otherwise have been lost to the world, are easily to be gathered from the pages of this biography. His kindly nature (which won him hosts of friends), his ready assistance to those who wanted it; his life-long interest in all that might benefit humanity, which included the acquisition for England of that life-giving remedy for tropical fevers, cinchona, after a difficult and perhaps dangerous quest for the seeds and plants in Peru—all these things combined to illustrate a character which is perhaps unique in these days, and fully deserves the permanent record which has been so ably rendered by Admiral Sir Albert Markham.

As a rule, biographies written by relatives are accepted with a certain amount of justifiable suspicion. There need be no such suspicion in this case. No one who had the privilege of friendship with the subject of these memoirs will say that there is a word too much of uncalled-for adulation. It is a fair record all through and a most interesting story.

T. H. H.

## OUR BOOKSHELF.

*Food Poisoning.* By Edwin O. Jordan. Pp. viii+115. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1917.) Price 1 dollar or 4*s*. net.

THIS little book gives an excellent summary of the subject of food poisoning. It is not within its scope to consider those cases in which definite poisonous substances are added to food with criminal intent. The term "food poisoning" is here limited to the occasional cases of poisoning from organic poisons present in normal animal or plant tissues, the more or less injurious consequences following the consumption of food into which formed mineral or organic poisons have been introduced by accident or with intent to improve appearances or keeping quality, the cases of infection due to the swallowing of bacteria and other parasites which infest or contaminate certain foods, and the poisoning due to deleterious substances produced in food by the growth of bacteria, moulds, and similar organisms. We have no certain statistics of the frequency of food poisoning, but Mr. Jordan has collected data of more than 1000 cases occurring in the United States in the two years October, 1913, to October, 1915.

In the chapter dealing with poisonous plants the poisonous fungi claim most attention. Some reference might have been made to the nutmeg, which is distinctly toxic in large doses, and in smaller doses to some individuals. In the section dealing with food-borne, disease-producing bacteria, the sub-heading is "Paratyphoid Infection," and this term is used many times. What is really meant is Gärtner (*B. enteritidis*) infection, and this organism is distinct from the paratyphoid bacilli, though belonging to the same group. Ptomaine poisoning is too briefly referred to, and we note the omission of all allusion to tyrotoxicon, which is somewhat surprising. One of the best sections is that dealing with food preservatives, to which several pages are devoted. In conclusion, reference is made to such conditions as beri-beri, pellagra, lathyrism, scurvy, etc. The book is well produced, very readable, and illustrated with several figures.

R. T. H.

*Adolescence.* By Stephen Paget. Pp. 59. (London: Constable and Co., Ltd., 1917.) Price 7*d.* net.

IN the adolescent mind ideas of sex and religious ideas often grow up together, and they should be correlated. While there is a wide range of individual peculiarity within the limits of the normal, there is no virtue in a child's being incurious. Careful preparation should be made by parents and teachers so as to give well-considered and honest answers to embarrassing questions. Perhaps there should be a home-ceremony or an initiation, "the whole thing well thought out, the exhortation written down beforehand, every word of it." "First-rate school teachers are more likely than second-rate parents to say the right thing to children." "The reasonable soul and flesh is one man," and there must be disciplining of both sides. "If I could be a young man again, I would get on without alcohol and cigarettes. . . . Let me, as a doctor, add a good tonic to steady the nerves of adolescence. I prescribe a full dose of the natural sciences." "What does harm the minds of children is not our plain speaking; it is their own secret reading, gossiping, and imagining." "And—so far as adolescence is concerned —if ever there was a time when we ought to speak plainly, it is now."

## 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.]*

### Sources of Potash.

SIR EDWARD THORPE'S lucid review of the known geological sources of potash (NATURE, January 3) is of absorbing interest to agriculturists, whose industry must be seriously affected by any permanent stinting in the supply of this indispensable fertiliser, entailing a corresponding diminution in the production of root crops. They might, however, tide over a temporary shortage of potash by availing themselves of a subsidiary source.

The Boards of Agriculture for England and Scotland having recently issued leaflets directing attention to the high percentage of potash contained in bracken fern, Prof. H. G. Greenish, director of the Pharmacy Research Laboratory in Bloomsbury Square, very kindly undertook at my request to make analysis of the ash of incinerated bracken. As it had been stated that the amount of potash contained in the fern cut in autumn showed a considerable diminution compared with that cut at midsummer, I sent Prof. Greenish three consignments, cut respectively in July, September, and, after the plant had withered, in November. The result proved practically the same in each case, and I may quote as follows from Prof. Greenish's very full report:—

"I find that the fern, when dried in a warm room and *completely* burnt to a nearly white ash, yields 4·82 per cent. of ash. This ash contains 41·5 per cent. of potash, $K_2O$. The dried fern itself would therefore yield 2 per cent. of potash, or 50 tons of fern would yield about 2·41 tons of ash, in which there would be about one ton of potash. . . . In addition to the potash the ash contains small quantities of soda, phosphates, sulphates, and chlorides."

It is clear from this that, although bracken can never compete with geological deposits as a source of potash, a considerable amount might be recovered by harvesting and burning the fern under a proper system. At the same time, it would tend to rid the land of a pest which has destroyed much of the best hill pasture in the North, and is spreading year by year. Bracken will grow only on good land; it cannot thrive on marsh. The destruction of pasture is far from being the only evil; animals feeding among bracken get their heads and necks covered with ticks—in fact, the death of a considerable number of sheep in this county seems to be justly attributed to this cause alone. If, therefore, land can be cleared of a most pernicious weed, and, at the same time, a valuable manure obtained for tillage, there are many farms where the work might be profitably undertaken.

The analogy of kelp presents itself. I understand that it takes from twenty to twenty-two tons of good wet seaweed to produce a ton of kelp, which yields between 30 and 40 per cent. of potassium salts, more than double the return from an equal weight of dried fern, besides the iodine which is recovered from kelp. But, on the other hand, it is far easier to cut bracken than to gather deep-sea tangle, and the ash can be used as a fertiliser on the farm where it is burnt.

Driving lately from Dorchester to Abbotsbury, I saw hundreds of acres of downland rendered absolutely valueless by bracken, whereof the luxuriant growth betokened a soil well adapted either for tillage or forestry.

HERBERT MAXWELL.

Monreith, Whauphill, Wigtownshire, N.B.

**The Supposed "Fascination" of Birds by Snakes.**

I HAVE been making further inquiries from my naturalist friends, and find Capt. G. D. H. Carpenter's observation recorded in NATURE of November 29 last (p. 244) is confirmed, together with the interpretation there suggested.

Dr. G. A. K. Marshall writes:—"The mobbing of snakes by small birds, and even by fowls, was frequently mentioned to me by residents in South Africa, and my general impression is that I have observed it on various occasions without specially noting it, and I cannot now recall the details of any particular case."

Mr. S. A. Neave, with a wide African experience, felt that the facts recorded by Capt. Carpenter were familiar to him, and associated in his mind "with parties of small finches and weaver birds in open, grassy places," but he was unable to remember any particular instance.

Mr. J. C. Kershaw, for a long time resident in Macao, China, and a traveller in the Malay Archipelago, Australia, and the West Indies, writes:—"I have often seen snakes pursued and annoyed by birds, just as cuckoos and hawks are by small birds, but never saw any sign of 'fascination' by the snake to obtain prey."

Mr. Kershaw has observed the mobbing of all kinds of snakes, and in many countries. "In China *Lanius schach* and *Dryonastes perspicillatus* especially raised an outcry over snakes. I remember one day hearing some shrikes (*L. schach*) making a great hubbub in a tall, thick bush; investigating, I found a snake (some 6 ft. or 8 ft. in length) in the upper part, and threw a clod of turf at it, striking it (by a fluke) about the middle of the body. The shrikes flew off, but the snake remained motionless for nearly half a minute, and then suddenly darted off. The light clod could not have really hurt it."

Mr. J. Williams Hockin, with a very long experience of South India, writes:—"The only case of birds *v.* snake I can remember is seeing a cobra attacking the nest of a ground thrush in a coffee tree at 3 ft. from the ground, and being clamorously assailed by the parents." A little later my friend kindly supplied further details of his observation:—"The cobra attack on ground thrushes (Geocichla, the slate and buff, not Pitta, the ruddy and kingfisher blue one) occurred in the Ellembelary Coffee Estate, three miles from Meppādi Village, in Malabar Wynaad, at an elevation of 3500 ft. So far as I can remember, it was eggs and not young birds the snake was after, but I cannot be sure. It was between 1894 and 1899. As you suppose, I was more humanitarian than scientific in those days, and got off my horse and went into the coffee to drive the snake off. The nest was on the top of a tree about 3 ft. high, the top forming, with those around it, a flat sheet of coffee. The snake was round the stem with its head over the edge of the nest, and the parent birds on each side, shrieking for all they were worth and fluttering round about on top of the boughs. On my approach the snake glided away, and the coffee was too thick for me to get at it. I do not think it took anything. The coffee in Wynaad was topped at 3 ft. or so, and all suckers removed when they appeared, so as to keep an even sheet of cover on the ground."

Not one of the above-named naturalists had seen anything like the traditional "fascination" of birds by snakes. Mr. F. Muir, however, told me that he had seen a bird—I believe in East Africa—sitting on a branch with its bill open and unable to move, while a snake approached and swallowed it. This *may* be an instance of "fascination." Weak-minded birds may sometimes act in this suicidal manner, just as some human beings may be paralysed by fear and unable to defend themselves or to escape from danger. But another interpretation is suggested by the following extremely interesting observation recorded by Dr. G. A. K. Marshall:—"When happening to look over a low stone wall near Estcourt, Natal, in 1897, I chanced to observe a small snake in the very act of striking a frog. After being bitten the latter hopped off at a great pace, and I was rather surprised to see that the snake made no attempt at pursuit, but merely followed in a very leisurely manner. Seeing that the frog had come to a standstill at a considerable distance off, I crept along under the wall, so as not to disturb the snake, and on getting near the frog I looked cautiously over the wall to see the end of the tragedy. The snake was still some way behind, approaching steadily, and on reaching its victim stood watching it for some moments with its head raised, the frog meanwhile sitting trembling in front of it. At last the snake seized its prey, and succeeded in swallowing it after but feeble resistance. It seemed clear that the trembling and inability to escape on the part of the frog were simply due to the action of the poison injected at the snake's first bite. It immediately occurred to me that these observations might supply a simple explanation of many of the stories of 'fascination' by snakes."

EDWARD B. POULTON.

Oxford, January 2.

## *THE SCIENTIFIC BASIS OF RATIONING.*

AN ideal ration is one which provides the adult with sufficient potential energy to meet all the demands made by the organs of his body for transformation into the kinetic form, and enough building material to make good the wear-and-tear of essential cells; a complete ration for children and adolescents must also make provision for the requirements of growth. Three methods of determining the quantities needed to fulfil these conditions are available. The first is to follow as closely as possible the system of an engineer, viz. to study the efficiency of the human machine as a transformer of energy when measurable amounts of work are performed under determinate conditions. The second is to measure the total energy transformed by the body under various conditions, also determinate, although not necessarily permitting of an exact evaluation of the amount of mechanical work done. Lastly, when it is neither possible to measure directly the energy transformed nor to evaluate the work done, the composition of diets consumed by samples of men engaged in different occupations throws light upon the probable needs of different classes.

These methods have been enumerated in a descending order of importance so far as the accuracy of the information which, under favourable conditions, they might yield is concerned; so far as practicability is involved, under normal conditions of life, the order is reversed. We shall refer briefly to the data available under each heading.

(1) The only type of work respecting which numerous and exact measurements both of energy transformed and of external work done are available has been that carried out with a stationary bicycle, the wheels of which are rotated against a known resistance. The best series of experiments is due to Benedict and Cathcart,[1] whose

[1] "Muscular Work: a Metabolic Study." (Washington, 1913.)

results are concordant with those of Macdonald[2] and others. From these experiments it appears that, for any one person, the relation between H, the total energy transformed (measured in thermal units), and W, the external work done (also measured in thermal units), is adequately expressed by the equation $H = aW + b$, where $a$ is a constant and $b$ a variable parameter, varying with the speed of work performance. In the case of a professional cyclist, upon whom Benedict and Cathcart performed a large number of experiments, $a$ was approximately equal to 3·3, while $b$ increased from 2·4 to 5·2 as the rate at which the pedals were rotated increased from 68–72 to 108–112 revs. per min. When unpractised persons used the ergometer the value of $a$ increased, but the available data were not sufficient to permit of the parameters being determined with any accuracy.

