NATURE

SATURDAY, MARCH 9, 1929.

CONTENTS.

Land and Industry.

THE very heavy imports of foodstuffs into Great Britain and the urgent need for increasing the home production of food have been emphasised with wearisome iteration these many years past. A study of the trade returns for 1928 shows clearly enough that the position in this respect is getting worse. But our dependence on other countries to save us from starvation is only one part of the story. There are many other collateral factors of vital consequence. For example, it is not well that nine-tenths of our population should be entirely urban, completely exiled from the land, and wholly bereft of any land interest whatever. We may not all agree with what Mr. Galsworthy says about 'town blight,' but no one who has seriously thought about the matter, no one who has any appreciation of the teaching of history, can doubt that this entire exclusion from the land and all that it means is a potent source of national weakness, or at least of national one-sidedness.

Then, again, there is the vitally important question of leisure and its proper use. This has been hitherto a little neglected by economists, and yet, with the comparatively short hours of work now in vogue, it is a matter of the utmost moral and economic significance ; the more so, in view of the increasing monotony of the greater part of the factory and office work of to-day, and mainly carried on indoors. These considerations point to the supreme need for a more natural and outdoor form of recreative work, such as would be provided by a land interest, as a powerful antidote to the present indoor monotony of work and the general artificiality of town life. The national love of outdoor sport, if sufficient facilities could be provided for its adequate expression and exercise, may be thought sufficient mitigation. But always there are more spectators than players, and we believe that there are many of both sexes and of all ages to whom some kind of land interest would make a more powerful appeal, and would certainly prove more useful and economically stronger. It is a pity that the allotment movement of the War period has not been more vigorously continued and extended since. It was a great deal better than nothing, though far from being the best thing of its kind that could be provided. The national housing programme offered the opportunity for something vastly better. That opportunity has been missed so far.

In fact, despite the very obvious and rather

disconcerting factors in our modern industrial civilisation noted above, very little has been done, at all events in Great Britain, where it is perhaps more urgently needed than in any other country, to counteract what must be described, without exaggeration, as a serious social evil. We have had, it is true, much talk of 'back to the land,' really a fatuous and useless shibboleth in England; many acres of small-holding legislation, for the most part derelict and only applicable to a small minority; and endless discussion of agricultural policies leading to little or nothing.

We shall never be a nation of peasant proprietors despite the panegyrics of Mill, Sismondi, and others on that very admirable ideal; and therefore it might be advisable to look for something else, less drastic and complete, but more practicable, let us hope. The suggestion has been made not infrequently in recent years that a partial return to the land would be the best, a part time recreative interest rather than a whole time occupation. It would be merely a modified and improved form of industry-cum-agriculture which largely characterised our economic structure in pre-industrial days, when the Lancashire weavers had their little farms and the Sheffield cutlers were noted for their culture of flowers. To-day it is a prominent feature in the United States of America, in Canada and other British dominions overseas, in many parts of Europe, and is struggling to make some headway in Great Britain, where, as already intimated, it is more urgently needed than anywhere. It means the provision of homes or homesteads worth the name, with gardens and perhaps even orchards and greenhouses, embodying not only the primeval need of shelter but also the still more primeval need of food.

So far from being original and novel, this idea goes back to Babylonian times. Within the mighty walls of that ancient city were sheltered fields and gardens to provide food in time of siege, and indeed at all times. Some day the same imperative need may be ours; and we should make provision in time. A great deal has already been done along these lines in other countries, especially in the United States, and to some extent on the Continent. It is strange indeed that the need for this sort of thing has been more clearly realised in the United States, where there is no preponderating town population and no 80 per cent dependence on foreign food; but it has been adopted over there not so much from the point of view of food supply but rather as a refreshing counter-current to modern artificiality and rush. It is a profitable hobby too, healthy, and absorbingly interesting. In the case of the smaller holdings of industrial workers, from a quarter-acre to one or more acres in extent, it is possible to pay the greater part of the rent—or, better still, the mortgage interest and sinking fund—from the garden and orchard produce, or, what comes to the same thing, save equivalent expenditure on vegetables and fruit for the home. This would appear to be a very sound financial basis on which to establish any housing policy; and there, too, is the right solution of the leisure or 'dopo lavoro' problem as it is called in Italy.

Italy has taken up the 'dopo lavoro' (after-work) or leisure question with enthusiasm in conjunction with home food supply. It came up before the International Labour Conference at Geneva in 1924, but was discussed in Italian labour and commercial journals long before that date. In Germany the great firm of Krupps some years ago purchased estates and farms for the production of food for its employees, many of whom became the proud owners of small holdings. It is scarcely necessary to point out here that no shrewder blow could be struck at communism and general labour unrest than such a policy as this. The ownership of a little bit of one's own country is surely the safest guarantee for sound and sober citizenship and real patriotism, and gives a man something to do other than listening to street corner oratory. Several firms in Germany and Austria have followed the example of Krupps. The municipality of Vienna has based its extensive housing schemes largely on this principle of ownership and land settlement. It seems, indeed, to be the only common-sense principle on which to base any housing programme, except blocks of flats or tenements to replace slums; and possibly even this exception is not often valid. The subject presents many and varied openings and ramifications. It has an important bearing on unemployment, emigration, and land settlement.

So far, only one form of combining industry and agriculture, farm and factory, has been considered. There is not space to deal with the converse form, that of giving the agricultural worker an industrial or rather a manufacturing interest, in the form of village and cottage industries and handicrafts. This is another chapter, and is a well-known economic feature in India, also in Switzerland, Norway, and elsewhere. It is being taken up in Canada, for example, in Quebec, where the need for some occupation in bad weather and during the dark days of winter is very evident. In these and other ways a people may be made to work harder

without knowing it; or, knowing it, they enjoy it. It is doubtful if, in the sterner, strenuous, and fiercely competitive days ahead—if they have not already arrived—we can much longer afford to neglect this vital matter of using even our leisure to the best purpose. At least greater opportunity for such could be afforded, and is within the range of practical politics.

The question of leisure occupation for those already in work, important as it is, almost fades into insignificance, however, beside the greater question of unemployment. So far as the programmes of the chief political parties have been revealed in view of the coming election, there does not appear to be anything refreshingly original or practically effective in contemplation to deal with this great evil; and it is not, of course, pretended in this article that the suggestions herein tentatively offered contain anything very helpful by way of remedy or mitigation. It is, however, firmly believed that a vast field of employment could be opened up along the lines of land settlement, land reclamation, village industries, combined with industrial enterprise, possibly a programme somewhat similar to that adopted for the Greek refugees.

It is not possible here to go fully into this part of the subject, except to say that the land interest—allotment, small holding, or the like—could be more effectively provided in garden cities, industrial villages, and so forth, where new industries could be established, than in or near existing industrial centres where little or no land is available. In any event, the new derating concessions should be a great help in establishing industrial small holdings; and the extent to which such holdings are already used by those engaged in other occupations is revealed by a recent study of small-holding economics in one county alone, for example, Carmarthen. Nearly fifty per cent of all holdings under fifty acres are occupied by persons with non-agricultural employments, representing nearly every trade and profession; miners, general labourers, carpenters, butchers, and grocers being the chief. We are glad to know in this connexion that in some districts in South Wales, where allotments have gone out of cultivation on account of inability to pay rent for them, or purchase seeds or manures, the Society of Friends is successfully reviving allotment holdings and providing facilities for unemployed miners to work them for the production of food. There could be no better use for grants from the Central Coalfields Distress Fund, in suitable districts, than to encourage work on the land in this way.

Reform of the British Patent System.

IT is clear from statements which have been made in the House of Commons during the past few months that a serious state of affairs exists at the Patent Office. On July 18, 1928, Mr. Herbert Williams stated, in answer to a question, that 6300 complete specifications were awaiting first action by the examiner and that these arrears were accumulating at the rate of 67 per week. On Feb. 26 last, in answer to a further question, he stated that the arrears now amounted to 8400 complete specifications and were increasing at the rate of 76 per week. Since about 20,000 complete specifications are filed annually, the work is therefore just over five months in arrear on the average.

Figures given by Mr. Williams in July indicate that while the number of specifications to be dealt with annually had increased by 26 per cent as compared with 1912, the strength of the examining staff had decreased by 10 per cent. This economy, at a time when the Patent Office obtains a large and increasing surplus of fees over expenditure, appears to be most unjustifiable. The present critical state of affairs could have been foreseen and provided against some years ago, for the input of patent applications has been steadily increasing since patent business became normal after the War. The public has a right to know why such steps were not taken in good time. Did the Comptroller of the Patent Office fail to warn the Minister or did the Minister fail to heed his warnings? Or is it that, as in the case of certain other technical departments, there is interposed between the Minister and the technical chief a body of administrative officials who fail to appreciate technical requirements?

Last October an important report on the reforms which are needed in the British patent system was published by the British Science Guild. This report met with an enthusiastic reception from the financial, technical, and daily press, and we understand that it has received the formal support of a number of important bodies. Asked whether the Board of Trade proposed to take any action in this connexion, Mr. Herbert Williams stated on Feb. 26 that the President of the Board proposed to set up a committee in due course to review existing patent law and practice.

While the British Science Guild Committee may be congratulated on this promise of a result arising from its labours, some disappointment will be felt at the absence of any indication that the matter will be carried through expeditiously.

Letters to the Editor.

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Soft X-Rays from Crystal Faces.

THESE experiments originated in an attempt to improve and extend those of Richardson and Chalklin on the generation of soft X-rays from surfaces of tungsten formed by deposition *in vacuo* on carbon (*Proc. Roy. Soc.*, A, **119**, p. 71; 1928). In that investigation difficulties were met with owing to the deposition of impurities on the carbon target by the bombarding process necessary to secure the requisite high vacuum. To avoid this difficulty we made a target like two doors folded together on a hinge. We could bombard this target with the doors shut, and then open it out and so make the X-ray tests on the inner surface which had been heated but not exposed to the residual gases in the tube.

The tests are made by measuring the photoelectric current generated by the soft X-rays when they fall on a nickel plate, dividing this by the primary thermionic current, plotting the fraction so obtained against the exciting voltage, and looking for discontinuous changes of slope in the resulting curves. On making this experiment we were surprised to find a large number of discontinuities extending all over the range from 20 to 560 volts. These discontinuities are mostly well defined and quite persistent, and they repeated with a second target made from a specimen of spectroscopically pure arc carbon kindly supplied to us by Dr. R. C. Johnson. In this case the carbon was so soft that the hinge could not be made, and the surface of the target was protected during bombardment by a sliding shutter made from the same carbon.

In the hope of simplifying the problem, we decided to try experiments in which the X-rays were generated by bombarding a single crystal face of crystalline carbon. Through the kindness of Prof. W. T. Gordon we were able to obtain a diamond with a large natural face and some large pieces of natural crystalline graphite. Unfortunately, the diamond was found to be unsuitable for the experiment, as an attempt to determine its electrical resistance showed it to be immeasurably high. This would suggest that little confidence can be placed in the results of Lukirsky (*Zeits. für Physik*, **22**, p. 351; 1924) which were made with this substance. A repetition of his experiments with the substitution of graphite carbon for diamond in this laboratory by Miss L. P. Davies led only to data which were very difficult to interpret, and, furthermore, his results are incapable of reconciliation with the very reliable conclusions of Rudberg (*Proc. Roy. Soc.*, A, **120**, p. 385; 1928).

After some trials we were able to split off a piece of graphite with a surface large enough to be suitable for testing. The surface used was that at which natural graphite cleaves most easily (the 0001 plane). On testing the graphite surface between about 70 and 320 volts, seventeen discontinuities have been found, each of which either agrees with a value or with the mean of two values a few volts apart, found previously with carbon. Fifteen discontinuities which were present in this range with the carbon target are absent with the graphite target. It should be added that the surface used was by no means perfect, so that it is possible that a still further reduction in the number of discontinuities might be effected if a more perfect surface could be obtained. From these experiments there seems no doubt that the number of discontinuities from a single crystal surface is smaller than from a polycrystalline surface. It is satisfactory to note that the K level discontinuity is not one of those which disappears.

We should be grateful to any readers of NATURE who could supply us with any specimens of conducting crystals suitable for these experiments. The materials must be capable of withstanding a bright red heat *in vacuo*.

O. W. RICHARDSON.
U. ANDREWES.

King's College,
Strand, W.C.2.

Soft X-Rays from a Single Nickel Crystal.

AT the suggestion of Prof. O. W. Richardson, an investigation was made on the excitation of soft X-rays from a single crystal of nickel, kindly lent by Dr. H. H. Potter, of the University of Bristol. The face chosen was the [100] face and the range of potential was from 0 to 300 volts. The experiment was conducted with an all-quartz tube similar to the one used by Richardson and Chalklin (*Proc. Roy. Soc.*, A, **110**, p. 247; 1926). Curves were drawn between the applied potential and the energy of the soft X-ray excited as measured by the usual photoelectric method. When the bombarding current was maintained at about 1·5 milliamperes, definite and strong inflections appeared at 63·8, 72·2, 106·2, and 116·0 volts. A very weak inflection was also noted at 94·4 volts. No other inflections were obtained. If, however, the thermionic current was increased to about 3 milliamperes, there appeared also, besides the four strong ones noted above, weak inflections at 129·0, 144·8, 155·9, 179·9, 186·0, and 217·7 volts (all of which appear in the results of Thomas for nickel), while the inflection at 94·4 volts became stronger.