From these results we may infer that (i) the incremental efficiency of muscular work may be as high as 30 per cent. in favourable circumstances, and (ii) the total cost of work performance depends upon its rate. We can scarcely, however, venture to generalise the arithmetical results by using them to calculate the needs of those doing other kinds of work.

(2) This method was largely used by Zuntz and Schumburg[3] in their well-known study of the requirements of marching soldiers, and has also been employed by Amar[4] in investigating the energy transformations of industrial workers. Many physiologists, including Atwater and Benedict, Voit, Rubner, and Tigerstedt, have carefully determined the heat output of persons at rest, obtaining reasonably concordant results, so that the energy transformations of workers can be contrasted with those of sedentary persons.

From Amar's experiments it appears that a metal filer plying his tool at the rate of 70 strokes per minute (a skilled operative, aged thirty-eight years, weighing 74 kilograms) would transform or liberate 3656 Calories daily if he worked at the rate mentioned for eight hours, slept for eight hours, and "rested" the remaining eight hours. The figure just given is reached on the assumption that the heat output during sleep is 1 Calorie per kilogram of body-weight an hour; during non-working but waking hours, 1·25 Calories—assumptions in accord with the means of other experiments. Allowing a margin of 12 per cent. to cover unavoidable waste in the preparation of food and non-assimilation of portions of the ingredients consumed, this daily transformation is covered by a diet having an energy value of 4155 Calories as purchased. Little significance attaches to an isolated series of observations, and it is to be hoped that the method will be more widely employed in that organised physiological research into industrial conditions which is an urgent need of the time.

(3) This process has been widely adopted, the largest individual collections of statistics being (a) those recently compiled and analysed by the Welfare and Health Section of the Ministry of Munitions, and relating to more than 18,000 munition workers[5]; (b) the studies issued from the Nutrition Laboratory of the United States Department of Agriculture, which cover more than 13,000 persons, of whom, however, only a small minority were industrial workers[6]; (c) the Solvay Institute's analysis of the food consumption in more than 1000 Belgian industrial families[7]; (d) English urban working-class and agricultural budgets analysed by the Board of Trade some years ago.[8]

In the following table mean values computed from the above-mentioned material (omitting the American data, which may not be strictly comparable with those describing European conditions) are collected :—

| Source of data | No. of observations | Grams of protein daily | Grams of fat daily | Grams of carbohydrate daily | Calories daily |
|---|---|---|---|---|---|
| English agricultural families | More than 100 | 90·9 | 92·4 | 570·3 | 3571 |
| Urban industrial families, earnings 25*s.*–30*s.* | 289 | 91·8 | 70·6 | 564·6 | 3348 |
| Urban industrial families, earnings 30*s.*–35*s.* | 416 | 99·0 | 82·4 | 587·6 | 3581* |
| Belgian industrials, moderate and hard work | 687 | (83·4) | (98·3) | (524·3) | (3495) 3972 |
| Belgian industrials, very hard work | 372 | (84·3) | (113·1) | (562·8) | (3772) 4286 |
| English munition workers (1917) | 18,000 | 115·7 | 141·3 | 408·4 | 3463 |

* The average for the whole 1944 families (wages ranging from less than 25*s.* to more than 40*s.*) is :—

| Protein | Carbohydrate | Fat | Calories |
|---|---|---|---|
| 98·8 | 593·2 | 83·7 | 3615 |

The figures in this table, excepting those for Belgium, refer to food as purchased. The Belgian investigators have expressed their results in terms of food absorbed by the digestive organs; the deduced averages are accordingly enclosed in brackets, not being directly comparable with the others. The unbracketed figure for Calories is that obtained on the assumption that a discount of 12 per cent. should be allowed between purchased and assimilated values, and is (if the assumption be admitted) comparable with the remaining average energy values.

These statistics must be interpreted with caution. Two assumptions are made in computing nearly all averages of the kind, and a third is often involved also. The assumptions in question are (a) that published analytical results showing the composition of foodstuffs are generally applicable to the qualities used by the persons whose

[2] Proc. Roy. Soc., B, 1917, vol. lxxxix., p. 394.
[3] "Studien zu einer Physiologie des Marsches." (Berlin, 1901.)
[4] "Le moteur humain" (Paris, 1914), pp. 527 *et seq.*

[5] Summarised in Dr. Leonard Hill's "Memorandum on Workers' Food" (Health of Munition Workers Committee, No. 19, Cd. 8798).
[6] Contained in successive Bulletins of the U.S.A. Department of Agriculture.
[7] Slosse and Waxweiler, "Enquête sur le Régime alimentaire de 1065 ouvriers belges." (Brussels, 1910.)
[8] Board of Trade, 1903, Cd. 1761, p. 210; 1913, Cd. 6955, p. 300.

diets are under investigation; (*b*) that in families composed of persons of different sexes and ages the individual distribution of food among the members of the families can be expressed by the age and sex coefficients proposed by Atwater; (*c*) that published coefficients of wastage and proportional absorption are trustworthy. In addition to these special difficulties there are, of course, the usual pitfalls of statistics (errors of sampling, randomness or otherwise of sampling, etc.).

From the evidence furnished by a short series of control experiments carried out by the Belgian inquirers, Slosse and Waxweiler, it seems likely that the American coefficient of reduction for sex, *i.e.* putting the consumption of an adult woman as 80 per cent. of that of an adult man, is not far from the truth; but, on the other hand, the American coefficients of consumption by children may be appreciably too small. The result is that, so far as reduction to "man values" is concerned, the English munition workers' mean is accurate, while the means of the other collections of data (which are reduced from family budgets comprising the nourishment of children as well as that of adults) may over-estimate the *per caput* "man" consumption, perhaps even as much as 20 per cent. Regarding the discount to be allowed for waste in preparation and non-assimilation, much depends upon the constituents of the diet, and the figure of 12 per cent. cannot be regarded as more than a very rough approximation.

Notwithstanding these limitations, the value of the data is considerable, and a study of them might induce some popular journalists and amateur food economists to moderate their strictures upon the extravagance of the English working classes which is alleged to have been fostered by the war-time rise in wages. The data do not suggest that the energy value of the diet consumed by so important a group of operatives as the munition workers is substantially greater than that received by persons of the same social and industrial class before the outbreak of hostilities. The distribution of energy between the three classes of foodstuffs has been different, an inevitable result of the potato famine and the appeals to eat less bread which characterised the period (spring and summer of 1917) during which the data were collected.

The general conclusion to be drawn from the statistics and the relatively few experiments available is that 3500–3800 Calories in food as purchased are by no means an over-estimate of the nutritive requirements of an adult man engaged in moderately strenuous work. Recent work, indeed, confirms the view that Atwater's standard, so far as energy value is involved (3500 Calories), is not an extravagant one.

The *British Medical Journal* in its issue of December 1 directed attention to the fact that the Food Controller's voluntary ration for men on medium work provided about 2100 Calories, leaving a deficit of 1400 Calories from the total of 3500, which the evidence just set out shows to be a minimum requirement of workers in this class. Our contemporary concluded that a weekly consumption of 9½ oz. of fish and a daily consumption of one pint of milk were as much as could be hoped for from these so far unrationed articles, which leaves (cheese being notoriously scarce) a balance of nearly 950 Calories to be obtained from potatoes, involving a daily consumption of more than two pounds. These facts show the urgent necessity of carefully organising the distribution of potatoes within the country and the obligation imposed upon persons living near the centres of supply (for instance, in suburbs with available allotments) to make free use of potatoes, thus helping to increase the quantities of cereals available in the industrial districts to which bulky vegetables are not easily transported. The gravity of the situation imposes a further duty upon the readers of a scientific journal, who must inculcate upon their friends the elementary principles of bioenergetics. That the relation between muscular work and food is as close as that between the mileage of an automobile and its consumption of petrol is a truth still hidden from nine out of ten educated persons; ignorance of the facts has been the parent of many untrue charges.

M. G.

## *SCIENTIFIC WORK OF THE MEDICAL RESEARCH COMMITTEE.*

THE third annual report of the Medical Research Committee, which has recently been published (Cd. 8825: H.M. Stationery Office, price 6*d*. net.), testifies to a very large amount of work of a varied nature. A notable proportion of this has necessarily been devoted to problems arising, directly or indirectly, from the war. But the introductory remarks rightly point out that it is meaningless to try to separate the practical from the scientific aspects of any set of investigations. There are many problems, moreover, which the state of war brings into urgency for solution and, at the same time, offers unique opportunities for inquiry.

Limits of space forbid the reference in detail to all the questions dealt with in this very interesting and important report, and a mere list would be of little value or interest in itself. The report should be read carefully by all who have at heart the health and efficiency, not only of our sailors and soldiers, but also of the nation as a whole. It is proposed here rather to direct attention to a few results of general scientific importance.

It cannot escape notice how prominent have become the methods and results of the physiological laboratory. Two cases may be mentioned in illustration: the regulation of industrial work in relation to fatigue, and the supply of oxygen to men flying at high altitudes. In other instances our ignorance of fundamental physiological processes has been vividly brought home to us. One of these may be referred to in the next place.

Many diseases are caused, as is well known, by the invasion and presence in the blood of minute organisms of animal or plant nature, protozoa or bacteria. This is now, indeed, a matter of common knowledge. For a long time efforts have been made to discover some chemical agent which shall be able to kill these organisms, without injury to the tissues in which they flourish; but with little success. It is somewhat remarkable that most success has been obtained, not, as might have been expected, with the destruction of plant organisms, but with certain protozoa which have shown themselves to be readily susceptible to the toxic action of metals in organic combination. The present report gives an account of some steps towards the solution of the general problem. The hypochlorites introduced by Dakin have been found, in the hands of Lorrain Smith and Ritchie, to be comparatively non-toxic when injected into the veins in the form of "Eusol," while having an unmistakably beneficial effect in certain infections. But, as Dakin has shown, hypochlorites enter at once into combination with the proteins of the blood and cannot be supposed to exert a direct bactericidal action therein. The effect is apparently produced by some change in the blood itself, and it is interesting to note that Dale and Dobell have been led to the conclusion that the action of alkaloids on the amœba of dysentery outside the body is not an index to their therapeutic efficiency, and that their influence on the tissues of the patient is of equal importance. On the other hand, the work of Dr. Carl Browning and his colleagues has brought forward a compound, related to the acidine series of dyes, which is apparently much more toxic to bacteria than it is to animal cells. On account of its colour, this antiseptic was originally called "flavine." It kills bacteria in concentrations in which it has but little effect on the activity of leucocytes, and is non-toxic in intravenous injection. Since the report was issued Dr. Browning has described experiments in which rabbits received intravenous injections of flavine without harm, but the serum of which was found *in vitro* to destroy bacteria. Opinions are, as yet, divided as to the value of flavine as a treatment for wounds. Some surgeons find that it prevents the normal growth of new tissue; but it is possible that the correct conditions have not yet been discovered.

In connection with the practical use of these various antiseptics, the law of distribution between phases, according to solubility, receives application in the value of the solutions of dichloroamine, acriflavine, and iodoform in fatty solvents, such as eucalyptol, paraffin, and soap.

The physiological importance of the presence in the organism of minute quantities of certain chemical substances, the constitution of which is, for the most part, unknown, becomes every day more evident. In two respects the report adds further valuable information. The "accessory factors" in food, without which growth is impossible and various diseases develop, appear to be of some variety and number. The growth factor in milk is shown by Winfield, in the laboratory of Hopkins, to be preserved in the drying process, a fact of practical bearing at the present time. The necessity of such factors for the growth of unicellular organisms themselves has been known for some time, but Miss Jordan Lloyd adds an important further contribution in her investigation of culture media for bacteria. She is of opinion that these growth factors act as catalysts. The chemical reactions, or some of them, necessary for growth proceed naturally at too slow a rate to be effective; but they can be accelerated by the presence of the factors in question. This hypothesis is in agreement with the fact that, although the substances are present in very small amount, they do not disappear from the organism for some days after the food has been deprived of them. They appear to exercise their function without themselves suffering chemical change. The second important addition to our knowledge concerns the internal secretion of the parathyroid glands. Noel Paton and his coadjutors show that the muscular tremors, which make their appearance when these glands are removed, are due to a disturbance of the metabolism of guanidine, which becomes present in excess under these conditions.

A brief reference should be made to the results of the laborious statistical work undertaken by the Committee, especially to that which shows the occurrence of two distinct types of micro-organisms producing phthisis. The comparative incidence of kidney disease in the ordinary population and in the men in the trenches also deserves mention. The value of the statistical method, under appropriate control, is well demonstrated.

A final reference may be made to the latest development of the Committee's work (see p. 78 of the report). The present writer, when visiting some casualty clearing stations in France and Flanders in August last, found so great a divergence of views as to the cause and treatment of the "shock" following injury that, on his return, a special investigation committee was formed, consisting of surgeons at the front and laboratory workers in England. Results of much physiological importance may be expected, especially as to the cause of the low blood-pressure and its indirect effects. Several memoranda are already in course of publication.

W. M. BAYLISS.

## SCIENCE AND INDUSTRY IN AUSTRALIA.

THE Executive Committee of the Advisory Council of Science and Industry for the Commonwealth of Australia has recently published a report covering the period from its appointment to June 30, 1917.[1] The Advisory Council was originally appointed on March 16, 1916, and was intended to be a temporary body designed to prepare the way for a permanent Institute of Science and Industry, and to exercise in a preliminary way the functions that will in future belong to the institute.

The council as a whole has met only twice, but a vast amount of work has been done through committees. The Executive Committee has previously made two reports, but the document recently issued is a survey of the work done, and represents to a large extent the completion of the task of the temporary organisation in preparing the way for the permanent institute.

[1] C. 7963. (Melbourne: Government Printer.)



Australia—Industries + resources

The activities of the committee have been far-reaching. Attention has been given to the encouragement of researches already in progress, and it has initiated many fresh inquiries. It has got into touch with colleges and technical institutes, and collected information as to the facilities for research and the supply of research workers. But the main work of the committee has consisted in a most exhaustive survey of the problems retarding the development of existing industries, and of the research work necessary for the establishment of new industries. It would be almost tedious to enumerate the subjects which have received attention; no industry has been neglected, but perhaps special attention has been devoted to the agricultural and pastoral industries.

Some very sound principles are again and again emphasised in the course of the report. The necessity of securing a greater supply of skilled research workers is frequently referred to, and the committee has made a beginning in the way of encouraging promising students to take up such work by finding remunerative employment for some of the men at present available.

A second point which is regarded as of great importance is the improved training of artisans in technical schools. If research methods are to be more generally applied to industries, it is clear that greater skill and accuracy will be required from the general body of workers, so that it is not merely the duty of the universities and colleges to supply highly trained research workers, but the technical schools have also the important duty of educating the artisan for the new type of work required under the new conditions.

We detect here and there in the report a tendency on the part of the committee not to wait for an industry to come to them, and, indeed, not even to delay in order to secure the co-operation of the industry, but to get research work going when convinced of the necessity for it. For example, the Executive Committee decided to appoint a special committee to investigate the processes of extraction of tannin from wattle bark, and feeling that negotiations with the tanners in all the States would take too long, the investigations have been commenced without waiting for financial assistance from the industry. This method of procedure is interesting, and one would like to get further information as to whether the committee intends to publish freely the results of such investigations, or whether it is going to communicate them to firms on certain conditions.

The present report is in the main confined to a survey of the promising fields for research work, and does not deal with questions connected with the administration of public funds. Most people will probably regard it as of good omen for the success of the scheme in Australia that research, and not administration, is being given the premier place, although no doubt the authorities of the institute will find it very necessary to formulate some guiding principles. In the attempt to apply science to industry it is, however, quite clear that the result will be fatal if we take too great care to avoid a few mistakes and thus set up a system with a tendency to damp the enthusiast.

There is one respect in which the present report is rather peculiar. As we have stated, it is in the main a survey of the field for future work, but in describing the proceedings of several of the subcommittees there is included an account of the experimental results obtained in some of the researches that have been started. The effect produced is scarcely satisfactory, as the researches are only in their initial stages, and it is not possible to give definite conclusions. The public should not be encouraged to expect results of importance to industry too soon, and when given they should be stated as definitely as possible.

The Executive Committee has evidently carried out its duties with great thoroughness, and has made a very complete survey of Australian industries. In matters relating to agriculture and stock breeding the work of the Australian Institute promises to be of special interest to the mother country if we are really determined to apply science to agriculture in a systematic way in the future.

## NOTES.

WE are very glad that the Government has been induced to abandon the intention to use the British Museum at Bloomsbury for the purposes of the Air Board and the Natural History Museum at South Kensington for other Government departments. Lord Sudeley directed attention to the proposed appropriation of these buildings in a question asked in the House of Lords on January 9, and, in reply, Earl Curzon said that, as regards the British Museum, he was glad to state that for the accommodation of the Air Ministry it was no longer necessary to appropriate that building. As to the Natural History Museum, it had been found, after detailed examination, that any attempt to convert the galleries into public offices would involve the closing of the building to the public, extensive internal rearrangements, and the consumption of an enormous amount of labour and material and very considerable delay. In these circumstances it had been decided that there was no necessity sufficiently urgent to warrant the use of the museum as had been contemplated.—This decision has given much satisfaction to all who cherish regard for national prestige and understand the intellectual stimulus or practical value of the collections in our national museums. What astonishes us, however, is that Sir Alfred Mond, the First Commissioner of Works, and a son of the late Dr. Ludwig Mond, should have placed himself in such an indefensible position by putting the scheme before the Government. It is difficult to comprehend also why, before deciding to requisition the building, the Government did not inquire as to whether such action was imperatively needed, and consult the trustees and other responsible authorities as to what its consequences would be. If that had been done, a storm of protest would have been saved, and Earl Curzon would not have had to confess in the House of Lords that there was no real necessity for the proposed occupation, which would, indeed, have been more like the act of an invader than of a Government entrusted with the care of national interests in every direction. The trustees of the museum, at their meeting on January 12, expressed their gratitude, on behalf of the nation whose treasures they hold in trust, to the newspapers which so unanimously gave voice to the public disapproval of a proposal which threatened the safety of the museum and its collections.

REPORTS and opinions relating to the "capture" of 257 recipes for manufacturing dyes produced by the Badische Company appeared in the *Daily Mail* of January 10 and following days, and the subject has been much commented on by other journals. It has been rightly pointed out that the view that the knowledge thus gained will enable us after the war to compete with Germany in every line of dyed goods is too sanguine, and that, although the possession of these recipes may undoubtedly be of considerable assistance, it is a comparatively small item in the general scheme that it is necessary should be organised for the satisfactory establishment of the dye industry in this country. The provision of buildings, plant, and labour is not easy under war conditions, and, of course, more chemists and engineers are required. Were all these readily available, however, it is doubtful whether the inexpert organisations controlling most of the undertakings in England could hope to establish one of the most scientific of industries. In the extensive literature on this subject that has appeared during the last three years the necessity for chemists, engineers, and plant has been repeatedly urged, but the outstanding feature of the great German organisations, namely, that the boards of directors can, and do, direct their businesses, seems to have been overlooked. If, as is suggested, the Government can be induced to acquire these 257 recipes for the benefit of the nation an admirable opportunity will arise of organising the industry as a whole. More than twenty firms are now advertising the sale of dyes manufactured by themselves, but it is evident that each has started independently, with the result that the majority are making "sulphide" dyes. Unless some mutual arrangement can be made according to which the whole field of manufacture is divided out in order to prevent undue overlapping and to provide a wide range of products, many of these praiseworthy beginnings will inevitably come to an early end.

THE following official announcement was made on Monday:—It is with great regret that the Secretary of State for War has decided that the time has come when Surgeon-General Sir Alfred Keogh, G.C.B., Director-General of Army Medical Services, must be permitted to resume his duties as General Executive Officer to the Imperial College of Science and Technology, and he will be replaced at the War Office from March 1 next by Col. T. H. J. C. Goodwin, Royal Army Medical Corps, until recently the Assistant Director of Medical Services to the British Recruiting Mission in America, who will be appointed Acting Director-General of Army Medical Services. Sir Alfred Keogh's services were placed by the governors of the Imperial College of Science and Technology at the disposal of the War Office at the beginning of the war, and, although during the last three years they have on several occasions requested that he should return to his former duties owing to the development of matters of great national urgency which are delayed by his absence, it has not hitherto been possible to spare him. It is very largely due to Sir A. Keogh's intimate knowledge and grasp of all matters connected with the Army Medical Services and the medical profession generally that the medical needs of the Army have been met to the fullest extent during the war, and he has been able to secure the assistance and advice of various committees of eminent consultants, which it is hoped will continue to be at the disposal of his successor.—We understand that Sir Alfred Keogh has for some time desired to return to his work at the Imperial College. The Royal Army Medical Corps as it now exists is essentially his creation, and his organisation of it to the present state of efficiency and strength is a high testimony to his great administrative powers and an achievement of which the nation is justly proud.

THE National Museum of Wales has received an important addition to its collections through the gift by Lord Rhondda of the "Rippon" collection of insects, shells, and minerals. The late Mr. Robert H. F. Rippon was an enthusiastic and careful collector, and is well known to entomologists as the author and illustrator of "Icones Ornithopterorum." By dint of assiduous labour during more than forty years he accumulated very extensive collections, which are especially rich in Lepidoptera; there are more than 3000 specimens of Papilionidæ and more than 5000 of Nymphalidæ, the whole insect collection consisting of above 100,000 specimens. In addition to the more showy forms, such as the cones, cowries, olives, volutes, and the like, the shells include a long series of land shells from the tropics and the islands of the Pacific Ocean. As these collections are mainly exotic, they will supplement, and not duplicate, those already in the museum, which are for the most part British. It remains to be added that the specimens are in excellent condition, and the localities have in almost all cases been recorded. Another welcome gift recently received by the museum has been the British Hemiptera, Neuroptera, and allied groups from the "Briggs" collection, which were presented by Mr. Ernest Heath.

WHAT has been done to make use of waste stores in the Army is described in a reply given by Mr. Bonar Law to a question asked by Mr. Herbert Samuel, chairman of the Select Committee on National Expenditure. A Salvage Board has been formed, with the Quartermaster-General as chairman, to deal with the use and disposal of all waste stores. The following are amongst the results achieved:—(1) From waste fats collected from Army camps alone have been produced: (i) Tallow sufficient to provide soap for the entire needs of the Army, Navy, and Government Departments, with a surplus for public use, producing an actual revenue of about 960,000*l.* per annum, in addition to saving valuable tonnage; (ii) 1800 tons of glycerine for ammunition—sufficient to provide the propellant for 18,000,000 18-pr. shells. The glycerine costs the Government 59*l.* 10*s.* per ton as compared with 300*l.* per ton, the price of imported glycerine. (2) Well above 1,000,000*l.* worth of military rags have been recovered and used in the manufacture of new cloth and blankets for the Army. (3) Many thousands of pounds' worth of cuttings from cotton textiles have also been recovered and utilised in connection with munition and aeroplane requirements. (4) Some hundreds of thousands of pounds' worth of condemned boots have, after the expenditure of some labour in sorting and minor repairs at very small cost, been sold for distribution among the labouring classes, agricultural and industrial

AMONG the changes recently announced as having been made at the Admiralty one has reference to the organisation of the Admiralty Board of Invention and Research. The object of the change is to secure greater concentration of effort in connection with scientific research, and to ensure that the men of science who are giving their assistance to the Admiralty are more constantly in touch with the problems upon which they are advising. Mr. C. H. Merz, the electrical consulting engineer, who has been associated with the Board of Invention and Research since its inception, has consented to serve as Director of Experiments and Research (unpaid) at the Admiralty to direct and supervise all the executive arrangements in connection with the organisation of scientific research. Mr. Merz will also be a member of the Central Committee of the Board of Invention and Research under the presidency of Admiral of the Fleet Lord Fisher. The functions of the Central Committee will, we learn from the *Times*, as hitherto, be to initiate, investigate, develop, and advise generally upon proposals in respect to the application of science and engineering to naval warfare; but the scientific experts at present giving their services will in future work much more closely with the technical departments of the Admiralty immediately concerned with the production and use of apparatus required for specific purposes. The general arrangements in regard to the organisation of scientific research will in future come under the direct supervision of the First Lord of the Admiralty.