As could be seen from the published microphotograph of the surface of a nickel crystal by Davisson and Germer (*Phy. Rev.*, II. **30**, p. 710; 1927), it is very difficult to obtain an ideally crystalline surface over an area of as much as 12 mm. × 6 mm. (the area used in these experiments), and there are bound to be some irregularities on the surface. It looks, therefore, very probable that when an ideal crystal surface is used only four inflections appear, these being at 63·8, 72·2, 106·2, and 116·0 volts. The first two can be associated with transitions from the $M_{II,III}$ level in the nickel atom, 63·8 volts representing the energy necessary to shift an electron from that level to the periphery of the atom and 72·2 representing the energy necessary to remove the electron altogether from the atom. The emission data of Thoraeus (*Phil. Mag.*, vii. 2·2, p. 1007; 1926) gives for the $M_{II,III}$ level the value of 73·2 volts. In the same manner, the values 106·2 and 116·0 volts may be associated with similar transitions from the M_I level, the energy of which is 112·4 volts according to the same authority.

It is well known that when a metal target (non-crystalline) is heated strongly by electronic bombardment, the surface looks altered, probably because of the formation of small metallic crystals. These crystals may in some manner be the origin of the large number of inflections observed by recent investigators. Further, it would be interesting to determine the effect of a crystal surface on the secondary emission of electrons, since Prof. Richardson has shown that there is a close similarity between the excitation of soft X-rays and the emission of secondary electrons (*Proc. Roy. Soc.*, A, **119**, p. 531; 1928). Farnsworth (*Phy. Rev.*, II. **31**, p. 419; 1928) has

already reported that the characteristic secondary electron emission inflections from a crystal surface are different from those of ordinary metals between 0 and 40 volts. It is proposed to repeat the soft X-ray experiments with other crystals, as also to investigate the secondary electron emission from crystals further at higher potentials. My sincere thanks are due to Prof. Richardson for his kind help and encouragement, and to Dr. H. H. Potter for the crystal of nickel.

S. RAMACHANDRA RAO.

Wheatstone Laboratory,
King's College, London, W.C.2,
Jan. 29.

Incoherent Scattering.

THERE are several surprising peculiarities of the phenomena of modification of wave-length in scattering, but the most striking is the rareness with which one is able to find an infra-red line to fit even approximately the frequency shifts observed. On the other hand, there are many strong infra-red lines which have no corresponding frequency shift. Moreover, there is scarcely any direct correlation of intensity even when there is a supposed match in frequency.

The idea suggested by Smekal that a molecule may subtract from or add to an incident quantum one of its characteristic energy quanta and scatter the resultant sum or difference in a single quantum is so neat and clear that it is accepted as the explanation of the scattering experiments of Raman and Krishnan and others. The most important characteristics of such a process are those just indicated which are not realised in the experiments.

Kramer's and Heisenberg's correspondence principle treatment is much more successful in accounting for the facts, and Schrödinger's wave mechanics gives an almost identical result, formally, which is on closer inspection in even better accord with experiment. The wave theory for the scattering of light of frequency ν by a system excited in two of its characteristic states—let us call them k and l—leads to terms incoherent with the incident radiation of frequencies $\nu_{kl} \pm \nu$ and with intensities proportional to the square of the quantities

$$A_{kn}A_{ln}\left[\frac{1}{\nu_{kn} \pm \nu} + \frac{1}{\nu_{ln} \mp \nu}\right](\nu_{kl} \pm \nu)^2.$$

The upper signs or the lower signs are used throughout. The A_{kn}, for example, is the matrix element $\int x\psi_k\psi_n dx$, which describes the intensity of the transition between states k and n, giving out radiation of frequency $\nu_{kn} = \nu_k - \nu_n = \dfrac{E_k - E_n}{h}$.

We see that the modified frequencies $\nu_{kl} \pm \nu$ differ from the incident ν, not by absorption frequencies (although these may also appear) but by differences between these. That is to say, only when two allowed transitions (*i.e.* A_{kn} and A_{ln} different from zero) have a common level (n) is there any intensity in the scattered frequencies $\nu_{kl} \pm \nu = \pm(\nu_{kn} - \nu_{ln}) \pm \nu$.

Examination of the data shows that the frequency shifts in scattered light can be interpreted in this way. The case of carbon tetrachloride is not the most striking, but it is perhaps the simplest which has so far been tried. Only two out of five frequency shifts coincide with known infra-red lines. These two correspond perhaps to the weakest shifted lines, while the infra-red lines are the strongest. The intensity formula indicates that the strongest frequency shifts should correspond to the frequency differences between the strongest fundamentals and the other fundamentals which end on the same level. This rule suggested the energy diagram (Fig. 1). It is believed to contain elements of reality, but should not be considered as a final and complete picture. The numbers along the full vertical lines are wave numbers of the infra-red lines due to transition indicated. The numbers by the dotted lines are the differences between levels joined, and indicate frequency shifts to be expected in scattered light. The one of 27 wave numbers would be too close to the exciting line to be observed. The others were obtained from grating and prism plates, and are probably correct to a couple of wave numbers.

The test of the theory is to compare the wave-lengths calculated from this diagram with those observed. The infra-red data are from J. Lecomte, "Le Spectre infrarouge," p. 213, and the references there given. The table gives the wave-lengths which are directly connected with the frequency shifts. All the other known lines are faint, and with one exception

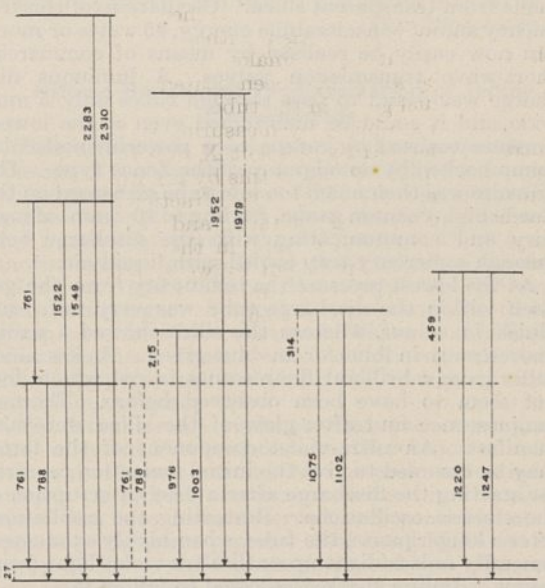

FIG. 1.

of much shorter and more uncertain wave-length. The exception is the weak line observed by Marvin at 15 μ. Its interpretation is not yet definite. The others are explicable as overtones or combinations of the levels shown. In fact, just those combinations appear which, according to the wave theory, indicate the possibility of the modified lines actually observed.

TABLE.

Calc. (μ)	13·14	12·69	10·24	9·97	9·30	9·07	8·20	8·02	6·57	6·46
Obs. (μ)	13·10	12·72	10·23	9·96	9·3	9·07	8·26	8·02	6·57	6·45

The agreement is in every case well within the experimental latitude. The significance and power of the scattering experiments in unravelling infra-red spectra is very much greater than if they merely checked infra-red measurements. With their help and with more precise infra-red data it may be hoped that the vibrations of complex molecules will be interpreted. A beginning will be made in a fuller account of this work.

R. M. LANGER
(National Research Fellow).

Bureau of Standards,
Washington, D.C.,
Jan. 4.

Luminous Discharge in Gases at Low Pressure.

CONSIDERING the very minute quantities of matter required for a luminous discharge in gases at low pressures excited by electric oscillations of high frequency, this method would seem to be specially adapted for spectroscopic tests for the products from atomic disintegration, spontaneous as well as artificial. Experiments to this end were started some time ago in the Institut für Radiumforschung of Vienna and have recently been carried further in this Institute. The following phenomena, which appear to be of general interest, were observed.

In order to make the discharge pass through narrower tubes and in gases of still lower pressure than what appears to have been feasible in the experiments of Kirchner, Gill and Donaldson, and others, oscillations of still higher frequency, 10^8 cycles per second, were applied to electrodeless discharge tubes made from transparent silica. Oscillations of this frequency and of considerabble energy, 45 watts or more, can now easily be realised by means of commercial short-wave transmission valves. A luminous discharge was found to pass through tubes only 5 mm. wide, and it could be maintained even at the lowest pressure realised by means of a powerful molecular pump backed by an oil pump of the Zenco type. The pressure was then much too low to be measured on the Gaede high-vacuum gauge, reading to 10^{-5} mm. of mercury and communicating with the discharge tube through a mercury trap cooled with liquid air.

At the lowest pressure the luminosity from the gas itself within the discharge tube was very faint and bluish in colour, whereas the silica showed a strong fluorescence in blue or in blue-green. A few silica tubes gave a brilliant fluorescence in red which does not seem to have been observed before. Thermoluminescence and after-glow of the silica were also manifest. An ultra-violet component of the latter may be assumed to give the initial ionisation required for starting the discharge after a brief interruption of the electric oscillations. Restarting the oscillations after a longer pause, the tube, when highly exhausted, generally fails to light up until ultra-violet light from, say, a cadmium spark, is allowed to fall on it.

On passing the discharge through the exhausted tube when disconnected from the pump, a curious phenomenon was observed. The luminosity rapidly increases, and from a faint blue glow takes on a white hue of increasing brightness, the manometer at the same time showing a considerable rise in pressure. Adsorbed gases cannot be held responsible for the effect, which remains unabated when the pump has been running for several hours, and is also unaffected by baking out the discharge tube for more than an hour at 600° C. in an electric furnace. The production of gas goes on at a rate of about 1 c. mm. N.T.P. per minute at very low pressure, and is noticeable even after the pressure has increased to several hundredths of a millimetre of mercury.

The only possible explanation of this phenomenon seems to be that silica is decomposed, releasing oxygen, under the action of the electric oscillations, or rather by ultra-violet light of very short wave-length generated at the discharge. Whether the active rays are the strong emission lines of oxygen itself in the far Lyman region will have to be settled by means of a vacuum spectrograph. Light transmissible through silica seems to be ineffective, since no sensible rise of pressure was noticed when the exhausted discharge tube with the oscillations off was exposed for more than one hour to the intense light from a quartz mercury lamp close to it.

The above explanation is in agreement with the results from recent observations by Gillam and Morton (*Phil. Mag.*, p. 1123, December 1928), who found the general decrease with age in the emission from quartz mercury lamps to be due to a deposit of silicon over the inside of the walls, caused by decomposition of the silica. Anyhow, my experiments prove that the presence of mercury vapour is not essential for the effect. Also, judging from the relative magnitude of the effect in both cases, one would infer that the light from the oscillating discharge is much richer in active components than the mercury light.

The light emitted from the self-generated gas was examined in the visible region by spectroscope and spectrograph, and also, in the ultra-violet, by a medium-sized quartz spectrograph, the plates showing that its spectrum is rich in strong bands, especially in the ultra-violet. Oxygen, from permanganate of potassium, when introduced into the discharge tube, gave a different light of yellow colour with a different and much fainter band spectrum which, however, very soon merged into that of the self-generated gas and took on its white colour. The explanation was found by applying a tuft of cotton-wool soaked in liquid air to the tip of the discharge tube, when the white light disappeared and was replaced by the yellow oxygen light, the manometer showing a progressive fall of pressure. On removing the liquid air the beautiful snow-white light reappeared and the pressure rose, but only by about two-thirds of the previous reduction. This proves that the oxygen, under the action of the oscillations, is more or less completely transformed into ozone, which gas is condensed at − 190°, the vapour pressure being at that temperature only a few thousandths of a millimetre of mercury. The spectrum from the white light of the self-generated gas, which is identical with that from the ozonised oxygen, must therefore represent the band spectrum of ozone with a few sharp lines from elementary oxygen superimposed. By means of a larger quartz spectrograph this band spectrum has now been resolved into characteristic groups of lines, which are at present being examined. The fluorescent and chemical effects of the 'active' radiation assumed to exist within the discharge tube will be further studied.

This method of excitation seems to be particularly adapted for the study of band spectra, whereas for the purpose mentioned at the beginning of this letter, the steady production of oxygen within the discharge tube remains a serious complication. Possibly this effect may be a contributory cause of the softening of deep-therapy Röntgen tubes and of transmission valves.

HANS PETTERSSON.

Lunds Fysiska Institution,
January.

Solutions and Heat Engines.

IN Dr. Holmyard's informed and charming review, under the title "The Theory of Atoms," in NATURE of Feb. 16, the statement is made that Hellas bequeathed to civilisation the priceless gift of logical deduction but lacked the spirit of modern science. "Everything," said Thales, "is full of gods."

The motive power of modern experimental science, without doubt, is a certain spirit but so highly diluted that it is not easily discerned: the atmosphere is so befogged with gods. The jesuitical notice, following Dr. Holmyard's, by an anonymous reviewer of Dr. Haldane's book on "Gases and Liquids," is an exemplification of this thesis. A certain school has long elected to worship van't Hoff—nothing that is said will lead its members to examine the premises of their deity's osmotic doctrine (hypothesis). Being

disputed, it cannot be called a theory. The reviewer altogether disregards Dr. Haldane's contention that the solvent has been neglected and only the solute considered. Van't Hoff never thought in terms of water: his was a purely thermodynamic mind. The hypothesis *is* inherently unintelligible. The late Prof. FitzGerald said so long ago. There is no proof of bombardment by the solute molecules; the tendency is more and more to admit that the solute molecules, whatever their form, are anchored to the solvent: scarcely a preparation for ballistic exercise. Whence does the bombardment come in the Perrin experiment, in which only water and very minute resinous particles are in interaction?

Worship is part of our nature: a faith once imposed is all but fixed: we scarcely ever ask ourselves whether the gods held up to us be false or not. Hellas may have bequeathed to us the gift of logical deduction—it in no way follows that we have learnt to use the gift. However much of so-called science there may be in us, it is rarely in us to be scientific. The main difficulty in dealing with problems of solutions comes from the tendency to take mathematical expressions too seriously and absolutely and greatly to overrate their value: to treat them as if they had a sacred meaning rather than as devices for wrapping up and obscuring meaning. We need to get rid of gods and to put more of the holy ghost into our musings, so that they be made with method. I agree with Dr. Haldane, that in this matter of osmotic pressure we have but "engaged in idolatrous worship of ununderstood equations." In any case, the discussion of such problems should be open, not anonymous: anonymous attack should not be permissible in our society.

HENRY E. ARMSTRONG.

MAY I inquire from Prof. Armstrong whether it is jesuitical to ask Dr. Haldane to consider what the effect of the bombardment of the solute molecules will be even if I hope that his answer may, after all, be favourable to van't Hoff? Moreover, as Prof. Armstrong wishes to enter the arena, may I ask him also to consider the same question? That there is bombardment is not a subject for question unless we are prepared to give up the dynamical theory of matter. Prof. Armstrong asks, somewhat sceptically, whence the bombardment comes in the Perrin experiment. Surely what Perrin achieved was to show *visibly* that the dynamical theory is true. The particles *are* in rapid motion, and are frequently colliding, and each collision produces its expected dynamical effect. That there is bombardment is not merely a happy hypothesis; it is an observed fact. It cannot be explained away by the assertion that it is 'unintelligible.'

Prof. Armstrong, however, in spite of the evidence of his senses—for I presume he has seen Brownian motion, though perhaps he has not himself experimented with it quantitatively—wishes to ignore its effect, and suggests instead that the solute molecules are anchored to the solvent. I challenge him to show how a pressure can arise from such attachments. He must bear in mind that when there is equilibrium between the liquids on the two sides of an osmotic membrane, the solution is at a higher *external* pressure (that is the fact which is directly observed), and that attractions between molecules always act to reduce the *external* pressure.

Physical chemists do not ignore the solvent. It assists in certain cases to break up the solute molecules; and especially in strong solutions it has a great modifying influence, so that a simple 'gas' calculation is quite insufficient. We need not be surprised at this, because similar modifications are produced in gases at high pressure.

Prof. Armstrong holds strong beliefs on these questions. I urge him to put them into logical form so that others may be led into the right path. Those of us who have read his papers find no rational theory there from which osmotic pressure can be calculated. He must remember, however, that forces do not arise out of nothing like gods of ancient mythology. Let him not be afraid of an equation which, after all, is only a somewhat condensed form in which the quantitative results of our thinking can be expressed. It, of course, need not be 'idolatrously worshipped'; and, indeed, it may be dispensed with, though the alternative methods of description are not so compendious. Above all, let him learn that assertion, even when strong, is no adequate substitute for proof.

Again, I ask Prof. Armstrong to join Dr. Haldane and consider the question as to what the effect of the known bombardment of the solute molecules will be when a semi-permeable membrane is provided through which the solvent can flow if it is induced to do so.

THE REVIEWER.

Diffuse Bands and Predissociation of Iodine Monochloride.

THE absorption spectrum of iodine monochloride consists of a group of bands (group Cl*) with an upper convergence limit at about 17430 cm.$^{-1}$ corresponding to the dissociation of ICl into a normal iodine atom and a chlorine atom in the 2^2P_1 state. There is also another group (group I*) of which only two members (17446 cm.$^{-1}$ and 17570 cm.$^{-1}$) were observed by Gibson and Ramsperger. Several further members of this group have since been observed (Gibson: unpublished measurements). These are visible in the region between the convergence and the absorption maximum of the continuum of group Cl*.

We have strong evidence that the convergence limit of group I* corresponds to dissociation of iodine monochloride into normal chlorine and excited iodine atoms. A second continuum farther in the ultra-violet has also been observed and probably corresponds to this same process. The band 17446 cm.$^{-1}$ of group I* shows the fine structure clearly. The rotation lines are sharp near the head, but show a marked increase in width for large rotational quantum numbers. The next following bands of this group are diffuse and fade out in the region of continuous absorption of group Cl*. It seems very likely that this effect is of the same nature as that discovered by Henri and termed predissociation. The place at which the widening of the rotation lines begins in the band 17446 cm.$^{-1}$ corresponds within experimental error to the convergence limit of group Cl*. This suggests strongly that interaction between the Cl* continuum and the discrete states of group I* is responsible for the diffuseness.

A similar assumption has been made by Wentzel to account for the diffuseness of the lines corresponding to the higher terms of the p' series of Ca, and by Bonhoffer and Farkas and by Kronig to account for diffuse band spectra. Kronig has shown that under favourable conditions the life period of a discrete state may be so shortened by the presence of a continuum that it becomes less than the period of rotation, in which case diffuseness may be expected. Calculations were made by us using perturbations of the type considered by Kronig, which arise from the terms in the wave equation neglected in the separation of electronic and nuclear co-ordinates (see *Z. Physik*, **50**, 347; 1928). A formula has been obtained (to be published shortly by Rice) which permits a direct quantitative calculation of the width of the rotation lines when the perturbation matrices are known.

Kronig arrives at two results for the perturbations according as the quantum number n which determines the angular momentum of the electrons about the nuclear axis changes by ± 1 or remains constant in the radiationless transition. In the first case the width of the rotation line varies with the square of the quantum number j, which determines the total angular momentum. In the second case the width of the line is independent of j. Kronig has made rough estimates of the orders of magnitude of the perturbations. Using his estimates, we cannot account for the observed width of the lines of higher rotational quantum number unless we take the first case in which n changes by ± 1 and the width is therefore proportional to j^2. We have reason to believe, however, that n has the same value for group Cl* as for group I*.

It is possible, however, to account for the magnitude of the effect, even in this case, if we take into account the fact that the eigenfunctions are oscillating functions of the co-ordinates. We have made calculations, using Kronig's estimate for the electronic eigenfunctions and making very reasonable assumptions as to the nature of the vibrational eigenfunctions of the two states. The vibrational eigenfunctions are approximately sine curves. It is entirely consistent with what we know of the energy and moment of inertia of the molecule in its two states to suppose that the eigenfunctions have nearly the same wave-length and such a phase relationship as to produce a large effect. The calculations show that perturbations of the type considered by Kronig are then sufficient to account for the observed widths. The effect would be still further enhanced if the electronic eigenfunctions of the two states should coincide in a similar manner, in which case a less complete coincidence for the vibrational eigenfunctions would be sufficient to reproduce the experimental values.

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Effect of Parathyroid Hormone on the Structure of Bone.

IN the current issue of the *Journal of Experimental Medicine* (January 1929), Bauer, Aub, and Albright have reported that the administration of the parathyroid hormone (Parathormone, Eli Lilly), to rabbits over a period of 91 days in doses up to 8 units per diem results in a depletion of the trabeculæ of bone, without gross changes in the cortex. The X-ray plates showed that the bones contained less calcium than those of control animals belonging to the same litter, whilst the blood calcium increased to about 15 mgm. per cent as compared with a normal value of 10 mgm. per cent. In similar experiments with young rats the administration of parathormone did not give a similar result, but rather increased the number of trabeculæ and the density of the bones, whilst the blood calcium did not differ appreciably from that of untreated animals under similar conditions. With cats the results were entirely negative.

All these experiments were carried out with a diet rich in calcium.

It has for some time been recognised that the diseases osteitis fibrosa and osteomalacia are not infrequently associated with tumours or hyperplasias of the parathyroid glands. For example, parathyroid adenomata were found in the case of osteitis fibrosa described in great detail by Dawson and Struthers (1923) in a communication from this laboratory. In another case of the same disease also associated with parathyroid adenomata, more recently investigated from the biochemical point of view by one of us (C. G. L.), a very marked hypercalcæmia (17 mgm. per 100 c.c.) was found, together with a negative calcium balance (see Lambie, *Brit. Med. Jour.*, 1927). It appeared possible that in these cases the primary disturbance was the existence of the parathyroid tumour resulting in an excess production of the hormone over a long period. This would cause the hypercalcæmia, the negative calcium balance, and, presumably, the removal of calcium from the bones.

In order to test this hypothesis it was thought desirable to carry out experiments to ascertain what is in fact the effect of prolonged administration of parathyroid hormone upon the structure or bones. In preliminary experiments carried out with young growing rats, kept on an ordinary diet, in which two were used as controls and two were given 10 units each of parathormone per diem for 21 days, it was found, on histological examination of the bones, that there was marked thinning of the trabeculæ in all the bones examined, especially the femora and vertebræ. In one of the two treated animals changes were also apparent in the cortex and in the epiphyseal cartilages. The bones, when dried, exhibited a greater tendency to fracture than did normal ones, and when ground up showed themselves to be more fibrous in texture. On chemical analysis it was found that the bones of the treated animals gave rise to less ash on ignition, but that the percentage of calcium in the whole bones was not significantly altered. It appears, therefore, that the inorganic ash from the treated animals actually contained more calcium than that of the untreated. This latter finding is puzzling, but may indicate a change in the form in which calcium exists in the bones of the treated animals.

These results confirm the positive findings of Bauer, Aub, and Albright as to the effect of parathyroid hormone upon the structure of bone, and it is hoped that by further experiments on these lines light may be thrown upon the pathogenesis of osteitis fibrosa, osteomalacia, and other bone dystrophies.

Bauer, Aub, and Albright (1929). *Jour. Exper. Med.*, **49**, 145.
Dawson and Struthers (1923). *Edin. Med. Jour.*, **30**, No. 10, 421.
Lambie, C. G. (1927). *Brit. Med. Jour.*, II. (Oct.) 785.

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Edinburgh, Feb. 13.

Spiral Markings on Carborundum Crystals.

IN the course of another investigation, we have had occasion to examine crystals of carborundum under the microscope. These crystals were of very dark purplish colour, with often a greenish sheen. Pure carborundum is said to show little colour, and the deep colour of the crystals of commerce is attributed to a minute quantity of free carbon, which doubtless tends to distort the lattice. Certain of our crystals exhibited, on their smooth hexagonal, basal pinakoid, surfaces, striations formed of numerous curved parallel lines, some thirty or forty microns apart, and roughly equidistant. Such striations have been mentioned in the literature. We were fortunate in finding a crystal face which showed that these markings may form a rather perfect spiral. A photomicrograph of this is reproduced as Fig. 1.

It will be seen that we are here in possession of a very clearly defined fact. Very often in science our theories are sufficiently clear, while the facts are much less so. The opposite is here true.

Three crystalline modifications of carborundum have been described, all of hexagonal symmetry ; and striation by straight parallel lines occurs, and calls for no comment. Spiral forms are very uncommon in inanimate Nature, but may perhaps occur when two types of crystal architecture alternate. That the observed spiral is related to the underlying hexagonal, or di-trigonal, structure may be seen from the slight flattening of the curvatures at azimuths 60° apart. Furthermore, the markings on different crystals have an obvious relation to the margins of the crystals, when these are visible. It may be true that some carborundum crystals have a thin surface coating of silica ; but hydrofluoric acid does not affect the markings we have observed.

FIG. 1.

Not all specimens of carborundum exhibit such striation. This we have ourselves noted ; while Negri, who states that he examined thousands of carborundum crystals with a hand lens and measured about one hundred on the goniometer, makes no mention of surface markings.

At its broadest portions the ' line ' that forms the spiral can, interpreting merely in terms of appearances, be analysed into three lines, two marginal about six or seven microns apart (which may be the margins of a shallow channel or trough), and a third, between them, about two microns from the inside line. The outside line is in parts of its length fringed by outgoing excrescences, which may be of the same nature as the minute lozenge-shaped crystals which the photomicrograph shows lying in parallel orientations 60° apart.

Before venturing to put forward a too imaginative hypothesis, we should be glad to learn what others suggest in interpretation of this unusual phenomenon.