THE *Times* of January 8 contained a letter from Profs. J. Stanley Gardiner and G. H. F. Nuttall on the applicability of the method of preserving herrings by freezing in brine, and on January 10 Mr. J. M. Tabor had a letter dealing with the process from the commercial point of view; a further letter in the *Times* of January 14 appeared from Profs. Gardiner and Nuttall. The method suggested by the last-named is evidently the Otteson method developed and worked in Norway, Sweden, and Holland. It was investigated by Mr. H. Bull, of the Norwegian Fisheries Bureau, and later by a commission of three experts appointed by the German Government. There is a very good account of the process and its effect on the tissues of fish in the *Fish Trades Gazette* of October 20 last. The fish are frozen rapidly in solutions of salt in water of such strengths that the temperature can be reduced to 6·8° F. if necessary. "Glazing" by the formation of an ice film occurs and prevents osmotic interchange, and the rapidity of the freezing produces very small ice-crystals between the muscle-fibres, instead of the large crystals which are mainly responsible for the deterioration of the flesh. Experiments on a commercial scale were made at Fleetwood and elsewhere in this country in 1917, and successful results were obtained, so much so that it was claimed by the writer of the article in the *Fish Trades Gazette* that the very difficult problem of refrigeration of sea fishes had been completely solved, and strong recommendations were made for its commercial adoption. It is suitable for most species of fish, but herrings and some others require rather careful handling, and gutting is probably necessary. Mr. Tabor's letter in the *Times* directs attention to the practical side of the matter, suggesting difficulties that are, just now, very formidable. A further, very useful contribution to this important discussion is contained in the leading article of the *Fish Trades Gazette* of January 12.

ACCORDING to a note in *L'Economista d'Italia* for January 1, an eminent Brazilian geologist has been commissioned by his Government to investigate the deposits of oxide of zirconium in the Caldas region (Minas Geraes), as well as to carry out further work to ascertain the extent of the coal formations in the State of São Paulo.

THE presentation of the Thomson Foundation gold medal of the Royal Geographical Society of Queensland was made to Dr. Griffith Taylor on November 8 last for his thesis on "The Settlement of Tropical Australia," which deals specially with the control of crops and health in relation to temperature and rainfall. The progress made in the settlement of this part of Australia is also compared with that of other tropical areas.

MR. R. BULLEN NEWTON, F.G.S., of the Geological Department, British Museum, has just completed fifty years of Government service. Shortly after entering on his official career, which commenced on January 6, 1868, Mr. Newton became one of the assistant naturalists of the Geological Survey under Prof. Huxley. He was transferred to the British Museum in August, 1880. His numerous published researches on various branches of palæontology, especially the Mollusca and Foraminifera, have had a direct bearing on the geology, both theoretical and economic, of widely scattered regions. Mr. Newton has been president of the Malacological Society of London and of the Conchological Society of Great Britain and Ireland.

THE buildings of Dalhousie University suffered severely in the recent explosion on the munitions ship which wrecked the northern part of the city of Halifax, N.S., on December 6 last. Nearly all the windows in the medical school were blown in, and much material in the laboratories was destroyed. The new science buildings and library suffered almost worse damage. On the day following the disaster there was a blizzard, during which much snow was driven into the buildings before the windows could be boarded up. The damage is being rapidly repaired, and arrangements are being made to continue the session this month. No members of the staff were injured. Prof. Fraser Harris has been asked by the military authorities to undertake the duties of historian of the medical aspect of the recent disaster.

THE death is announced, at sixty-seven years of age, of Mr. J. E. Cullum, late superintendent of the Valencia Observatory, Ireland.

THE *Morning Post* announces the death, at thirty-nine years of age, of Mr. H. L. Burgess, medical secretary to the Advisory Medical and Sanitary Committee for Tropical Africa and to the Yellow Fever (West Africa) Commission.

THE annual meetings of the Institution of Naval Architects will be held on March 20–21, in the hall of the Royal Society of Arts. The Right Hon. the Earl of Durham, president, will occupy the chair. A gold medal will be awarded by the council to any person, not being a member or associate member of council, who shall at the forthcoming meetings read a paper which, in the judgment of the council, is deemed to be of exceptional merit.

WE learn from the January issue of the *Observatory* the announcements of the deaths of M. S. Javelle, astronomer at the Nice Observatory, and Dr. E. Kron, junior observer at the Potsdam Observatory. The following particulars of their careers are extracted from obituary notices in our contemporary:—M. Javelle was born at Lyons in 1864, and joined the staff of the Nice Observatory in 1884. He assisted Thollon in his solar researches and Perrotin in his double-star observations. In 1889 the great equatorial was placed in his charge, and remained so until his death. He made many observations of comets and minor planets, but his principal work was the discovery of more than two thousand faint nebulæ.—Dr. Kron was killed on October 24 last in Flanders, where he was serving as oberleutnant and battery commander. Born in 1881, after graduating at the Berlin University he was appointed assistant at Potsdam in 1906, and at first was engaged upon the measurement of the plates in the Potsdam zone of the Astrographic Catalogue. In 1910 he accompanied Prof. Müller on the Potsdam eclipse expedition to Teneriffe. His most important work was also carried out in conjunction with Prof. Müller—the photometric Durchmusterung of the polar zone $+80^\circ$ to $+90^\circ$. On the outbreak of war Dr. Kron was engaged upon this work, and also upon an important investigation of the absorption of rays of short wave-length in the earth's atmosphere, using a quartz spectrograph.

NEWS of the death of Dr. Jean Clunet, a victim to typhus in Rumania, has recently reached us. The greater part of Dr. Clunet's scientific work was devoted to the subject of malignant disease. He was the author of "Tumeurs Malignes," a volume filled with new experimental data, mostly original, upon the forms and varieties of tumours, the evolution of neoplastic growths, and the action of X-rays upon malignant tumours, human and animal. Dr. Clunet devoted a great amount of labour to these latter investigations, and he was able to show the various stages of degeneration through which malignant cells pass after adequate exposure to X-rays. Perhaps his most important work was the production of malignant tumours in rats by exposing them to repeated doses of X-rays. On two occasions he produced tumours in rats which satisfied two of the criteria of malignancy, viz. histological conformation to malignant type of cell and successful propagation with other normal rats. Since the outbreak of war Dr. Clunet had served in a medical capacity, at first with his regiment, and afterwards in some special capacity at the Dardanelles, with the Serbian Army at Corfu, and finally upon a mission of hygiene to the Rumanian Army. His scientific publications during the war include "La jaunisse des camps et l'épidémie de paratyphoïde des Dardanelles" and "La relation des accidents nerveux émotionnels, observés chez les naufrages de la Provence." Dr. Clunet was made an honorary corresponding member of the Röntgen Society in 1913. Those who had the privilege of knowing him deplore the loss of a life so full of promise of deeds to come.

*Kew Bulletin*, Nos. 7 and 8, published together, are occupied entirely with a list of economic plants, native or suitable for cultivation in the British Empire. The list is prefaced by some introductory remarks by Dr. A. B. Rendle, keeper of the Department of Botany, British Museum, South Kensington, explaining the origin and object of the list. The suggestion of the publication of the list arose at the British Association meeting, 1916, of which Dr. Rendle was president of Section K, and as Kew contained so much economic information in its museums, its preparation there was most fitting. In the list many well-known and already cultivated plants are mentioned, and references are given to the more important papers dealing with particular products, but there are many little-known plants to which reference is made which may be of value for future developments. Under every plant the country of origin is given and some particulars of its use. The plants are arranged under the products they yield, such as fatty oils, gums, etc.; rubber, gutta-percha, and balata; drugs, dyeing and tanning materials; paper-making materials and timbers.

THE botany and physical geography of the Holy Land are of considerable interest at the present time in connection with the campaign in Palestine, and the article on the subject from the pen of the veteran botanist, Mr. J. G. Baker, published in the *Gardeners' Chronicle* for December 22 and 29, 1917, is most opportune. Several good illustrations add to the interest of the text. Though so small a tract of country, the flora, owing to the diverse physical features, is remarkably rich, comprising some 4000 species, exclusive of the lower plants, such as mosses and fungi. Boissier's "Flora Orientalis" is, of course, the classic work on this region, and additions to the list have been made by Sir Joseph Hooker and Sir Daniel Hanbury. The subtropical region of the Jordan Valley and southern deserts contains many forms unknown further to the west. Then there is the flora of the rich loamy coastal plains, with the limestone promontory of Mount Carmel; the mountain region of Lebanon and Antilebanon, above 4000 ft., rising on Lebanon to 10,000 ft., and here, as in N. Africa, the familiar Arctic-Alpine plants, found so far south as the Caucasus, are not represented, though they extend through to the mountains of Central Asia and the Himalayas. Lists of the more interesting plants are given for the different regions. Palestine in its botany combines in a remarkable manner the characters of the East and the West, but the abnormal feature of the Jordan Valley and the Dead Sea, deeply excavated below sea-level, constitutes, both florally and geologically, its most interesting feature.

THE Advisory Council of Science and Industry of the Commonwealth of Australia appointed in August, 1916, a special committee to consider the problem of worm nodule disease in cattle, which is a source of serious loss to the Australian meat industry. The report of this committee has now been published as Bulletin No. 2 of the Advisory Council. The bulletin includes a report on the occurrence of onchocerciasis in cattle and associated animals in countries other than Australia, and also a translation of an article by M. Piettre on bovine onchocerciasis in South America. Further sections deal with Australian investigations, some of which have been recently dealt with here. The committee makes recommendations for a generous provision of assistance for further investigations.

IN the *Journal of Agricultural Research* (vol. xi., No. 7) Messrs. W. Moore and J. J. Willaman give an account of studies in greenhouse fumigation with hydrocyanic acid. Evidence was obtained that the fumigated plants absorbed more or less of the gas, which led to a reduction in the activity of the oxydases and catalase, and, hence, in respiratory activity. This resulted further in an inhibition of photosynthesis and translocation of carbohydrate, and a closing of the stomata. Another result was an increase in the permeability of the leaf septa, with consequent less rapid intake of water from the stems and more rapid cuticular transpiration. In cases of mild fumigation this resulted in merely a temporary wilting, and the subsequent recovery was followed in many cases by a rate of growth and of fruit production (in the tomato) in excess of the normal. Within a few hours after fumigation oxydase activity had returned to normal, while the catalase and the respiratory activities exceeded the normal. By this time the recovery of photosynthetic action was first apparent; complete recovery, however, of this and of translocation of food material was not attained until after an interval of from two to three days. Respiration remained above normal for several days. The stimulation of growth may be due to at least two factors—namely, to the increased activity of the catalase and to the increased permeability of the cell-walls, allowing readier exchange of food materials and of gases. It is very improbable that the extra nitrogen contributed by the cyanide exercises any direct nutritive effect.

IN a paper which has appeared in the Proceedings of the Tokyo Mathematico-Physical Society (1916, p. 513, and 1917, p. 208) Prof. H. Nagaoka has taken up the theory of the concave grating in order to determine the errors introduced when a wide grating is used. He finds that the resolving power of concave gratings is far less than that of flat gratings of the same width. As, however, the utilisation of the whole power of a plane grating necessitates the use of a collimating telescope of large size, the best plan seems to be to construct concave gratings of very small curvature. The results of investigations of the structure of spectral lines with the concave gratings hitherto available have been inferior to those obtained by interference methods giving the same resolving power. But the latter methods are in turn subject to the drawback that the order of the spectrum for a particular constituent observed may not be identical with that of the principal line of the group under investigation.