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Polarisation of Compton Scattering according to Dirac's New Relativistic Dynamics.

IN a letter to NATURE of Dec. 1, 1928 (vol. 122, p. 843), I gave a formula for the intensity of the radiation scattered at right angles first by one and then by a second electron. In this formula, unfortunately, no account was taken of the change of frequency of the radiation during the first scattering. When this mistake, which has been kindly pointed out to me by Mr. Chr. Møller, is corrected, the formula in the letter referred to is replaced by

$$I = \frac{e^8}{2m^4c^8r^2r'^2}\,\frac{I_0}{(1+2\alpha)^3}\left\{\sin^2\theta + \frac{\alpha^2(2+4\alpha+3\alpha^2)}{2(1+\alpha)^2(1+2\alpha)}\right\}.$$

Owing to this, the comparison of the theory with the measurements of Lukirsky comes out somewhat differently. Thus, for $\theta = 0°$, the intensity is 5·3 per cent instead of 6·5 per cent of the intensity at 90°, when the wave-length is assumed to be 0·085 A.; and agreement with Lukirsky's result would be obtained with a wave-length of 0·13 A. instead of 0·14 A.

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The Language of Science.

IT has been said yet once again (NATURE, Feb. 2, p. 161) that 1 and 1 are not always 2. With great respect to Sir Oliver Lodge, I would suggest that there is here some confusion, if not of thought, at least of language. In the common use of our language, when we say 1 and 1 make 2, we imply that each unit suffers no change in being added to, or rather associated with, the other. The usual, that is, not the special physical or chemical or biological, meaning of 1 and 1 is 1 + 1, where + stands for "associated with, but involving no change in either." Thus 1 (apple or mercury globule or amœba) and 1 (apple or mercury globule or amœba) *always* make 2 (apples or mercury globules or amœbæ). When, however, in the phrase 1 + 1, the symbol + is distinctly defined to mean (1) reacts physically with, or (2) reacts chemically with, or (3) reacts biologically with, the result, *as experience shows*, need not be 2. For example, 1 + 1 = 1 when + means (1) and the units are mercury globules ; 1 + 1 = 4 when + means (3) and the units are amœbæ. In each of these cases a *change* has taken place, not a mental or an arithmetical addition.

To express any such change by saying simply 1 and 1 are 5 is to misuse our language. To go further, and say 1 and 1 are 2 and sometimes 5, is to confuse both thought and language.

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Hamilton's Contributions to Geometrical Optics.

WE are at present engaged in preparing for the Royal Irish Academy the first volume of a collected edition of the mathematical papers of Sir William Rowan Hamilton. This volume is to contain Hamilton's contributions to geometrical optics.

If any readers of NATURE should happen to be in possession of any mathematical manuscripts written by Hamilton, we would be glad if they would communicate with one of us.

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Feb. 18.

Erratum in Lodge's "Energy."

ON page 65 of numerous early copies of my little sixpenny book on "Energy," published by Messrs. Ernest Benn, Ltd., there is an erroneous reference to page 61, instead of to page 44. My object in making this reference was to call special attention to the apparently mysterious formula $ipq - iqp = h/2\pi$, which I anticipate will loom large in the physics of the future.

OLIVER LODGE.

Aspects of Fossil Botany.

By Dr. D. H. SCOTT, F.R.S.

II. EARLY FLORAS.

DR. CHURCH has reminded us that "the Beginnings of Botany are in the Sea." This is undoubtedly true, whether we accept his hypothesis of a universal ocean, or hold that the surface of the cooling earth was so corrugated that seas and continents co-existed from the first. The Plankton stage, of microscopic, free-swimming organisms, postulated by Dr. Church, has left no trace in the rocks. We have, however, abundant evidence of the early presence of marine plants. Apart from some disputable Cambrian records, we have numerous well-preserved seaweeds from the Ordovician onwards. It is, of course, mainly calcareous Algæ which have lent themselves to fossilisation. The verticillate Siphoneæ, above all, form a fine evolutionary series, admirably investigated by Dr. Julius Pia, of Vienna. Their interest has perhaps scarcely been sufficiently recognised by botanists, though among geologists Prof. Garwood has emphasised the importance of calcareous Algæ as rock-builders. The Siphoneæ, however, form a line of their own, without any relation to the land-flora with which we are now concerned.

At some unknown period the transmigration to dry land took place. If we accept the theory of continents and oceans as equally ancient, it is quite probable that there may have been successive transmigrations. As we shall see, highly organised land-plants occur about contemporaneously with apparently primitive types. Dr. Bidder, in his address to Section D (Zoology) of the British Association in 1927, pointed out the probability of the early appearance of land-organisms. He regarded the occurrence of extensive beds of graphite in pre-Cambrian rocks as evidence of an abundant vegetation in land-locked waters, with every opportunity of migration on to the neighbouring shores. Thus a land-vegetation may have made an early start, and some of the descendants may have persisted among later floras. It is suggested that Hugh Miller's 'cone-bearing tree' of the Middle Devonian may have been such a survival. To quote Dr. Bidder's words: "There may be a class or classes of terrestrial animals or plants which have breathed air two or three times as long as those which left the sea in the Devonian."

We have, however, as yet no perfectly trustworthy record of land-plants earlier than the Lower Devonian. First of all there is the classical, but once disputed, *Psilophyton* of Dawson, with its rhizome, forked aerial stems, bearing thorns but no leaves, and large terminal sporangia. There seems to be little doubt that Dawson's description was essentially correct. The contemporary *Arthrostigma* was like a larger *Psilophyton*.

The oldest known land-plant with well-preserved structure is *Gosslingia breconensis*, recently discovered by Dr. Heard in the Lower Devonian of South Wales. In habit this was something like *Psilophyton*; the branches, as in that genus, had circinate tips. It is a curious fact that circinate venation, often found in these early plants, is older than the frond itself, for it occurs on thalloid branches not yet differentiated as leaves. *Gosslingia* had a well-developed vascular cylinder, considerably larger than in the somewhat later Rhyniaceæ. The wood was evidently developed centripetally, contrary, as it appears, to the direction in the family just mentioned. Stomata were detected, as in the contemporary *Psilophyton*, in which Mr. W. N. Edwards demonstrated them very clearly. The great antiquity of the typical stoma is interesting, but not surprising, for we know that this organ is common to Bryophytes and vascular plants. *Gosslingia* also possessed terminal bodies which are interpreted as sporangia.

It is unnecessary to recapitulate the characters of the Middle Old Red Sandstone Rhyniaceæ, now familiar to botanists. A word may be said as to their relation to the Bryophytes, as indicated chiefly in the somewhat *Sphagnum*-like sporogonium of *Hornea* and Halle's *Sporogonites*. Dr. Church has gone so far as to say that "*Rhynia* and *Hornea* between them present all the characters deduced as significant for early Bryophyta"; and Prof. Bower, with more caution, maintains that "the new facts are thus seen to link the Bryophytes and the Pteridophytes more closely together than ever before." We may accept this latter statement, and then the question arises whether these supposed Devonian intermediates were on the up-grade or the down-grade. Were they on the way to become full-blown Pteridophytes, or in course of reduction to a moss-like level? Here we will only recall Haberlandt's opinion that the mosses were reduced forms. At that time one asked: But reduced from *what*? Possibly the Rhyniaceæ may suggest an answer.

The late Dr. Arber, at a time when only *Rhynia* was known, took a different view, for he thought that this genus represented "a now obsolete race of Thallophyta." He was so far justified that the Rhyniaceæ in their external morphology are no more complex than some purely thalloid seaweeds, such as *Polyides* or *Pycnophycus*. It is an interesting question whether any of the other early fossils suggest an algal connexion. *Hicklingia* of Middle, and *Zosterophyllum* of Lower Old Red Sandstone age, both have a somewhat alga-like habit, and yet were probably (certainly in the latter case) vascular plants. *Pseudosporochnus* (Middle Devonian), the largest of all these plants, probably 10 ft. high, with a bulbous base, thick stem and numerous fine branches, has all the appearance of a big seaweed, but this too was a vascular plant. *Fœrstia furcata*, an Upper Devonian fossil, though fragmentary, combines algal structure with the spores and cuticle of a land-plant. As Kidston and Lang say, it "almost serves to break down any sharp distinction between Algæ and the

simplest Pteridophyta." *Milleria* (formerly *Ptilophyton*), on the other hand, "appears to approach, without reaching, the more definitely fern-like forms that come into evidence in the Upper Devonian" (Lang).

We may now leave these simpler types and pass on to definitely leafy plants, such as the genus *Asteroxylon*. The Rhynie species, *A. Mackiei*, is now well known. It will be remembered that the connexion of the associated sporangia and sporangiophores with the plant has never been proved. The German species, *A. elberfeldense*, of perhaps somewhat later age, serves to remove any doubt, for the plant bore, towards the summit, naked branches, resembling the Rhynie sporangiophores, and in two cases sporangia were found upon them. Kräusel and Weyland's species combined the external features of the form-genera *Thursophyton*, *Psilophyton*, and *Hostimella*. It differs in definite respects from *A. Mackiei*, notably in the apparent presence of a pith in the stele of the main axis. Thus *Asteroxylon* appears really to present the extraordinary combination of characters attributed to it by Kidston and Lang—the anatomy and vegetative habit of a Lycopod, with a reproductive apparatus suggesting that of some of the Carboniferous ferns. Another early plant, looking like a Lycopod, is *Protolepidodendron*, only known by its external features.

Among Kräusel and Weyland's discoveries at Elberfeld, in the Upper Middle Devonian, are the two oldest known Articulatæ, *Hyenia* and *Calamophyton*. The most interesting point is the fructification, which in each case consists of a lax cone, bearing no bracts, but only sporangiophores, which are forked and support pendulous sporangia. The absence of bracts in these 'Protoarticulatæ' supports the view of Lady Isabel Browne that these sterile organs were a later intercalation in the Calamarian cone.

The variety of Early Devonian plants was naturally far greater than the few better-known types here mentioned would indicate. For example, Prof. Lang, in his assiduous investigation of the Old Red Sandstone flora of Scotland, found eight different kinds of spore in the fish-beds of Cromarty. They run up to 400μ in diameter, and some may thus have been megaspores. One type has been identified by Kräusel and Weyland with the spores of the Elberfeld tree-fern *Aneurophyton germanicum*.

Aneurophyton was a tree-fern in habit, but its affinities are quite uncertain. All parts of the plant are known: stem, root, fronds, and, to a certain extent, the fructification. There was much secondary wood, resembling that of *Palæopitys Milleri*. Quite recently the primary wood has been discovered. It was solid and three-lobed in transverse section, recalling that of the Lower Carboniferous genus *Stenomyelon*. It is a remarkable fact that all parts of the frond show stem-structure. Only the ultimate leaflets are regarded as truly foliar; they have no vascular strand at all—hence the generic name. The sporangia are borne in clusters on special leaflets. The plant bears a general resemblance to *Eospermatopteris*, but there is no evidence of seeds. *Palæopitys Milleri* (Middle Old Red of Cromarty), as just mentioned, has somewhat similar wood-structure to that of *Aneurophyton*, but nothing is known of its habit. The structure, while not that of a typical Gymnosperm, is more like a Gymnosperm than anything else, and to that extent may justify the discoverer's bold description of it (in 1847) as a "cone-bearing tree." At any rate it is a highly organised plant to find at so low a horizon.

Returning to the Elberfeld records, we must note the remarkable discovery of a Middle Devonian *Cladoxylon* (*C. scoparium*), the oldest species known, and the only one in which the external habit and something of the fructification are shown. The complex anatomy is exactly that of the well-known species first described by Unger in 1856. The leaves are numerous, small, forked appendages, very different from the large fronds which, on anatomical evidence, appear to have characterised the Thuringian Cladoxylons. It has been suggested by Dr. Hirmer that the genus (following the analogy of *Asteroxylon*) possessed leaves of two categories, the small appendages of the Elberfeld species representing Lygnier's 'phylloids,' while the massive fronds of the later forms were true leaves derived from modified branch-systems. The sporangia of *C. scoparium* were borne on the margins of lobed outgrowths, differing in shape from the vegetative foliage. Nothing was found to support the hypothesis that *Cladoxylon* belonged to the Pteridosperms.

We have, in fact, apart from *Eospermatopteris*, no direct evidence for the occurrence of seed-plants in Devonian times. The leaves of the genus *Psygmophyllum*, which goes back at least to the Middle Devonian, are somewhat like those of the Maidenhair tree, and appear to have belonged to woody plants. One may imagine that we have in them an early race of Gymnosperms, but habit is notoriously deceptive. A fossil found in the Middle Old Red Sandstone of both Orkney and Caithness, named *Hostimella racemosa* by Lang, bears lateral bodies which may be either sporangia or seeds; no spores could be obtained from them, but neither is there any evidence of seed nature.