AT the meeting of the Scottish Meteorological Society on December 20 last, a paper was read on ground-ice by Dr. John Aitken. It was pointed out that as ice cannot begin to form unless the water is cooled 2° or 3° below freezing point, any radiation effect from the bottom of rivers could never start the freezing there. An experiment was described in which ice was formed in running water by the action of radiation and cold air. The ice so produced was in small crystals, or frazil-ice, and was found attached to the bottom and to obstructions in the stream, the same as observed in rivers. This ice, when massed, was of a soft, spongy nature, like ground-ice. Observations made where there is ground-ice show that the very slight heating of the sun's rays soon causes it to loose its attachment to the bottom and rise to the surface. It is shown that this is due to the ice crystals slipping when the temperature is just above freezing point, and adhering when it is just under it. The difference measured on the thermometric scale is infinitesimal, though the physical results are enormous. While frazil-ice gives great trouble by adhering to the hecks of inlets at power stations, none has been experienced from it adhering to the guide-blades in the turbines. This difference, it is pointed out, is due to the water at the inlets being on the cold side of the freezing point, while in the turbines it is just above it, owing to its being under greater pressure and the ice melting.

PROF. M. TIFFENEAU informs us that the first volume of the correspondence of Charles Gerhardt, the centenary of whose birth was celebrated by the Chemical Society of France in December last, will be published in a few weeks' time. This volume will contain fifty-eight letters from Auguste Laurent and twenty from Gerhardt, between the dates 1844 and 1852. It is hoped that two other volumes of Gerhardt's correspondence will appear during this year. The complete work will contain five hundred letters exchanged, for the most part, with the chief chemists in Europe during a period—1837 to 1856—which, from the point of view of chemical science, was of the highest historical significance. The publisher of the three volumes will be M. P. Masson, 120 boul. Saint-Germain, Paris, and the price will be about fifteen francs per volume, or thirty-two francs for the set if this sum is subscribed before the end of the present year.

ONE of the difficulties with which railway maintenance engineers have to contend is creeping of the rails in a longitudinal direction, which necessitates periodic rectification of the position of the rails after the creep has taken place. Two papers were read on this subject at the Institution of Civil Engineers on January 8. In one of these papers Mr. H. P. Miles describes investigations of this phenomenon made by him for a period of five years in this country on a line consisting of 850 track miles of main and branch lines, over which various kinds of traffic passed. In the other paper Mr. F. Reeves describes some simple experiments he has carried out on pine, iron, and rubber laths by causing loaded wheels to roll along them. He concludes that creep is due primarily to deformation of the rail as the wheel passes over it, and that the more violent the deformation, the greater will be the creep; thus creep is increased by increasing the wheel load, and also by diminishing the rigidity of the rail, either by reducing its section or by using a weaker material. The weight of the wheel appears to be the most powerful factor affecting the amount of creep. Creep is accentuated by braking, and is greater down-hill than up-hill, but is by no means absent on the latter. Creep is always with the traffic. Creep can be resisted more or less completely by putting in enough anchorage or resistance, and Mr. Reeves describes several such devices, including one of his own design which is in use on the Buenos Ayres and Pacific Railway. Many railway structures are affected by creep, and their design should take it into consideration. This requires special emphasis in the drawing office.

## OUR ASTRONOMICAL COLUMN.

THE MASSES OF THE STARS.—The masses of all the double stars for which sufficient data are available have recently been calculated by Prof. H. N. Russell (*Popular Astronomy*, vol. xxv., p. 666). The results for the mean mass of a pair of stars, grouped according to the spectral classes of the bright components, are summarised in the following table, the unit being the mass of the sun:—

| Spectrum | Spectroscopic binaries | | Visual binaries | | Physical pairs | | From parallactic motions | |
|---|---|---|---|---|---|---|---|---|
| | No. | Mass | No. | Mass | No. | Mass | No | Mass |
| B0–B5 ... ... | 13 | 17·5 | | | 8 | 10·4 | 36 | 7·1 |
| B8–A5 ... ... | 18 | 4·0 | 6 | 5·9 | 12 | 3·0 | 114 | 8·4 |
| F–G "giant" ... | 34 | 3·9 | | | | | 37 | 8·1 |
| K–M ,, ... | | | | | | | 38 | 9·8 |
| F–F5 "dwarf"... | | | 17 | 3·5 | 9 | 3·4 | 60 | 2·5 |
| F8–K0 ,, ... | | | 21 | 1·8 | 10 | 1·4 | 51 | 0·7 |
| K5–M ,, ... | | | 4 | 0·7 | 8 | 1·0 | | |

The first three groups present quite independent data, but the fourth, though for the most part independent, includes stars of the second and third groups. The giant stars of all spectral classes are thus shown to be nearly equal in mass, as they are in brightness. Among the dwarf stars, however, where the luminosity falls off rapidly with increasing redness, the mean mass also falls off, but much more slowly. The masses of the stars thus seem to be more closely related to absolute magnitudes than to spectral types; that is, the brighter stars are the more massive. This result is in accordance with Prof. Russell's view that only the more massive stars can attain great luminosity in the course of their evolution.

THE SPECTRUM OF $\alpha$ CANUM VENATICORUM.—It was discovered by Belopolsky a few years ago that certain lines in the spectrum of $\alpha$ Canum Venaticorum were alternately visible and invisible, and the same observer found later that such lines could be arranged in two groups. In a brief report in *Popular Astronomy* (vol. xxv., p. 656) it is stated that the spectrum has been further investigated at the Detroit Observatory by Mr. C. C. Kiess, who has obtained sixty-seven photographs, and has determined the wave-lengths of more than two hundred faint lines. The star is classed as Ap. Belopolsky's groups have been verified and added to, and the lines have been respectively identified with those of europium and terbium. Many of the lines not definitely recognised as being of variable intensity have further been found to agree with the stronger lines of yttrium, lanthanum, gadolinium, and dysprosium. The peculiarities of the spectrum thus appear to arise from the exceptional development of lines belonging to rare earths. It may be added that the presence of europium lines in this spectrum was first detected by Mr. Baxandall, of the Solar Physics Observatory, Cambridge.

THE SOCIETY FOR PRACTICAL ASTRONOMY.—The annual report of the president of this society for 1916–17 is included in the *Monthly Register*, vol. ix., No. 2 (1338 Madison Park, Chicago, Ill.). The chief purpose of the society is to promote the practical study of astronomical phenomena, and to encourage co-operation among its members through the various observing sections which have been organised. A section for the teaching of astronomy, under the direction of Dr. Mary E. Bird, appears to have been especially successful. There is also a section for the construction of astronomical instruments, which is directed by Prof. M. F. Fullan, who is contributing a valuable series of articles on the construction of a Newtonian reflector, from the grinding and figuring of the mirror to the actual mounting of the telescope.

## BUTTER SUBSTITUTES.

THE present shortage of fats, especially butter, gives a particular interest to two papers published by the Society of Chemical Industry. The first, printed in the Journal for October 31 last, is by Dr. A. Lauder and Mr. T. W. Fagan, who experimented on the utilisation of fatty acids for feeding purposes. The large increase in glycerol manufacture for explosives has resulted in the production of a quantity of fatty acids much in excess of what can ordinarily be utilised. According to the view now held of the digestion of fat in the animal organism, there does not seem to be any physiological reason why it should not assimilate free fatty acids. In the authors' experiments ten young pigs (about seven weeks old) were fed, the first five on a mixture of maize meal and sharps, the remaining five on a smaller ration of the meal and sharps mixture, together with a small quantity of the fatty acids from coconut oil. About 5 oz. of the fatty acids replaced 1 lb. of the meals. In addition to the above rations, a certain quantity of cabbage was given to the pigs. The results showed that the increases in the live weights of the two lots of pigs when the experiment had lasted for seven weeks were practically identical. The conclusion is drawn that the fatty acids were assimilated, and that they replaced about two and a half times their weight of carbohydrate.

The second paper, published in the issue of December 15, by Mr. W. Clayton, deals with "Modern Margarine Technology." The first butter substitute was prepared at the time of the Franco-Prussian War by Mège-Mouriès, who digested animal fat with sodium carbonate solution in the presence of pepsin (from pig or sheep stomach), the product being afterwards churned with 10 per cent. of cow's milk and water containing macerated cow's udder. In modern margarine manufacture the fat is no longer artificially digested with pepsin, whilst animal fat is more and more being replaced by vegetable oils (coconut, palm-kernel, cotton-seed, arachis, soja-bean, sesame, kapok, maize, and wheat), and by hardened or hydrogenated oil. It has been established that the very small quantity of nickel which remains in the hydrogenated oil is quite harmless. In the preparation of margarine milk is used for two primary reasons: first for flavouring purposes, and secondly as an emulsifying agent. The milk is pasteurised by heating at 82° C. for a few minutes (a possible improvement would be to sterilise it by means of ultra-violet light or a high-tension alternating current), cooled to 10° C., and delivered into souring tanks. In the latter it is inoculated with lactic acid bacilli and the temperature then raised to the point favourable to lactic fermentation. When the fermentation has proceeded so far that the acidity causes a rapid precipitation of curd the milk is again cooled to a safe inhibiting temperature. The mixture of vegetable and animal fats and oils is melted, strained, and brought to a suitable temperature (best 25° C.–35° C.). It is then run into a churn containing the prepared milk (the milk is sometimes added to the oil, but then emulsification is not so good), and the mixture emulsified by the action of revolving baffle-plates. The emulsion is allowed to flow on to a slanting shoot, where it meets a spray of ice-cold water. This causes immediate solidification and a breaking up of the mass into yellow granules. These granules, after draining, are kept at a constant temperature in a maturing room, where the bacteria introduced by the milk can develop. Maturing takes longest in the case of the best animal margarines. When mature the product is kneaded to form a coherent butter-like mass and to expel the excess of moisture, and then passes to the blending department, where it is prepared for sale. Boric acid (not exceeding 0·5 per cent.) is generally added as a preservative. Lactic fermentation imparts to the milk a pleasant acid taste, but does not give it the true butter flavour. Much research will be necessary before margarine can be made with a taste like that of butter.

E. H.

## SEA-PENS OF THE "SIBOGA" EXPEDITION.[1]

THE Pennatulacea of the *Siboga* expedition—the richest collection of sea-pens made by a single expedition—comprise about 550 specimens, which Prof. Hickson has referred to seventeen genera and forty-five species (seventeen new). Having at his disposal this wealth of material, and other specimens in his own collection and in that of the University of Manchester, Prof. Hickson has taken the opportunity of making a thorough survey and revision of the order. He regards the order as consisting of only a few well-marked generic groups, and considers that new generic names should not be introduced without very strong reason. No new generic name is proposed in this memoir, and several recently described genera have been merged in older ones. Prof. Hickson carefully defines the descriptive terms employed in his memoir in the hope that henceforward there may be a greater measure of uniformity in the terminology; certainly he has set a high standard of precision in the systematic descriptions.

In the course of interesting speculations on the hypothetical ancestor and the evolution of sea-pens, Prof. Hickson says he is inclined to believe that Cavernularia is nearer the ancestral form—which he suggests was a dimorphic Alcyonacean similar in build to *Sarcophytum trochiforme*—than Lituaria, which Prof. Kükenthal considered to be the most primitive sea-pen.

Pennatulacea were obtained by the expedition from sixty-five of the 322 collecting stations, and the names

[1] "The Pennatulacea of the *Siboga* Expedition, with a General Survey of the Order." By Prof. S. J. Hickson. Pp. x+265+plates x+1 chart. (Leyden: E. J. Brill, 1916.) Price 13.50 francs.

of the species are printed on a large chart adjacent to the stations at which they were collected. Prof. Hickson directs attention to the rich harvest of sea-pens gathered around Amboyna, the Banda and Kei Islands, and off the south coast of Timor and Flores, and concludes that the Malayan region is the headquarters of the genera Pteroeides and Virgularia. He remarks that, although there is not sufficient information in regard to other genera to justify a similar conclusion, the facts as they stand are in accordance with the view that the Malay Archipelago is, or has been, a distributing centre of the Pennatulacea of the world. Of special interest from the point of view of geographical distribution is the occurrence of the following, all deep-sea forms: *Chunella gracillima*, previously known from the east coast of Africa; the genus Gyrophyllum, hitherto recorded only from the North Atlantic; and five species of Umbellula.