We now come to *Eospermatopteris*, the tree of the fossil forest of Gilboa in the State of New York. A great flood on the Schoharie Creek exposed five stumps in 1869. They were referred to Sir William Dawson, who named them as two species, *Psaronius erianus* and *P. textilis*. It turned out to be true that the plants were really tree-ferns in habit. In recent years further exposures have revealed hundreds of stumps scattered over a district $1\frac{2}{3}$ miles in length, and occurring at three different levels. The stumps attain a diameter of 3 feet or more. Portions of the stem and large compound fronds of the plants are associated with the rooted stumps. Seeds were first detected by Dr. Ruedemann in 1920. There are numerous specimens associated with fragments of the fronds. They were investigated by Miss Goldring, who has published full and excellent descriptions; to her the name *Eospermatopteris* is due. The seeds are

borne, often in pairs, on stalks; they are about 5-6 mm. long by 3 mm. broad, and are described as cupulate. They appear to be perfectly clear seeds, so far as impressions can show. Male organs, rather large terminal discs, with apparent impressions of sporangia on the lower surface, have also been observed. This, then, is the oldest seed-plant known, for the age is undoubtedly no later than Upper Devonian.

We may now briefly review the results of our rapid survey. Recent research has revealed, in the Early Devonian, vascular plants far simpler in structure than any known before. We can no longer regard these simpler types as reduced, for there are too many of them. With these primitive forms, however, much more advanced types are associated, possibly, as Dr. Bidder suggests, the survivors of an earlier land-flora.

Lignier's theory of the double origin of the leaf, from emergences forming 'phylloids,' on one hand, and from thallus branches forming true leaves, on the other, seems to find strong confirmation from the early flora, as, for example, in *Asteroxylon*. In many cases the circinate tips of thalloid branches clearly indicate incipient fronds.

On the whole, the data now available favour the rise of the land-flora from a well-developed thalloid stock of marine origin, which branched out into the two main Archegoniate lines, the mosses and the ferns.

The Progress of Marine Propulsion.

By Engineer Captain EDGAR C. SMITH, O.B.E., R.N.

NEVER since Fulton launched the *Clermont* or Bell built the *Comet* has there at any time been a fixed or standard type of machinery for all ships. Inventions, improvements, innovations have followed in rapid succession, and the history of marine engineering presents an endless and bewildering variety of engines and boilers which have been adopted one day, only to be superseded by better ones the next. With all this change and development, however, designers have never before been faced with the problem of choosing between so many rival methods of driving ships as they have to-day, each method of propulsion making by its performance or promise some claim to consideration. Modern marine engineering embraces in its scope not only steam boilers and steam engines, but also steam turbines, oil engines of various types, and also the use of electricity on an extensive scale.

One of the most notable steps in the progress of the marine engine was the adoption of compound working associated with the name of John Elder; another the introduction of the triple expansion engine by Alexander Kirk; another stage in marine propulsion was marked by the application of the Parsons steam turbine; while to-day there is an ever-increasing fleet of ships driven by Diesel oil engines. The advance made during the last sixty years will be realised by comparing the Cunard ships of 1869 with modern liners. Then, no Cunard ship used more than 30 lb. pressure in her boilers; the greatest horse-power in any ship was 4200, found in the *Scotia*; while the coal consumption was 3-3½ lb. per h.p. per hour. To-day, ships are running with 350-400 lb. pressure; the total horse-power of a big Atlantic liner is 70,000-80,000; while in the most modern steam machinery less than ¾ lb. of oil per h.p. per hour is used. At one time, Great Britain built 80 per cent of the steamships of the world. Owing to various causes, one of which is the rise of great shipbuilding yards abroad, this proportion has fallen considerably; yet the volume of construction and marine engineering remains very large, and there is no slackening of the effort to maintain our position. For a long period marine engineering was largely a matter of experience and rule-of-thumb, but to-day it is not only influenced at every stage by scientific research, but sometimes very costly large-scale experiments are made and the industry is ready to try out any new system which offers reasonable expectation of success. Very great popular interest was taken formerly in the records of the ships of the 'Atlantic ferry,' the blue riband of which has now been held for twenty-two years by the famous *Mauretania*. During the coming summer, the new German turbine-driven liners *Europa* and *Bremen* are due for completion, and it may be that for a time the Atlantic record will pass to Germany as it did some thirty years ago.

Apart from the new machinery for very large and fast ships, however, there are many developments taking place, and a few particulars of recent marine practice may be of value to those who, though not directly associated with marine engineering, may nevertheless be engaged in the study of some of the numerous problems which are connected with it. Marine engineering to-day owes very much to the mathematician, the chemist, the physicist, and the metallurgist.

Confining this article to recent steam practice, it is proposed to give a few notes on up-to-date boiler work and then refer to some recent improvements in reciprocating engines, steam turbines, and electric transmission gear. At first simply great square or oblong boxes with internal flues, or with banks of tubes in place of flues, sixty years ago the box boilers gave way to the cylindrical or Scotch boilers, and these have been used until recently almost without exception in merchant ships. Such boilers are suitable for steam pressures up to 200 lb. or even 250 lb. pressure, but with still higher pressures, marine engineers have had to follow naval engineering practice and use one or other of the many types of water-tube boilers, of which the Babcock and Wilcox and the Yarrow are favourite examples.

In the successful working of water-tube boilers, a supply of pure water free from grease or scale-forming substances is an absolute necessity. In high pressure steam vessels the condenser is

still the Achilles heel of the machinery, and any leakage of the condenser tubes is a source of great anxiety. Some of the most interesting boiler installations of recent times are seen in the new vessels of the Canadian Pacific Railway Company, such as the *Duchess of Bedford*, *Duchess of Atholl*, and *Duchess of York*. These vessels are driven by steam turbines with single reduction gear. Each of them has six Yarrow boilers working at 350-370 lb. per sq. in. with 250° of superheat; and also two Scotch boilers working at 200 lb. pressure. All the steam from the Yarrow boilers and a part of the steam from the Scotch boilers passes to the turbines, but it is the latter which supply steam to the auxiliary engines. Separate condensing and separate feed systems are used, and by this means oil which happens to pass over from the auxiliary engines is prevented from entering the Yarrow boilers. Salt and grease in high pressure boilers are things to be avoided at all costs. By the use of high pressure superheated steam in these Canadian Pacific vessels, it is expected to be able to reduce the running costs by 20-30 per cent.

While the turning of the water into steam, and the condensation of the steam and its return to the boiler as feed water, present the marine engineer with one set of problems involving questions such as the conduction and transmission of heat, the flow of cooling water through tubes and the prevention of deposits and corrosion in condensers and boilers, the burning of the fuel affords ample scope for ingenuity and experiment in another direction. Important mercantile steam vessels, like warships, have abandoned coal for oil, but now the possibilities of burning coal in the pulverised state are being explored. Reference was made to this by Sir Eustace D'Eyncourt in his paper on "Fuel for Ships," read to the Royal Society of Arts on Dec. 5 of last year.

Pulverised coal has been used in large boilers in some important power stations ashore for some time, and now in the American ships *Mercer* and *Lingan* and the British ships *Stuartstar* and *Horotata*, various pulverised coal systems are on trial. The *Mercer* was the first ship with pulverised coal to cross the Atlantic, the *Stuartstar* is the first British ship to be fitted with a pulverising plant, and the *Horotata* is the largest ship so fitted. Many firms have carried out experiments, and it is apparently only a question of time before the main problems of crushing, pulverising, distribution and burning will have been solved. There may possibly be a great future for pulverised coal for ships.

In the propelling machinery itself, many changes are being made, all with the object of improving economy and reducing running costs. The first essential for marine machinery is trustworthiness, but with present-day manufacture and design, few serious breakdowns occur in any of the various types. Triple expansion and quadruple expansion engines have been fitted for many years and, in spite of the progress of the steam turbine and the oil engine, the reciprocating engine is found in more ships than is any other engine. In triple expansion engines new valve gears are being tried, while a very promising development is the fitting of an exhaust steam turbine in series with the reciprocating engine and coupled to the same shaft through reduction gearing. Suggested by Sir Charles Parsons, but introduced first in Germany, this plan is known as the Bauer-Wach exhaust turbine system. The Anchor liner *Britannia*, a vessel of 8464 tons, built two years ago, has just had such a turbine fitted to her quadruple expansion engines, resulting in an increase of power with a reduction in oil consumption per horse-power, and other vessels are being similarly altered, among them being five P. and O. ships running to Australia via the Cape. In view of the large number of ships with reciprocating engines, it may be expected that exhaust turbines will be adopted on a wide scale.

Marine engineering has always been influenced by contemporary land practice, but up to the coming of the steam turbine no power station contained machinery comparable in size to that of an Atlantic liner. The steam turbine to some extent has reversed that position, but while the largest single unit turbines are found in the super-power houses, practice ashore and afloat tends to progress on parallel lines; higher pressures and higher temperatures being used in both cases. Then, too, marine steam turbines to-day drive the propeller shaft through reduction gearing, instead of directly, or alternatively use hydraulic or electric transmission. The introduction of reduction gearing with pinions and wheels with helical teeth cut with extreme accuracy led to a great increase in both turbine and propeller efficiency. In a presidential address delivered about two years ago, Engineer Admiral Sir Robert Dixon stated that in torpedo boat destroyers the use of gearing had led to an increase in the distance steamed per ton of oil of 14 per cent at full speed and 70 per cent at cruising speed. With the use of gearing came the introduction of the single collar thrust block invented by Michell of Australia, a solution of a difficult problem as complete as it was unexpected. In the development of the turbine, the gearing and the thrust block are seen many striking results of the successful application of theoretical investigations to urgent practical problems of ship propulsion.

For the transmission of the power of the turbine to the propeller shaft, electricity has been used extensively in the United States Navy, which tried out the system first in the collier *Neptune*, now the aircraft carrier *Langley*. This system is also found in about thirty ships with a collective horse-power of 500,000 plying on the Great Lakes. Much interest was created last year by the performances of the American Panama-Pacific Liner *California*, with turbo-electric machinery, and in view of the recent completion of the P. and O. *Viceroy of India* with turbo-electric machinery, comparative figures may be of interest. Though tried in an experimental launch, the *Electric Arc*, in 1911, and in the s.s. *Tynemount* in 1912, the electric drive has not previously been fitted in any large British ship, and the running of *Viceroy of India* will be

watched by every superintendent engineer. The *California* is 601 feet long and has a gross tonnage of more than 20,000 tons. Steam is supplied by oil-fired Babcock and Wilcox boilers at 275 lb. pressure and 120° F. superheat to two turbo-alternators, each of 8500 s.h.p. running at 2880 revolutions per minute, which supply current to the twin-screw propelling motors running at 120 r.p.m. At full power the vessel has a speed of 18 knots, and the consumption of oil on the first voyage for all purposes was 0·8 lb. per h.p. The *Viceroy of India* is 612 feet long, with a gross tonnage of 19,000 and a displacement of 25,000 tons. In her, six Yarrow boilers supply steam at 350 lb. pressure to two 9000 k.w. turbo alternators running at 2700 r.p.m. supplying current to twin screw motors running at 109 r.p.m. The speed of the ship at full speed will be 18¾ knots, while with only one alternator in use a speed of 16½ knots will be obtained. It is stated that the guaranteed consumption for propelling purposes only is 0·6 lb. per s.h.p. per hour. Besides the main generators, the *Viceroy of India* has four 500 k.w. auxiliary turbo generator sets and two 165 k.w. oil-driven sets, while for the pumps, fans, steering motors, etc., which are electrically driven, there are no fewer than forty-three circuits. This notable vessel is advertised to sail on her maiden voyage on Mar. 28. It has been announced that the new 'Super-Olympic' liner building at Belfast for the White Star Line will also have electric drive, but particulars of her machinery have not yet been published.

Progress in steam marine machinery has unquestionably been stimulated by the growing popularity of the motor-driven ship with its surprising economy in fuel. For fast ships and warships, however, the steam turbine is at present the only suitable engine, while in other classes of vessels no doubt various types will continue to be used according to circumstances. In Lloyd's Register Book the tonnage of ships above 100 tons included amounts to 65,159,413 tons gross, of which 5,432,302 tons are driven by oil engines, 9,682,063 tons by steam turbines, and 50,045,048 tons by steam reciprocating engines, while of the total tonnage 62·4 per cent burn coal and 37·6 per cent use oil either under the boilers or in the engines. Some of the steamers fitted for burning oil can if necessary use coal.

Obituary.

Sir Bertram Windle, F.R.S.

IT is with deep regret that we record the death of Sir Bertram Windle, professor of anthropology in St. Michael's College, University of Toronto, which took place in Toronto on Feb. 14. Bertram Coghill Alan Windle was born on May 8, 1858, the son of the Rev. S. A. Windle, vicar of Market Rasen, Lincolnshire. He was educated at Kingstown and Repton schools, and had a distinguished career at the University of Dublin, where he graduated M.D. and D.Sc. He was for a time Dean of the Medical Faculty and professor of anatomy and anthropology at the University of Birmingham. He afterwards became professor of archæology in University College, Cork, of which he was appointed president in 1904, holding this office from 1904 until 1919, when he went to Toronto. During his residence in Ireland he was extremely active in educational and other affairs, with results that were not always conducive to his tranquillity of mind.

In his more strictly professional studies, Windle attained considerable eminence. His contributions to anthropological literature were marked by originality and freshness of view. Besides papers in scientific journals, he was the author of a manual of surface anatomy, now in its third edition, and of "The Proportions of the Human Body," published in 1892. He was, however, almost as widely known as an archæologist as an anatomist. He published several books on prehistoric archæology, of which the best known are "Life in Early Britain" and "The Prehistoric Age." His "Romans in Britain" was of a more popular character and was based on lectures delivered in Toronto. He was elected a fellow of the Royal Society in 1899. The breadth of his interests was also shown in a series of literary guide-books, of which "Shakespeare's Country" is most likely to be of enduring value.

Windle's main preoccupation, however, outside his professional studies, was in religious questions, and especially the relations of religion and science. At the age of twenty-five he joined the Roman Catholic Church, and by far the greater part of his not inconsiderable literary output was concerned with religion. "The Church and Science" was awarded the Gunning Prize in 1917, and Windle was honoured for his writings by two popes; Pius X. made him a knight of the order of St. Gregory, and Pius XI. made him an honorary Ph.D.

News has just reached us of the death on Jan. 17 at Moscow of Dr. G. S. Zaitzev, director of the Turkestan Plant Breeding Station. Beginning in 1914, Dr. G. S. Zaitzev devoted himself to serious and large-scale genetic, botanical and breeding work in cotton, occupying the position of the chief of the Division of Plant Breeding of the Golodnostepskay Agricultural Experiment Station until 1919. In 1919 Dr. Zaitzev was appointed director of the Turkestan Plant Breeding Station, where he remained until his death, which has interrupted a life full of scientific achievements in our knowledge of the cotton plant. In addition to his work at the Turkestan Plant Breeding Station, Dr. Zaitzev was engaged in the U.S.S.R. Institute of Applied Botany (Leningrad) as cotton specialist, and in the Central Asia State University (Tashkent) as professor of cotton growing at the Agricultural College. By the death of Dr. Zaitzev, the Soviet Union and the whole world have lost a distinguished scientific worker in the field of genetics and plant breeding, whose memory will be long preserved and honoured.

News and Views.

THE following names of scientific workers and others associated with scientific activities appear in the New Year's honours list, which, owing to the illness of His Majesty the King, was not issued until Mar. 1: *Barons:* Sir Jesse Boot, for services in the promotion of education; Sir Berkeley Moynihan, president of the Royal College of Surgeons. *Knights:* Prof. J. A. Fleming, emeritus professor of electrical engineering, University College, London; Mr. G. A. Julius, chairman of the Council for Scientific and Industrial Research, Commonwealth of Australia; Col. T. F. Purves, Engineer-in-Chief, Post Office; Mr. A. V. Roe, for distinguished services to British aviation; Sardar Jogendra Singh, Minister for Agriculture, Punjab; Lee ah Yain, Minister for Forests, Burma; *Companion of Honour:* Lady Florence Elizabeth Barrett, Dean of the London School of Medicine for Women and president of the Medical Women's International Association. *C.B.:* Sir Walter Morley Fletcher, secretary of the Medical Research Council; Dr. G. F. Hill, Keeper of the Department of Coins and Medals, British Museum. *C.M.G.:* Mr. F. C. Madden, Dean of the Faculty of Medicine, Egyptian University, Cairo. *K.C.I.E.:* Sir Thomas Middleton, lately member of the Royal Commission on Agriculture in India. *C.I.E.:* Mr. R. S. Finlow, Director of Agriculture, Bengal; Mr. N. N. Gangulee, lately member of the Royal Commission on Agriculture in India; Mr. J. A. Madan, lately joint secretary to the Royal Commission on Agriculture in India; Mr. W. Mayes, Chief Conservator of Forests, Punjab; Mr. F. W. H. Smith, lately joint secretary to the Royal Commission on Agriculture in India. *G.B.E.:* Sir William McCormick, chairman of the University Grants Committee and of the Advisory Council of the Department of Scientific and Industrial Research. *D.B.E.:* Prof. Anne Louise McIlroy, professor of obstetrics and gynæcology, Royal Free Hospital School of Medicine for Women, University of London. *C.B.E.:* Prof. Winifred Cullis, professor of physiology, London (Royal Free Hospital) School of Medicine for Women; Mr. R. Hewison, late Director of Agriculture and Forests, Sudan Government; Mr. W. Nowell, Director of the Amani Research Institute, Tanganyika Territory. *O.B.E.:* Mr. G. E. Hunt, lecturer in engineering, Gordon College, Khartoum; Mr. W. A. Taylor, superintending examiner, Patent Office. *M.B.E.:* Mr. G. E. Holden, technical adviser to the Dyestuffs Advisory Licensing Committee; Mr. A. J. W. Hornby, agricultural chemist, Nyasaland Protectorate.

WE publish elsewhere in this issue a résumé of a detailed research on the performance of ammeters and voltmeters made by the British Scientific Instrument Research Association, of which the director is Sir Herbert Jackson. The research is of a somewhat novel type, but there can be no question about the usefulness of this kind of research to industrial undertakings, and we hope that it will be widely followed. The research was initiated by some members of the Association, who were naturally disturbed by the disparaging remarks made by a few station engineers about British switchboard instruments. They desired that a critical examination be made of the operation, appearance, and permanent qualities of British and foreign ammeters and voltmeters for use on switchboards in central electrical stations. In order to bring the research within manageable limits it was restricted in the first place to permanent magnet moving coil instruments. The research was to be impartial and thorough, the best foreign and British instruments being obtained from well-known makers.

THE results of this investigation of British and other ammeters and voltmeters are satisfactory from the point of view of the British manufacturers. Naturally there is much in the detailed report which is confidential to members of the Association, but the synopsis proves conclusively that their products were at least as good as those of their American and continental rivals. The greatest value of the report, however, lies in the criticisms made freely about all the instruments and the reasons given why certain makes are more desirable than others. These criticisms should prove most useful to the designer. As a rule, design is largely a compromise: the better the instrument is made in one respect the worse it is in another. It is largely a balancing of incompatibilities, and the successful maker is the one who secures the best balance. The nature of the materials used for the instruments has been examined, and such questions as to the relative merits of aluminium and copper wire for use in winding the coils is fully discussed. To manufacturers this kind of research is of the greatest value, and we congratulate the Association on its report.

REFERENCE is made in the *Times* of Mar. 2 to a biennial fibre plant to which the name 'Brotex' has been given. The plant is being grown on a small scale near Totnes in South Devon, and it is claimed that in less than eighteen months from planting it will produce fibre for textiles, cellulose for paper-making, and seed containing oil suitable for cattle food. That a plant with so many desirable qualities, which will survive the winter in the south of England, should only now have been brought to notice, is somewhat remarkable and merits further investigation. It is stated that the plant grows to a height of about 10 feet in the course of 15-18 months, but nothing is said as to the soil exhaustion that is likely to take place with a crop of this kind, nor is it pointed out that land suitable for such a crop is somewhat limited in the south-west of England.

THE "evolution of the plant" has not been disclosed, pending application for patents, though it has been stated elsewhere to be of hybrid origin. It is known, however, that it belongs to the genus *Lavatera* of the family Malvaceæ, and the plants now being grown in Devonshire very closely resemble a species which is a native of the Canary Islands, a plant which would certainly be hardy only near the warm south-

west coast of England in normal winters. The mallow family contains many well-known fibre-yielding plants, such as *Abutilon Avicennæ* (the source of Chinese jute), *Hibiscus cannabinus*, *Sida rhombifolia*, etc., and in some cases the seeds are also of value for cattle food. None of these plants is hardy in Great Britain, and even *Lavatera arborea*, which is the only *Lavatera* found in England, will only succeed well near the coast. If, therefore, 'Brotex' can be proved to be of hybrid origin, not only will it be of scientific interest to know its parentage, but it will also be of material importance to know whether it will regularly produce fertile seed in Great Britain. Moreover, it is of importance, from the commercial aspect, to know whether the fibre is superior to jute and hemp, with which fibres we understand the market is already fully supplied.

A TIMELY article by Sir Oliver Lodge appears in *The Nineteenth Century* for March on the philosophy of "the genius who now lives among us and whom we call Eddington," as expressed in the latter's recent book, "The Nature of the Physical World." After expressing his agreement with the greater part of Eddington's thesis, Sir Oliver proceeds, in a perhaps unnecessarily apologetic manner, to deal with one or two contentions against which, as he expresses it, "I politely and reasonably rebel." The points which he discusses are respectively the tendency to regard the subject matter of science as confined to quantities which can be measured, and the abandonment of the notion of force in the descriptions of field physics. On the second point Sir Oliver affirms his belief in the reality of a physical force exerted by the strained ether on a body placed in a gravitational field. Eddington, in company with all orthodox relativists, prefers to express the facts in terms of the geometrical properties of the field. To a large extent, if not wholly, the difference here is merely verbal, but the first point, concerning the essential character of science, deals with more fundamental issues. The suggestion that phenomena or ideas which cannot be measured are not amenable to scientific treatment has taken immediate root in the minds of philosophical writers, and its foliage seriously threatens the survival of the finer blooms of thought which have been reared with much greater difficulty.

THE simplicity of this false generalisation has gained for it a rapturous welcome from philosophers bewildered by the headlong advances of modern physics, and the relations between science and religion in particular are in consequence viewed in an entirely false light. The subject matter of science is the common experience, obtained through the five senses (the so-called *observations*), of the generality of observers. The purpose of science is to record and correlate such observations. Measurement may—in fact, does—assist both the recording and the correlation, but it does not dominate them. It is not, for example, exclusively employed—nor can it probably ever be—in recording the behaviour of a spider placed in a hive of bees, or in correlating the movements of swallows with the declination of the sun, yet these activities are certainly fair game for scientific investigation. A careful perusal of Eddington's book will show that it contains no specific warrant for the misconception, but if, as we believe, a writer of outstanding authority should guard as much against misinterpretation by the casual as by the meticulous reader, he can perhaps not be wholly absolved from responsibility for its prevalence. That, however, is of secondary importance. What is chiefly to be desired is that the true nature of science shall be clearly understood, and Sir Oliver Lodge's article should help considerably towards this end.

THE eighth Annual Report of the National Institute of Industrial Psychology shows a steadily progressive increase in the interest taken by firms in the application of the principles of physiology and psychology to industry. The range of the Institute's investigation services during 1928, as judged by the fees received, has expanded by 29 per cent in comparison with the previous year. A most diverse array of activities is represented by the list of investigations, which include spinning, the manufacture of electric-light fittings, pickles, jam, and soap, the selection of staff and the layout of large stores, to mention but a few. There has also been growth in the other departments of the Institute's work; for example, in vocational guidance, research, and education. It is hoped during 1929 to inaugurate a new department for the purpose of applying to the problems of the home those principles which have been found useful in other fields. The second part of the report gives an outline of some of the investigations undertaken during the year. The third part records the research work for the year; this includes experiments in vocational guidance in London and Fife, an inquiry into occupations suitable for the blind, and a varied number of researches initiated or continued with the grant given by the Laura Spelman Rockefeller Memorial. It is clearly a record of most important and useful work.

PROF. J. REILLY and D. T. MacSweeney give an account, in the *Proceedings of the Royal Dublin Society* for January, No. 15, of the work of William Higgins, whose book, published in 1789, "A Comparative View of the Phlogistic and Antiphlogistic Doctrines," contains some interesting speculations on chemical combination. The work is the first defence of the new views of Lavoisier in the English language and was written in answer to Kirwan's "Essay on Phlogiston." Higgins' work, according to Reilly and MacSweeney, contained the fundamental germs of the chemical atomic theory, and had it not been neglected it would have led to much that Dalton afterwards put forward. It is to the genius and industry of Dalton, and the encouragement and friendly criticism of his contemporaries, that the main credit for the establishment of the theory must be ascribed. Higgins' work (which is based on experiment and is by no means purely speculative) is particularly interesting in its attempt to represent affinities as well as combining proportions, a side of the subject which was, perhaps wisely, entirely

(*Continued on p.* 385.)

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Reviews.

Population and Depopulation.

(1) *The Balance of Births and Deaths.* Vol. 1: *Western and Northern Europe.* By Robert R. Kuczynski. (The Institute of Economics of the Brookings Institution.) Pp. xii + 140. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Co., 1928.) 10*s.* net.

(2) *The Shadow of the World's Future: or the Earth's Population Possibilities and the Consequences of the Present Rate of Increase of the Earth's Inhabitants.* By Sir George Handley Knibbs. Pp. 131. (London: Ernest Benn, Ltd., 1928.) 10*s.* 6*d.* net.