Anatomical and histological investigations have been made on a number of interesting points, *e.g.* (i) the ciliated radial canals, found throughout the rachis of Virgularia, which Prof. Hickson suggests are concerned with the flow of water into and distension of the colony; (ii) the large mesozooids of *Pennatula murrayi*, the structure of which indicates that they bring about rapid expulsion of water from the principal canals; (iii) the brown ciliated tubes of this species; and (iv) the gonads—all the species examined proved to be diœcious and oviparous.

Useful keys are given to the families, genera, and species, and the memoir is illustrated by ten plates and forty-five text-figures.

Prof. Hickson is to be warmly congratulated on the completion of this important memoir, which is characterised throughout by great care and sound judgment.

## EXPERIMENTAL HYDRAULICS.[1]

THE small amount of evidence, which many engineers are willing to accept as satisfactory proof of some principle or empiricism used in connection with their designing, is sometimes surprising to those who combine, with engineering experience, knowledge of the more refined and rigid methods of scientific inquiry. Perhaps there is no more striking evidence of this than in connection with the formulæ used by engineers, in perfect faith, to determine the flow of water over weirs and through orifices and nozzles.

Very frequently in experimental work there is a want of precision in the results, owing to lack of appreciation of what might be called the persistence of hydraulic disturbance. In our technical colleges apparatus which is supposed to compare the loss of head in certain lengths of pipes of different form, and certainly measures something, but not that which the designer intended, is not infrequently used by students.

It is to be regretted that so little attention has been paid in this country to precise experimental hydraulics; but because of that we are so much the more indebted to those workers who, in France and the United States, have added to our experimental knowledge of this important subject.

The modern universities of the United States are issuing from their experimental stations many interesting Bulletins describing the results of special researches, and Bulletin 96 of the University of Illinois, though not by any means ambitious, is yet of sufficient importance to receive a passing notice in the columns of NATURE. It describes experiments on the effect of fixing mouthpieces of different shapes on a discharge through a short drowned pipe. The apparatus is described, and the coefficients of discharge for a six-inch short pipe without mouthpieces at either end, and with the inlet projecting and not projecting inwards respectively, as well as for different combinations of mouthpieces at inlet and outlet, are given. A bibliography of the subject is attached to the paper.

[1] "The Effect of Mouthpieces on the Flow of Water through a Submerged Short Pipe." By F. B. Seely. Bulletin No. 96. (University of Illinois.)

## ASTRONOMICAL CONSEQUENCES OF THE ELECTRICAL THEORY OF MATTER.[1]

CERTAIN complications have recently been introduced into theoretical physics or physical philosophy which, though not of immediate application to engineering, should have an interest for all educated people.

The doctrine of relativity is based essentially on two negative experiments. One of these was conducted by me at Liverpool, and is fully recorded in the Philosophical Transactions of the Royal Society for 1893 and 1894. The outcome of the experiment is to show that the velocity of light is not affected in the neighbourhood of rapidly moving matter; thus, in language appropriate to æther, implying that the æther is stationary in space and cannot be carried along by moving matter; that there is no viscous or frictional drag between matter and æther. The other and more famous experiment is that of Michelson and Morley, which proves that the time of a light-journey to and fro between points fixed to the earth is not affected by azimuth; which therefore appears to imply that the earth is not moving freely through the æther, as the first experiment requires, but that the adjacent æther is stagnant with respect to the earth's surface, as if a layer of some thickness were fully carried along with the earth in its motion through space.

(I must here say that this is a conclusion which, if admitted, would involve many difficulties, and would complicate the relation between æther and matter amazingly.)

The two experiments are thus contradictory, suggesting that the wording of the conclusion in terms of æther may be wrong; and inasmuch as all experiments on the æther have so far given negative results except when there was some movement of matter relative to matter, a doctrine of relativity has arisen which begins by postulating that such experiments always will give negative results, that the properties of an æther can never be ascertained, that things go on as if space were empty, that movement of matter has no meaning except with reference to other matter, and hence that in all probability the æther does not exist. I ought perhaps to make it clear that I myself do not hold this doctrine; but on that subject I have expressed my own position in my British Association address, published by Messrs. Dent and Sons under the title "Continuity."

How the velocity of light, which is an undeniable and metrical fact, can thus be understood or systematised, without a medium possessed of definite physical properties, seems to conservative physicists a substantial difficulty at the outset. Nevertheless, they are willing to admit that questions directly addressed to the æther have always received negative replies: always except once—the measurement of the finite and definite velocity of light, both in free space and in transparent matter. Beyond this, the three salient optical phenomena—viz. the Bradley aberration, the Fizeau convection, and the Doppler change of frequency—all involve motion of matter relative to matter.

[1] Abridgment of a lecture delivered to the student-members of the Institution of Electrical Engineers on November 23, 1917, by Sir Oliver Lodge, F.R.S.

To get either aberration or Doppler effect the receiver must move relatively to the source; to get the Fizeau drift there must be a material medium transmitting the light, and that medium must be in motion with respect to both source and receiver.

We must admit, however, that if the æther is to be sustained as a reality, some way out of the contradiction of the two experiments first cited must be found. Such a way out was suggested by G. F. FitzGerald, and shortly afterwards independently by Prof. H. A. Lorentz. It consists in supposing that the shape of bodies is slightly dependent on their motion, so that a sphere moving through the æther in the direction of its polar axis becomes an oblate spheroid with a contracted axis, or a slightly swollen equator, or both. Such a change of shape, if applicable to all matter without exception, would be, ordinarily speaking, undiscoverable, but would account for the negative result of the Michelson experiment without any appeal to the principle of relativity or any abandonment of the æther of space; for the to-and-fro journey along the line of motion could then be considered shortened by the requisite amount, so that the time taken by light to travel in what for brevity we may call the axial direction (nothing to do with the axis of the earth) need be no longer than that taken to travel equatorially, in spite of its having to go in one case against and with the stream, and in the other case across it.

Thus with this special hypothesis the Michelson-Morley observation would be justified, even though the æther were streaming at full speed past the earth, no part of it being carried along with that body, entirely in accordance with the first experiment above cited. This would have the incidental advantage of rendering the theory of Bradleyan aberration quite simple and straightforward, and it would help us to begin to understand the relationship between æther and matter.

The amount of longitudinal contraction necessary is very small; the two-hundred-millionth part of the relevant dimension would suffice, a fraction corresponding with only $2\frac{1}{2}$ inches in the diameter of the earth; and Lorentz showed that on the electrical theory of matter such a contraction was quantitatively to be expected,[2] viz. an amount $\sqrt{\left(1-\frac{v^2}{c^2}\right)}$.

*The Electrical Theory of Matter.*

The electrical theory of matter took its rise about 1881 in some brilliant work of Sir J. J. Thomson, who showed that an electrical charge conferred on the body possessing it a slight extra inertia in excess of its ordinary mass.

The electric inertia thus gained by a sphere of radius $a$ charged with quantity $e$ was

$$\frac{2\mu e^2}{3a};$$

though this, when interpreted in micrograms, seemed hopelessly too small for any possibility of observation.

The extra, or electrical, inertia was due to the magnetic field excited by the motion of the charge, and was of the nature of self-induction; it reacted against acceleration or any change of velocity quite in accordance with Lenz's law. The magnitude of this inertia depends on the concentration of the lines of force, or, as we may express it, on the potential of the charge, and is proportional to its potential energy. The potential is $e/\kappa a$; the energy is half the charge × the potential; so the expression for the inertia may be written as the static energy of the charge multiplied by $4/3c^2$, where $c$ is the velocity of light. Hence the obvious smallness of the result.[3]

Some time later, viz. in 1887, Mr. Oliver Heaviside calculated that this electric inertia was not precisely constant, but must be a function of speed, and gave an expression for it at any velocity, incidentally showing that it tended asymptotically to an infinite value at the velocity of light.

Then Sir Joseph Larmor showed that the FitzGerald-Lorentz contraction corresponds with this extra inertia, by an increased concentration of the electric lines of force to the equator of a moving sphere, when by reason of motion it becomes deformed into an oblate spheroid.

All this, however interesting, seemed rather academic and without probable realisation in practice, until in 1899 Sir J. J. Thomson isolated the unit electric charge and discovered that it could exist apart from matter, and was of excessively minute bulk even when compared with a single atom.

The apparently insignificant expression, $2\mu e^2/3a$, now came into prominence, for the small size of an electron would mean excessive concentration of the lines close to the centre of force, and therefore a perceptible amount of inertia, even though the charge itself were small. The inertia of electrons was actually measured by ingenious vacuum experiments.

The inertia of light-emitting particles was also measurable, by aid of the Zeeman effect, and was found to be the same; and many other measurements of electric mass were made and found consistent.

Later, as we know, the speed of extra quick-moving electrons was measured, and their predicted extra inertia at high speed was verified and found to be correctly accounted for by electrical theory, on the assumption that their whole mass was electrical.[4]

Hence the speculation became reasonable that possibly there was no inertia in existence other than electric inertia, and that the electromagnetic phenomenon with which we had been familiar ever since Faraday and Maxwell, and had known for a long time as *self-induction*, was truly the basis of all inertia, and might be held to account for, and partly to explain, the most fundamental property of matter.

Thereupon arose various semi-astronomical speculations as to the nature or structure of an atom, the most probable of which at the present day assumes a central positively charged nucleus, of possibly complicated structure, surrounded by an equal opposite group of negative electrons revolving with intense rapidity in regular orbits and subject to various known kinds of perturbation, the number of electrons per atom in any given instance being determined by the numerical position of the substance in the chemical series of elements.

Assuming, then, that the familiar mechanical inertia of all matter is wholly electrical, we may summarise results by saying that when stationary in the æther its mass is the sum of terms like

$$m_0 = 2\mu e^2/3a,$$

but that when moving with velocity $v$, bearing a cer-

[2] In my British Association address "Continuity" I indicate a preference for a slightly modified change of this kind (see pp. 58 and 111), whereby the volume of a moving spherical unit remains unchanged, the polar axis shortening $\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{3}}$, while the two equatorial axes, *i.e.* those perpendicular to the motion, lengthen $\left(1-\frac{v}{c^2}\right)^{+\frac{1}{6}}$. This does all that is necessary, and evades some difficulties. It is, on the whole, sustained by some experiments of Bucherer.

[3] For example, a sphere 40 centimetres in diameter, charged to a potential of, say, 300,000 volts, would have an electrostatic energy of ten million ergs, and an electrical inertia, or extra mass due to its charge, of $\frac{1\cdot33\times10^7}{9\times10^{20}}=\frac{1}{7}\times10^{-13}$ gram, or the seventy-thousand-millionth part of a milligram.

[4] See Sir J. J. Thomson's interpretation of Kaufmann's results, as given, for instance, in "Conduction of Electricity through Gases," p. 535; or in my book on "Electrons," p. 134.

tain ratio to the velocity of light $c$, each of these terms becomes

$$m=m_0\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}=m_0 \sec\beta,$$

where $\sin\beta$ represents[5] the ratio $v/c$.

*Astronomical Applications.*

Since inertia is a function of speed, it becomes a question whether some astronomical perturbations may not thus be produced and accounted for. This problem I attacked in the *Philosophical Magazine* for August, 1917. It is true that the motion of planets is slow compared with the speed of light, but it is immensely quicker than that of cannon-balls or of any artificial movement that we can cause on earth. Moreover, the effects, if any, may perhaps turn out to be cumulative, and it is well known that the position of planets has now been observed for some centuries with prodigious accuracy.

The quickest moving planet is Mercury, and since it makes four journeys round the sun every year, there is some reasonable chance of perceptible accumulation of small effects in a moderate time. Now there is known to be an interesting historical outstanding discrepancy in the motion of Mercury which the theory of gravitation fails to explain.