AT the World Population Conference held at Geneva in 1927, one might observe a contrast in viewpoint of the very greatest interest. The delegates from the United States were much concerned with the imminence of the dangers of over-population, while the majority of European speakers, at least those who spoke with authority on their own national statistics, pointed out in almost monotonous succession that their birth rates either had already fallen or would soon fall below the level necessary to maintain stationary populations. Generally speaking, northern Europe has seen the end of the period of population expansion. Is it possible that the American average of 39 to the square mile is more impressive of over-population than the European average of about 300 ?

In the preface to his book, Sir George Knibbs says (p. 5):

"... it shows that the menace of the present rate of growth of those inhabitants is most serious. This rate is of the order of about 1 per cent per annum."

Mr. R. R. Kuczynski, on the contrary, remarks in his introduction:

"In case, then, that natality does not again increase, the population of England is bound to die out no matter how low mortality may be reduced. And this state of affairs is by no means confined to England. Conditions are about the same in Germany, and only slightly better in France."

The scope of the two books is very different. Sir George Knibbs considers the earth as a whole; Mr. Kuczynski takes northern and western Europe, while succeeding volumes of his series will deal with other regions. "The Shadow of the World's Future" is to influence national policies in respect of population, migration, and food production: "The Balance of Births and Deaths" is concerned with a detailed statement of the relevant statistical facts, collated for the whole group of countries considered. It confines itself strictly to the existing tendencies in the growth or decline of populations; whereas the rate "of the order of about 1 per cent per annum" is practically the only statement on this subject which seems necessary for "The Shadow of the World's Future." One book is scientific; the other, political.

(1) To take the scientific book first. It has four short chapters on "Birth Rates," "Fertility Rates," "Net Reproduction Rates," and "Present and Future Tendencies," followed by four long, and largely tabular, appendices. Fertility rates are birth rates based on the numbers of women actually available for reproduction. They lead to gross reproduction rates, giving the number of live daughters born per woman. For 1927 the value for Germany has fallen to 1·00 and for England to 0·98. Even with no mortality in infancy and childhood these figures are incompatible with biological increase. For the whole area in 1926 the value is 1·12.

In the net reproductive rates allowance is made for mortality; the figures may, in fact, be read as the actual births expressed as percentages of those needed to maintain a stationary population. The estimates for 1926 are: for England 88, Germany 89, France 94, Sweden 95, Denmark 110, Finland 109, and for the whole area about 93. These values also are falling rapidly, for in 1927 the estimates are: France 91, Germany 83, England 82.

The main points, which are being but slowly apprehended in Great Britain, are brought out with perfect lucidity. For example, that the present populations have an unusually large proportion of persons of reproductive age, and unusually few of the elderly; that the course of the changes in

reproduction has not been appreciably changed by the War; and that, since the mortality rates of persons above the reproductive age are without effect upon future population growth, the present tendencies to decreasing population can only be appreciably altered by increasing fertility.

(2) Sir George Knibbs's fears seem to be centred upon somewhat improbable prospects of the increase in the world's population. He allows that the earth's resources, if wisely exploited, would support about 7800 millions of human beings. This seems a very handsome allowance, being four times the total existing world population. Trouble is anticipated (p. 118) from "the mere increase in population, coupled with the fact that Man's moral development has not kept pace with scientific knowledge." The threatening shadow sometimes takes the appearance of a bogy (p. 119):

"We are rapidly approaching numbers that make the problem a stupendous, aye, an appalling one."

Should 2000 millions induce more stupor than 1900 millions?

The chapter on the world's cereal and food crops is of course written on the assumption that there is an immediate prospect of the demand for food outrunning the supply. No evidence is adduced that this is so, and the evidence to the contrary is ignored entirely. It might be strongly argued that the situation at present and the prospects of the immediate future indicate a systematic over-production of foodstuffs. Agriculture throughout the world is a depressed occupation in the sense that the worker on the land works harder for a lower economic recompense than the worker in any other industry. In agriculture the crops which pay best are either luxury foods or not food crops at all. Falling food prices have caused an increased consumption per head in most countries, but the increase is naturally least in the staple foods and greatest in the delicacies. What agriculture needs is higher prices for staple foodstuffs, relatively to the cost of buildings, clothes, and machinery, but with new areas still apparently yearning for agricultural development, the prospect of better prices is far off. It has indeed been calculated that the rate of increase in the supply of fixed nitrogen as fertilisers would more than suffice to meet the present rate of world population increase, without putting a single new acre under cultivation. However this may be, the supply of foodstuffs is elastic enough, it is the demand that is inelastic. From Sir George Knibbs's point of view it is, however, worth while discussing the most extravagant methods of increasing yields (p. 40):

". . . but it has recently been shown that greatly increased yields are at least temporarily attainable with cereals by transplanting. The increased yields are due to the greater root development thus obtained. The use of carbon dioxide has also led to higher yields. . . . In any case these results, *while they relieve the outlook for the immediate future* [Reviewer's italics], do not warrant any disregard for the outlook resulting from population increase."

While such diversities exist in intelligent opinion as are shown by these two books, there can be no doubt of the need for bodies devoted to eliciting the real facts, such as the British Population Society, for the parent international body of which Sir George Knibbs puts in a warm plea.

R. A. Fisher.

Old English Versions of Alchemical Texts.

The Works of Geber. Englished by Richard Russell, 1678. A new edition, with Introduction by Dr. E. J. Holmyard. Pp. xl+264. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., Inc., 1928.) 6*s.* net.

ENGLISH scholars first became interested in the translation of alchemical texts in the twelfth century, when they participated with the celebrated Gerard of Cremona and other continental scholars in making known to western Europe the accumulated wisdom of the Muslim world. Prominent among them were Adelard of Bath, Walcher of Malvern, Roger of Hereford, and Robert of Chester, the last-named of whom, according to tradition, first introduced chemistry into Europe. "Since," wrote Robert, in the preface to his first translation of an Arabic alchemical treatise, in 1144, "your Latin world does not yet know what alchemy is, I will explain in the present book." The translations of this period were of course done into Latin, and the same language was the usual medium in which the adepts embodied, or embedded, their observations and ideas throughout the succeeding five centuries.

The "Speculum Alchemiæ" of Roger Bacon, the earliest alchemical work of any note by an English author, was first translated from Latin into English in 1597; it appeared under the title "The Mirror of Alchimy," and is now very rare. Printed in company with Bacon's "Speculum" and other works, in such editions as those dated 1541 (Nuremberg) and 1545 (Berne), were certain Latin texts ascribed to Geber (Jabir). These texts, which can be traced back through the first printed edition of about 1481

to manuscript versions of the early thirteenth century, were first translated into English in 1678 by Richard Russell, under the title : "The Works of Geber, The Most Famous Arabian Prince and Philosopher. Faithfully Englished by R. R. a Lover of Chymistry." The English translation was reprinted in 1686, and it has now attained the distinction, after an interval of exactly 250 years from its original publication, of appearing in a third edition, enriched with reproductions of the bold woodcuts of alchemical apparatus which embellished the Latin edition of 1545.

In an interesting preface, Dr. Holmyard points out that no Arabic originals of the text are known, so that its authenticity is unproved. After considering the available evidence bearing upon the origin of the writings, he reaches the conclusion that "whatever the future may disclose concerning them, we may safely say that they are not unworthy of Jabir and that he is worthy of them ; and that we know of no other chemist, Muslim or Christian, who could for one moment be imagined to have written them." The main sections of the book are entitled : "Of the Investigation or Search of Perfection," "Of the Sum of Perfection, or of the Perfect Magistery," "Of the Invention of Verity, or Perfection," and "Of Furnaces, etc., With a Recapitulation of the Authors Experiments."

Possibly the most interesting part is the account "of the Natural Principles of Metals, according to the Opinion of Modern Philosophers, and of the Author," of "the Three Principles, viz. Sulphur, Arsenick, and Argentvive," and of the six "Metallick Bodies, which are the Effect of these Principles of Nature." The description of sulphur as "a fatness of the Earth" is suggestive of the statement of Paracelsus that "the life of Metalls is a secret fatnesse, which they have received from Sulphur, which is manifest by their flowing." The second principle, Arsenick, "needs not be otherwise defined than Sulphur. But it is diversified from Sulphur in this, viz. because it is easily a Tincture of Whiteness, but of Redness most difficultly : and Sulphur of Whiteness most difficultly : but of Redness easily." The third principle, Argentvive, or Mercury, "is a viscous Water in the Bowels of the Earth. . . . It is also (as some say) the Matter of Metals with Sulphur. And it easily adheres . . . to Saturn, and Jupiter, and Sol. . . . Therefore hence you may collect a very great Secret. For it is amicable, and pleasing to Metals, and the Medium of conjoyning Tinctures."

The metals are described in vivid terms, which suggest a close acquaintance of the writer with their properties. Gold is "Citrine, ponderous, mute, fulgid . . . under the Hammer extensible, fusible, and sustaining the Tryal of the Cupel, and Cement." Silver is "White with pure Whiteness, Clean, Hard, Sounding." Lead is "livid, earthy, ponderous, mute." Copper and iron are characterised with equal felicity ; finally,

"not omitting to discourse of Jupiter, We signifie to the Sons of Learning, that Tin is a Metallick Body, white, not pure, livid, and sounding little, partaking of little Earthiness ; possessing in its Root Harshness, Softness, and Swiftness of Liquefaction, without Ignition, and not abiding the Cupel, or Cement, but Extensible under the Hammer. Therefore, Jupiter, among Bodies diminished from Perfection, is in the Radix of its Nature of Affinity to the more Perfect, viz. to Sol and Luna ; more to Luna, but less to Sol, as shall be clearly declared in the following. Jupiter, because it receives much Whiteness from the Radix of its Generation, therefore it whitens all Bodies not White ; yet its vice is, that it breaks every Body, but Saturn, and most pure Sol. . . . And he who knows how to take away its Vice of breaking will suddenly reap the fruit of his Labour with joy."

These quotations serve a twofold purpose. In the first place, they afford an indication of the views upon the constitution of the metals which prevailed, with unimportant modifications, from the time of Jabir (*c.* 721–813) for a period of nearly a thousand years. Secondly, they illustrate the peculiar fitness of the seventeenth century mind for interpreting, and recording in the vigorous English of the day, the philosophy, the mysticism, and the superstition of the alchemists, from Jabir to Paracelsus and Glauber. Thus, Richard Russell imparts alike to the "Works of Geber," to "Beguinus his Tyrocinium," and to "the Triumphant Chariot of Antimony, with Kirkringius his Notes thereon," the same archaic flavour and picturesque charm which Lord Berners infused in the preceding century into his English version of Froissart's "cronycles of Englande, Fraunce, Spayne, Portyngale, Scotlande, Bretayne, Flaūders, and other places adioynynge."

A similar atmosphere permeates the writings of Russell's contemporary, John French, the translator of Glauber, Sendivogius and Paracelsus, and of "a Chymicall Dictionary explaining hard places and words met withall in the writings of Paracelsus, and other obscure authors." "Are not Philosophers," asks French in his introduction to Glauber's "Description of new Philosophical Furnaces," published in 1651, "the best moralised men, of the purest lives, and most serviceable in their generation ? It shall be my practise as long as I

live to be instrumental in promoting true knowledge, whether by way of Translation or any other way of making what is occult manifest."

Boyle's "Sceptical Chymist" (1661) marked alike the decline of alchemy and the gradual abandonment of Latin by exponents of the new chemistry which was to arise. Nevertheless, Walter Harris and others continued the tradition of the seventeenth century translators; and no true "Lover of Chymistry" would willingly forgo such passages as Boyle's own quotation of the experience of the Dutch sailors at Nova Zembla with a barrel of frozen beer in the winter of 1596, and Harris's description, in his Englished version of Lemery's "Cours de Chymie," of the rectification of spirits of wine, to which end, he says, "Artists have invented a long Machine, which they call the Serpent, by reason of the circumvolutions which it makes."

Dr. Holmyard has earned the gratitude of the present generation of "chymicall Artists" by placing such rare classical works as Russell's "Geber" and Norton's "Ordinall" within their reach. May we not persuade him to complete the "tria prima" by preparing a new edition of Roger Bacon's "Mirror of Alchimy!"—for, in the words of John French, "it is pitty that such useful and so learned writings should be obscured from the English Nation." JOHN READ.

Homing among Animals

How Animals Find their Way About: a Study of Distant Orientation and Place-Recognition. By Prof. Étienne Rabaud. Translated by I. H. Myers. (International Library of Psychology, Philosophy and Scientific Method.) Pp. ix + 142. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 7*s.* 6*d.* net.

DURING the present century the solution of the problem of 'homing,' or orientation from a distance, has come within sight, for backboneless animals at any rate; and the reason for the progress is to be found in the resolute use of experiment. For bees and wasps it seems quite certain that they cannot find their way home unless they have had some experience of the locality, and unless hey can see well during their return flight. Bees liberated on a lake near the hive do not return, unless by chance, for there are no landmarks to guide them. The cues utilised by bees and wasps are visual; by following these they retrace the path they travelled in leaving the hive or nest. But there is evidence that the cues are relations between objects rather than the objects themselves. There seems to be a co-ordination of clues into what might be called a synthetic impression—what would be in our case a mental picture; and there may be a successful bee-line for the hive though various intermediate cues disappear.