The orbit of any planet or satellite subject to a perturbing cause, such as the attraction of a third body, was shown by Newton to rotate in its own plane, the position of its perihelion changing slightly at each revolution. In most cases gravitation can account for the whole of this progress of perihelion; but the orbit of Mercury had been by careful measurement proved to revolve some forty or, more carefully estimated, forty-three seconds of arc per century more than could be accounted for by any known gravitative perturbation. It is not much, but it is reckoned unmistakable—no one questions the fact—and many attempts have been made to explain it.

Leverrier invented an intra-mercurial planet, Vulcan, to account for this progress of the perihelion of Mercury's orbit; but no such imaginary planet has ever been seen. Other astronomers have surmised that the law of gravitation might be slightly inaccurate; or, again, that the force of gravity travelled at a finite speed. Recently Einstein has applied the theory of relativity to the problem, and by extremely complex reasoning has arrived at the required result.

It remains to see whether without any of those efforts the straightforward and simple electrical theory of matter cannot account for the observed progression.

Hitherto the attempt has been made to tamper with the force acting on the planet; we now leave the force alone and tamper with the planet's inertia, as increased by its motion through the æther, and varied by any variations in that motion.

The whole solar system is known to be travelling among the stars; and sometimes the motion of a planet as it revolves round the sun will agree in direction with a component of the solar drift, while at other times—*i.e.* in the other half of its orbit—the planet's orbital motion and a component of the solar drift will be in opposite directions. Thus the absolute or resultant speed of the planet through the æther will vary, and hence, on the electrical theory of matter, its effective inertia will vary too.

It remains only to calculate what the effect of this varying inertia will be, given any reasonable value for the sun's true motion through the æther of space.

The resultant speed of the planet is to be reckoned as

$$\sqrt{(v^2+V^2+2vV\cos\phi)},$$

where $\phi$ is the angle made by its motion $v$, at any instant, with V, the solar drift. This last has a component $\theta$ in the plane of the orbit, such that $\cos\phi=\cos\lambda\cos\theta$, $\theta$ being the longitude and $\lambda$ the latitude of the sun's true way referred to the direction of the orbital motion $v$. So, expressing mass as a function of velocity in the ordinary equation of particle dynamics for any central force,

$$\frac{d^2u}{d\theta^2}+u=\frac{F/m}{h^2u^2},$$

where $u$ is written for $1/r$ in ordinary polar co-ordinates, the mass will depend on phase, and will be found to contain a factor $1+\cos\theta$.

Introducing this factor due to varying inertia into the above differential equation, I found it to take a form familiar to electricians, viz.:

$$\ddot{x}+\kappa\dot{x}+n^2x=E\cos pt,$$

or, rather, a special case of this, with $\kappa=0$ and $n=p$. In other words, it represents the case when free and forced vibrations are of exactly the same period, and undamped; it is the equation of perfect resonance. The solution accordingly shows a steadily increasing amplitude, without limit, as time goes on,

$$x=\frac{E}{2n}t\,.\,\sin nt.$$

In the same way the astronomical problem exhibits accumulation or resonance as regards progress of perihelion, the perturbation being essentially synchronous with the phases of orbital revolution; and accordingly after the lapse of, say, a century, the minute perturbation due to fluctuating inertia, even though so small as one-tenth of a second per revolution, may have accumulated in the course of a century to the still small, but very perceptible, value of forty-three seconds of arc. Moreover, the kind of perturbation caused by fluctuating inertia, as expressed by the equation worked out in the August, 1917, *Phil. Mag.*, turns out to be exactly the kind of perturbation required, viz. a revolution of the orbit in its own plane; and it will be of the right value provided the true or real solar drift has a component equal to twice the earth's orbital velocity in a direction parallel to the minor axis of the planet's orbit.

The progress of perihelion of a planet's orbit, after $n$ revolutions, comes out, according to this simple theory,

$$d\varpi=\frac{\pi nvV\cos\Phi}{ec^2},$$

where $v$ is the average speed of the planet, and $e$ the small eccentricity of its orbit; the unknown solar drift is V, in a direction making an angle $\Phi$ with the minor axis of the orbit; and $c$ is the velocity of light.

Assuming a drift of the above value, such as is required for Mercury, I proceeded to try its effect on Mars, and, as is shown in the August *Phil. Mag.*, found that it caused Mars's perihelion to revolve seven seconds of arc per century; which, I learn, is considered by astronomers to be the outstanding discrepancy for Mars.

[5] When velocity is constant, as it is during purely transverse or centripetal acceleration, the effective or transverse inertia is simply $m_0\sec\beta$, being greater than the slow speed or rest inertia in the inverse ratio $\sqrt{\left(1-\frac{v^2}{c^2}\right)}$, as stated above; but when velocity is increasing or decreasing by reason of a longitudinal force, we can write the conditions thus:

$$v=c\sin\beta$$
$$m=m_0\sec\beta$$
$$mv=m_0c\tan\beta$$
$$\text{and } F=\frac{d(mv)}{dt}=m_0c\sec^2\beta.\frac{d\beta}{dt}$$
$$=m_0\sec^3\beta.\frac{dv}{dt}$$

so that high-speed longitudinal inertia is $m_0\sec^3\beta$, and is greater than the slow speed or rest inertia in the ratio $\sec^3\beta$, or, what is the same thing,

$$\left(1-\frac{v^2}{c^2}\right)^{-\frac{3}{2}};$$

and is also, curiously, greater than the transverse inertia at the same speed, in the ratio $\sec^2\beta$.

Prof. Eddington, however, in succeeding issues of the *Phil. Mag.* (September and October, 1917), has now applied my theory to the Earth and Venus, and shown that according to it either their orbits must revolve, or their eccentricities must be affected, to an extent small indeed, but greater than is astronomically allowable. Also that there will be unpermissible variations of eccentricity for Mercury and Mars. Hence the whole matter is *sub judice*, and the last word has not been spoken.

*Conclusion.*

Finally, it is necessary to say that this astronomical application of the electrical theory of matter—at any rate as given here—assumes that the extra or spurious inertia due to motion is not subject to gravity. If it is a portion of the true mass, and as much subject to gravitational pull as all the rest of the inertia, then it would seem that there should be no perturbation at all,[6] for weight and mass will be still accurately proportional.

But certain analogies suggest to me that in all probability the part of inertia dependent on motion is due to æthereal reaction and is not likely to add to the body's weight.

Until we have some theory as to the nature of gravity we cannot definitely pronounce on such a point, though meanwhile the success or otherwise of the above astronomical application may tend to bear some testimony on this very point. If the calculated perturbation does not exist, it may mean either that the inertia of matter does not vary with speed as electrical theory predicts, or else that every kind of inertia, however caused, is fully subject to gravity, which in itself would be a momentous conclusion. In that case (I may say incidentally) the deflection of a ray of starlight grazing the sun or other large body is decidedly to be expected, the deflection being probably $2gR/c^2$; where the $g$ and R are solar.

We must, however, anticipate that if the ultimate conclusion does turn out negative, and if, taking all the planets into consideration, no such set of perturbations as is here foreshadowed can be really allowed, it will be claimed as one more negative answer returned by the æther. And we must regretfully admit that every negative answer tends (at least temporarily) to strengthen the apparently growing faith in that complex and perturbing view of the relation between space and time and matter which is known as the Principle of Relativity.

6 I have since seen reason to modify this at first sight obvious opinion, and have more to say on this subject; probably in the *Philosophical Magazine* for February, 1918.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Two Theresa Seessel research fellowships, to promote original research in biological studies, are offered in competition by Yale University. The fellowships are open to men or women, and each is of the value of 200*l.* Applications, accompanied by letters of recommendation, reprints of scientific publications, and a statement of the particular problem which the candidate is prepared to investigate, should reach the Dean of the Graduate School, New Haven, Conn., U.S.A., before April 1 next.

THE City Council of Rome has nominated a committee for the formation in Rome of an "Elementary School of Industrial Chemistry," with the view of "improving existing education on the subject and to arrange for new courses of instruction in this modern industry, which may have a great future in our city." The committee, according to *L'Economista d'Italia* for January 1, has already commenced work, and hopes to be able to conclude its deliberations during January, so that at the end of the present school year the school can begin its courses and take part at once in the professional culture of the Rome working classes and preparations for the after-war campaign in the city.

THE annual meeting of the Mathematical Association was held on January 9 and 10. In his presidential address on "Mathematics and Individuality," Prof. T. P. Nunn maintained that the development of individuality is the only natural and reasonable ideal in education. He pleaded for much greater freedom for boys and girls in choosing both the distribution of their time and the lines along which their energies should be directed. The function of the teacher should be to "stand by," giving help in the form of guidance and advice, and, where necessary, teaching. This teaching should be partly collective as now, but to a large extent it should be given to individuals, or at least to small groups of pupils. In this way boys and girls, free to follow their own bent and to give scope to their natural impulses towards knowledge, would not only find much greater vividness and reality in their school work, but each of them would also be prepared to make later that unique contribution which he alone can make to the variegated whole of human life. Such freedom to each to make the best of his life in his own way is the source of all higher goods; education can accept no lower, and can find no higher, aim. In a newly constituted "advanced section" Dr. W. P. Milne read a paper on "The Graphical Treatment of Power Series." He urged, in teaching higher algebra, both the use of graphical and intuitional methods and the application of the calculus. Principal Hatton raised the question of the omission of mathematics from Section A of the new scheme for Class I. of the Civil Service Examination. After some discussion it was agreed to ask the Commissioners to add the words "and mathematics" to the title of subject 4 ("The general principles, methods, and applications of science") and to double the number of marks assigned to that subject.

A RECENT issue of the *Educational Supplement of the Times* included a translation of an article published in the Berlin *Lokalanzeiger* describing how the German working classes in particular would be reduced to a wretched condition if Germany were to lose this war, or even if it were to be obliged to conclude a peace of renunciation. That, the article urges, is not only applicable to the economic position of the German working classes, it may also be said to the same extent of the intellectual development of the masses of the people. That they will be the most severely affected if Germany is obliged to bear alone the burdens of war will clearly appear from a retrospect of what Germany has achieved until now in regard to popular education. The total financial needs of the German States amounted in 1910, apart from the expenses on behalf of the Imperial Army and the Navy, to about 150,000,000*l.*; 13·8 per cent. of this was expended for science and instruction, 8·9 per cent. on schools alone, and 7·1 per cent. on the people's schools. In 1911 the German States and municipalities raised together nearly 44,000,000*l.* for the schools, of which 33,500,000*l.* was for the benefit of the people's schools alone. That means, the article states, that in Germany per head of the population 13*s.* was expended, in England 8*s.*, and in France 7*s.* "If in Germany until now more than 50,000,000*l.* was spent yearly exclusively for educational purposes, the question arises, the German writer continues, if these achievements in future will be possible in the event of a peace of renunciation. Anyone able to make a cool calculation must answer promptly in the negative. Certainly even in that case we should not collapse if we had to bear our war burdens alone; but as to this one should be under no illusion—we should then have to economise everywhere for these purposes, whether we liked it or not, in order at least to maintain our present rate of development."

EDUCATION (No. 2) Bill was introduced by Mr. Fisher in the House of Commons on January 14, and read a first time. In explaining the new measure, Mr. Fisher said:—"The Bill which I now introduce is substantially identical with the measure familiar to the House. It imposes upon the councils of counties and county boroughs the duty of providing for all forms of education. It abolishes exemptions from school attendance between five and fourteen years of age. It provides for further restrictions upon the industrial employment of children during the elementary-school age, and for the gradual introduction of a system of compulsory day continuation classes for adolescents. In the new Bill, as in the old one, local education authorities are empowered to give assistance to nursery schools, and in other ways to help the physical and social welfare of the children committed to their charge. Indeed, attention to physical welfare is a special and distinctive note of both Bills. On the other hand, I have either omitted or amended certain of the administrative clauses." Clause 5, which provided for provincial associations, is omitted, and provisions are embodied in Clause 6 which will facilitate the federation of local education authorities for certain purposes, which was the governing principle of Clause 5. Some alterations have been made in the clauses dealing with the attendance at continuation classes and at nursery schools, and also in the clause dealing with the abolition of fees. Mr. Fisher added:—"A White Paper will be circulated so that hon. members may be able to see clearly the changes of substance introduced. I hope it will be recognised that the adoption of this course will facilitate the expeditious discussion of the Bill in Committee. I hope that as the result of the consultations and discussions which I have held with the local education authorities during the last few months, a large portion of the measure which might otherwise give rise to acrid debate may be taken as substantially agreed upon."

## SOCIETIES AND ACADEMIES.

### LONDON.

**Röntgen Society,** January 1.—Capt. G. W. C. Kaye, president, in the chair.—Dr. W. D. **Coolidge**: A "radiator" type of X-ray tube. The anticathode consists of a block of copper faced with a small button of tungsten. This is fixed to a thick stem of copper which passes out through the glass neck of the tube and terminates in a fin radiator. The anticathode is thus kept cool and does not in consequence emit electrons, as in the case of the earlier type of Coolidge tube in which the whole of the anode speedily becomes red-hot. The new tube, therefore, so completely rectifies current that when an alternating potential is applied the current will only pass in one direction.—Dr. W. D. **Coolidge** and C. N. **Moore**: The field X-ray outfit of the United States Army. A petrol-electric unit supplies alternating current at 110 volts to a transformer arranged to give both high-tension and heating currents for the new radiator type of Coolidge tube. For simplicity of control the tube is worked at a constant potential of 5 in. equivalent spark-gap, and the current is adjusted to 5 milliamperes for continuous running of the tube or to 10 milliamperes for short periods. An electrically actuated control on the throttle of the engine maintains constant output. The small size of the bulb, 3½ in. in diameter, enables a close-fitting lead-glass shield to be employed. This is made in two parts, and completely surrounds the tube, a suitable aperture permitting egress of the useful rays.

**Optical Society,** January 10.—Prof. F. Cheshire, president, in the chair.—F. E. **Lamplough** and Miss J. M. **Mathews**: Relative dispersion and achromatism. The paper contained an account of an inquiry into the extent of the relation between the irrationality of dispersion in glasses and the mean dispersion and dispersive power. The work consisted chiefly in the reduction of observations made by Lt.-Col. J. W. Gifford on the refractive indices of thirteen spectral lines for thirty glasses. The results showed the absence of any accurate relations. It was found that in general the type of dispersion of a glass is determined by its dispersive power, but with a few special glasses mostly requiring protection an improvement could be effected on the achromatism secured by ordinary glasses of similar dispersive power. The problem of the triple objective was referred to.—J. **Guild**: A spherometer of precision. The chief feature of this instrument is the method employed for detecting the exact contact between the micrometer screw and the surface under test. The micrometer terminates in a small sphere of about 1·5 mm. diameter. A microscope with a suitable illuminating apparatus is mounted above, and the Newton's rings surrounding the point of contact are observed. By watching the behaviour of the rings when the screw is brought up, the exact point of contact is determined. The sensitivity is about one ten-thousandth of a millimetre.

### PARIS.

**Academy of Sciences,** December 24, 1917.—M. Paul Appell in the chair.—A. **Lacroix**: The forms of the leucitic magma of the Lazial volcano. Fourteen complete chemical analyses of the various minerals are given, and the results are compared with those obtained from the rocks of the Somma.—Y. **Delage**: The mesorheometer, an instrument for measuring the velocity of water currents intermediate between the surface and the sea-floor. The special point of the apparatus described is a contrivance for damping the effects due to the oscillation of the boat.—G. A. **Boulenger**: The marine origin of the genus Salmo. A reply to some objections of Louis Roule.—M. G. Friedel was elected a correspondant for the section of mineralogy in the place of the late M. Vasseur.—G. H. **Hardy** and J. E. **Littlewood**: The convergence of Fourier's series and Taylor's series.—M. **Guillet**: Measurement of the intensity of the field of gravity. Galileo's pendulum and Newton's tube. Some advantages are claimed for Newton's tube over the pendulum, and details are given of the best construction of the former apparatus.—Mme. E. **Chandon**: A determination with the prism astrolabe of the latitude of Paris Observatory. The mean of the determinations is $48^\circ\ 50'\ 11{\cdot}21''$. This compares with $48^\circ\ 50'\ 11{\cdot}07''$, the mean furnished by several instruments between 1851 and 1892, and $48^\circ\ 50'\ 11{\cdot}3''$, a more recent determination (1899 to 1901) with the meridian circle.—A. **Veronnet**: The law of densities inside a gaseous mass. A study of the density curve of a star considered as wholly gaseous.—V. **Schaffers**: The sound of cannon at a great distance.—H. **Hubert**: The use of the stereoscope for the examination of superposed projections.—E. **Chéneveau**: A relation between the refractive properties and chemical constitution of fatty substances.—G. **Fouqué**: The separation of the secondary amines arising from the catalytic hydrogenation of aniline. The crude mixture to be separated contains *cyclo*hexylamine, di*cyclo*hexylamine, *cyclo*-hexylaniline, diphenylamine, and some secondary products, benzene, *cyclo*hexane, and tar. A scheme is given for the separation and isolation of the above amines.—G. F. **Dollfus**: Geological observations made in the neighbourhood of Honfleur (Calvados).—L. **Dunayer** and G. **Reboul**: The diurnal variations of the wind in altitude.—C. **Gessard**: An erythrogenic variety of the pyocyanic bacillus.—M. **Belin**: A new method of general chemicotherapy: oxidotherapy. A description of results obtained by the injection of solutions of potassium permanganate in tetanus, typhoid fever, acute rheumatism, and other diseases.

PETROGRAD.

**Academy of Sciences**, September 13, 1917.—E. E. **Kostyleva**: The forms of corrosion of topaz crystals from Šajtanka (Oural).—N. N. **Adelung**: Contributions to our knowledge of the Palæarctic Blattoidea. II.: Supplementary notes on *Ectobiella duskei*, Adel.—A. P. **Semenov-Tian-Šanskij**: Preliminary synopsis of the Mydaidæ of the Russian fauna (Diptera).—V. K. **Soldatov**: New genus of Zoarcidæ—Gymnelopsis, n.gen., and *G. ocellatus, G. brashnikovi, Lycenchelis armatus*, nn.spp., from the Okhotsk Sea.—N. M. **Krylov** and Ja. D. **Tamarkin**: The method of W. Ritz for the approximate solution of problems of mathematical physics.—P. P. **Lazarev**: The laws of transitory illumination of the retina in peripheral vision.—A. **Bačinskij**: Molecular fields and their extent.—M. **Kasterin**: The inconsistency of Einstein's principle of relativity.—N. V. **Nasonov**: The fauna of the Turbellaria of Finland.—I. N. **Filipĭev**: Instructions for collecting free-living nematodes.—V. N. **Ipatĭev** and V. **Verchovskij**: The solution of zinc in hydrochloric acid under high pressure.

## *BOOKS RECEIVED.*

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. iv., part 2. (Sydney: W. A. Gullick.) 2*s*. 6*d*.

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series C. Zoology and Botany. Vol. iv., part 2. Cephalopoda. By S. S. Berry. Vol v., part 1. Arachnida from Macquarie Island. By W. J. Rainbow. (Adelaide: R. E. E. Rogers.) 1*s*. and 3*s*. 6*d*. respectively.

A Short Course in Elementary Mathematics and their Application to Wireless Telegraphy. By S. J. Willis. Pp. 182. (London: Wireless Press, Ltd.) 3*s*. 6*d*. net.

Britain's Heritage of Science. By A. Schuster and A. E. Shipley. Pp. xv+334+illustrations. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net.

The Linacre Lecture on the Law of the Heart. By Prof. E. H. Starling. Pp. 27. (London: Longmans and Co.) 1*s*. 6*d*. net.

## DIARY OF SOCIETIES.

*THURSDAY*, JANUARY 17.

LINNEAN SOCIETY, at 5.—(1) Restoration of the Head of Osteolepis; (2) Femur of Pterodactyl from the Stonesfield Slate: E. S. Goodrich.—Some Early Cape Botanists: J. Britten.—A Hybrid Stachys: C. E. Salmon.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—The Incidence of Taxation upon Metalliferous Mining in the British Isles: H. Louis.—Molybdenum in Norway: E. R. Woakes.

MATHEMATICAL SOCIETY, at 5.—A Method or Studying any Convergent Series: Major P. A. MacMahon.—Additional Note on Dirichlet's Divisor Problem: G. H. Hardy.—Note on a Diophantine Inequality: J. H. Grace.—Supernormal Curves: C. H. Forsyth.—A Note on a Theorem of Mr. Hardy's: K. Amanda Ran.—Plane Quartic Curves with a Tacnode: Prof. H. Hilton and Miss D. S. Tuck.

CHEMICAL SOCIETY, at 8.—The Synthesis of Ammonia at High Temperatures: E. B. Maxted.—Interactions of Formaldehyde with Urea: A. E. Dixon.—The Colouring Matters of Camwood, Barwood, and Sanderswood: P. O'Neill and A. G. Perkin.—Studies on the Walden Inversion. VII. The Influence of the Solvent on the Sign of the Product in the Conversion of β-Phenyl-α-bromopropionic Acid to β-Phenyl-α-aminopropionic Acid (Phenylalanine): G. Senter, H. D. K. Drew, and G. H. Martin.—Pure Piperidine Nitrate: A. K. Macbeth.—The Chemistry of Slightly Soluble Compounds of Thorium, as Investigated by Radio-active Methods: W. T. Spizine.

ROYAL SOCIETY OF ARTS, at 4.30.—The Tata Iron and Steel Works: H. M. Surtees Tuckwell.

*FRIDAY*, JANUARY 18.

ROYAL INSTITUTION, at 5.30.—Studies on Liquid Films: Sir James Dewar.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Traction on Bad Roads or Land: L. A. Legros.—Utility of Motor Tractors for Tillage Purposes: A. Amos.

*SATURDAY*, JANUARY 19.

ROYAL INSTITUTION, at 3.—The Chemical Action of Light: Prof. W. J. Pope.

*MONDAY*, JANUARY 21

ARISTOTELIAN SOCIETY, at 8.—The Category of Action in Indian Philosophy and its Value for Modern Thinking: Dr. F. W. Thomas.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—*Discussion*: Study of a Dune Belt: W. J. Harding King.

ROYAL SOCIETY OF ARTS, at 4.30.—High-temperature Processes and Products: C. R. Darling.

*TUESDAY*, JANUARY 22.

ROYAL INSTITUTION, at 3.—Palestine and Mesopotamia: Prof. Flinders Petrie.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—*Further Discussion*: Rail-creep: F. Reeves.—Creep of Rails: H. P. Miles.

*WEDNESDAY*, JANUARY 23.

GEOLOGICAL SOCIETY, at 5.30.

ROYAL SOCIETY OF ARTS, at 4.30.—Water Power in Great Britain (with Special Reference to Scotland); Its Amount and Economic Value: Alexander Newlands.

*THURSDAY*, JANUARY 24.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Graphical Solution for High-angle Fire: Prof. A. N. Whitehead.—Flocculation: Spencer Pickering.—Revolving Fluid in the Atmosphere: Dr. J. Aitken.—Ultra-violet Transparency of the Lower Atmosphere and its Relative Poverty in Ozone: Hon. R. J. Strutt.—The Pressure in the Solar Spectrum of the Water-vapour Band λ 3064: Prof. A. Fowler.—The Ultra-violet Band of Ammonia and its Occurrence in the Solar Spectrum: Prof. A. Fowler and C. C. L. Gregory.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Telephone Exchange Transfers and their Organisation: F. G. C. Baldwin.

*FRIDAY*, JANUARY 25.

ROYAL INSTITUTION, at 5.30.—The Motion of Electrons in Gases: Prof. J. S. Townsend.

*SATURDAY*, JANUARY 26.

ROYAL INSTITUTION, at 3.—The Chemical Action of Light: Prof. W. J. Pope.

## CONTENTS.




*Editorial and Publishing Offices:*
MACMILLAN AND CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

*Advertisements and business letters to be addressed to the Publishers.*

*Editorial Communications to the Editor.*

*Telegraphic Address:* PHUSIS, LONDON.
*Telephone Number:* GERRARD 8830.