After many journeys the insect becomes more confident; it is even probable that muscular memory may be substituted for visual cues over a large part of the course. When the bee is near the hive, olfactory, tactile, and perhaps other cues come into play. But, according to Rabaud, the homing of flying Hymenoptera depends mainly on visual cues, and it is quite unnecessary to postulate any special sense of direction. The experiments referred to convince one that this must be on the whole a sound conclusion.

In the pedestrian ants the cues are more heterogeneous. Olfactory hints are most important for those that travel in columns. Visual cues intervene when the trail is accidentally destroyed.

"As for isolated ants, they follow simultaneously visual cues of various kinds—light and large objects—closely associated, and connected in addition with features of the ground, notably with the slope. Every cue is associated with all the others and also with the topographical position of the nest."

There seems to be a registration of the topography as a whole, for on the return journey the experienced ant may neglect roundabout paths and take short-cuts. In the course of time the return perhaps becomes a matter of kinæsthesis and appreciation of distance. But, as in the case of bees, there is no warrant for postulating any special sense of direction.

Among the blind termites a trail is left by the troop and the cue is altogether olfactory. If the path is swept, the termites are completely disoriented. In limpets the return to the habitual position is mainly due to tactile cues. For all invertebrates that show any 'homing,' the facts can be satisfactorily interpreted in terms of visual, olfactory, tactile, and baræothetic or kinæsthetic cues.

In regard to vertebrates, the conclusions are less secure, for fewer experiments have been made. The most satisfactory data are in regard to carrier pigeons, but the case is complicated by the gradual training which the birds receive from man. They can find their way home from a distance of several hundred miles, and when they did not themselves make the particular outward journey. The evidence for a special magnetic or electromagnetic sensi-

tiveness is very dubious; the theory that the bird registers its outward journey in detail, and then retraces its steps, has to face the difficulty that the pigeons are often taken to a distance by train; Rabaud favours the view that the pigeons during their period of training acquire a considerable knowledge of places and utilise this experimentally on their return journey, even from a region not previously visited. There are, however, some alleged returns on the part of untrained carriers, but these might be fortuitous.

Against the possibility of homing without experience, it is perhaps enough to notice that in many cases the travellers from a great distance fail to return at all. In 1895 five thousand pigeons were released at sea at varied distances west of Croisic. The number of returns and the speed of the returns diminished with the distance and the altitude increased. Out of 1500 pigeons released at 500 kilometres, 300 returned within forty-eight hours—a sufficiently remarkable fact; the others were found scattered everywhere, in England, Spain, Portugal, Algeria, at Cape Verde, in Egypt, and in the Caucasus. Very significant is the fact that the return journey often takes far too long for the distance involved. Thus eight pigeons, ignorant of the particular route, were transported from Antwerp to London.

"Released at six o'clock in the morning, in fine weather, they turned about for a long time, and then flew off and had returned to Antwerp by seven in the evening, having taken thirteen hours to accomplish a journey normally requiring barely three."

This points strongly to the conclusion that whenever there is difficulty in the return journey, because of inexperience, absence of landmarks, bad weather, darkness, or the like, there is much tentative flying on the carrier pigeon's part. The more the groping bird flies about, the greater is its chance of finding some cue.

In the well-known experiments made by Watson and Lashley on the terns nesting on the Tortugas, a percentage of birds returned from great distances, even of 800 miles, and from previously unvisited waters into which they had been transported in closed baskets on board ship. But the successful return journeys took an unnecessarily long time.

It is regrettable that the cases of homing on the part of domesticated animals, such as cats, dogs, horses, cattle, and sheep, remain at an anecdotal level. "A cat taken by rail from Fife to Ayrshire was back again in two or three days"; there are many such unprecise records, which should be tested experimentally. There would certainly be some interesting result.

Prof. Rabaud has written a useful book on an interesting problem; and though, for our part, we should not wish to hurry to a conclusion, we admit that he has made out a strong case in favour of interpreting all homing in terms of a memory or registration of sensory cues. His book is a good example of scientific scepticism and caution, and it badly punctures the hypothesis of a special sense of direction. Yet when we think of the most recent experiments on homing bees, the average success of ordinary bird migration, and such striking cases as the return of a swallow from Africa to the Aberdeenshire farm-steading where it was born the year before, the work of Watson and Lashley on terns, and the stories we have heard of homing cats, we are glad that Rabaud does not consider the question entirely solved.

J. A. T.

General Science for Schools.

(1) *General Science.* (*Mainly Chemistry and Biology.*) By Dr. E. J. Holmyard. Pp. xiii + 236. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., n.d.) 4*s*.

(2) *Everyday Science: a Course of General Science related to Human Activities.* By Dr. L. M. Parsons. Pp. xi + 695. 8*s*. 6*d*. Also in parts: I, The Sky, the Earth, and Life. II, Physics: Man's Use of Motion. III, Chemistry: Man's Use of Matter. 3*s*. each. (London: Macmillan and Co., Ltd., 1929.)

(3) *Junior Science.* By C. A. Stebbins. Pp. xii + 352. (New York: The Macmillan Co., 1928.) 6*s*.

(4) *Introductory Science for Botany Students.* By K. E. Maris. Pp. vii + 181. (London: John Murray, 1928.) 3*s*.

(5) *The Romance of Reality: the Beauties and Mysteries of Modern Science.* By Dr. Beverly L. Clarke. Pp. ix + 225. (New York: The Macmillan Co., 1927.) 10*s*. net.

(1) FOR years past, teachers have been saying that in the early stages science should be taught in a general way; that historical treatment is desirable; and that the lessons should be of the object-study sort. It is to be hoped that they will like Dr. Holmyard's book, for here they have it all presented in an ideal manner. The author has excelled himself as historian and philologist, and the wine of his science teaching requires no bush. His volume is intended as a second course, between an introduction and more formal study; but it is to be

feared that it may prove rather difficult at that stage. For the sixth-form boy who wishes to link up his science with history and with classical lore, and vice versa for the history and the classical specialist, it should suit perfectly. Indeed, the science teacher himself who failed to derive pleasure from reading the pages would have to be either an exceptionally clever or an exceptionally dull person. For this reason, if for no other, the book is to be commended to his notice.

(2) Differing entirely from the foregoing in its method of treatment, the really excellent book which Dr. L. M. Parsons has written should make an equally wide appeal. It seems exactly suited to the general reader who desires a knowledge of the operations of natural phenomena or of the principles and applications of science. Primarily the book is designed for students at school, but the author has avoided any suggestion of writing down to immature minds, and the work everywhere demands intelligence and concentration from the reader. There are three parts, the first dealing with astronomy, geology and biology (including man); the second with physics; and the third with chemistry. The last section, very naturally, makes rather more difficult reading than the other two; but throughout there is a singleness of aim and a lucidity of presentation which cannot fail to secure appreciation. It may even do more and succeed in luring some of the rigid formalists among teachers from their straight and dusty paths.

(3) As in the case of the two books previously mentioned, Mr. C. A. Stebbins, though approaching the problem at a different angle, makes an attempt —and a good one—to instruct the young in natural science, through their interest in the things which surround them. Devoting more space to the biological than to the physical aspects, the ground is reached through such pursuits as gardening and poultry farming. The chapters on botanical subjects are exceptionally good, and contain useful descriptions of simple experiments on plant physiology. This book also is to be commended for consideration by those who wish to get out of the usual rut in teaching science to beginners.

(4) The intention of the author of the fourth book on our list is that it is to be studied as concurrent aid to a course in botany. Although she is right in asserting that the usual text-book of elementary science is designed either as a preliminary to more advanced study of chemistry and physics or merely as an introduction to the subject with no definite end in view, her own aim has not always been very steady. If her book is meant as an introduction to botany, much is included which might have been omitted; and on the other hand, it is not always of a sufficiently elementary character to serve as a 'first reader.' We confess to a liking for books which have no ulterior end in view; and in our childhood that liking was even stronger. It is so satisfying to feel—even if it is not true—that the book we are reading begins at the bottom and finishes at the top. All of which is not to say that there are not many good things in the present book, for there are. But the ideal school-book is one which can be read without help and gives the same sort of satisfaction as a dinner which has run through all its courses and has not stopped short at the fish.

(5) Dr. Beverly Clarke's purpose in writing differs from all those whose books have been mentioned above, for his immediate aim is, not so much to teach science as to show to those who are in outer darkness the beauties which can be revealed in the light of scientific knowledge. In treating of many diverse themes, from protozoa to relativity, he manages to avoid mathematics entirely, and so has frequently to fall back on analogy for elucidation. To the erudite this method may seem tedious and even unscientific, but doubtless it may help the unlearned, for whom he writes, to understand a little, and perhaps to marvel much.

C. L. Bryant.

Quantum Mechanics.

Materiewellen und Quantenmechanik: eine elementare Einführung auf Grund der Theorien de Broglies, Schrödingers und Heisenbergs. Von Prof. Arthur Haas. Pp. vii + 160. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1928.) 7·50 gold marks.

Wave Mechanics and the New Quantum Theory. By Prof. Arthur Haas. Translated from the German edition "Materiewellen und Quantenmechanik" by L. W. Codd. Pp. xviii + 124. (London: Constable and Co., Ltd., 1928.) 7*s.* 6*d.* net.

IT is now just three and a half years since quantum mechanics came into conscious being—or rather more than five years if we should date it back to the material waves of de Broglie. The new theory has changed and expanded with such rapidity that even the bravest and most industrious writers have shrunk until now from the task of systematic exposition. Now, however, books on the new theory begin to come to hand, and in the near future we may expect them in increasing numbers.

Books which can properly be called books on quantum mechanics, or for that matter on any important new theory, are of three types: (1) Systematic expositions which adopt a single consistent point of view and attempt, however imperfectly, whether in an elementary way or with elaborate mathematics, to develop the theory from that point of view as a logical whole; (2) reprints or translations of original papers by the main authors of the new theory; (3) books of an introductory or miscellaneous character, usually of the nature of, if not actually, courses of somewhat disconnected lectures. Books of the first type are welcome in any numbers, however great. The principal difficulty at the present stage is not how to use quantum mechanics but how to talk about it most intelligibly. This is strikingly shown by the fact that many physicists, some of whom should know better, still speak of wave mechanics, matrix mechanics, and even the q-number mechanics of Dirac, as if they were three distinct theories instead of merely three different ways of trying to expound the same theory.

It is likely that it is only by repeated attempts at systematic exposition that we shall achieve intellectual contentment about the new theory. The first book of this type in point of time is Weyl's "Gruppentheorie und Quantenmechanik"—likely to remain for a long time to come a very notable example. The great abstractness of its mathematical form is its outstanding feature and probably the main source of its more permanent importance. But most of us, if we are honest with ourselves, though we may admit the importance of such abstractness, will admit, too, that we are as yet scarcely educated up to it. The other book of the first type which has already appeared—Sommerfeld's "Wellenmechanischer Ergänzungsband" to his "Atombau und Spektrallinien"—which expounds the theory systematically from the starting-point of Schrödinger's wave equation—will prove to many of more immediate practical assistance. We await with interest the many other systematic expositions of which there are rumours, confident that most of them will help to clarify our modes of thought and speech about atomic physics.

Books of the second type of course tell us nothing new. They are obviously a convenience to many students, especially in translation. We welcome for this reason the recent publication of translations of the original papers of Schrödinger and of selected papers of Brillouin and de Broglie. In spite of this convenience, however, it is questionable if there is not an element of danger to the student in the immediate publication of collected papers in book form. A book is a much more imposing thing than a few offprints, and is liable to be given an authority which its contents do not warrant. It is clear from his preface that no one is more fully alive to this danger than Schrödinger himself.

Books of the third type may obviously range in value between very wide limits. At their best they have very much of the nature of books of the second type, with the added advantage that the material has been worked through by another mind. Birtwistle's "New Quantum Mechanics" is a book of this type, giving a convenient and faithful but uncritical reproduction of much of the earlier work on the theory. Another better example is Haas's "Wave Mechanics and the New Quantum Theory," which in the original and in translation is the occasion for this essay. This book is definitely not a systematic account of the new theory; it is fairly elementary—would that it were systematic too! But it does give an excellent account of various disconnected aspects and applications. The translation seems to be well done; there are one or two obscurities due to failure to use the accepted English equivalent for a technical mathematical term, but they are not serious, and slips and misprints are very few. It is likely to prove quite a useful book. R. H. F.

Bushmen of the Central Kalahari.

The Naron: a Bushman Tribe of the Central Kalahari. By D. F. Bleek. (University of Cape Town: Publications of the School of African Life and Language.) Pp. ix + 67. (Cambridge: At the University Press, 1928.) 6*s*. net.

ALTHOUGH the School of African Life and Language has been established in South Africa for a few years only, it has already accomplished much useful work in research. It has now turned to publication. It is appropriate that the first of a projected series of studies of South African tribes should be written by Miss Bleek, for, herself a distinguished authority, she worthily carries on the tradition of a name which will always be associated with the study of South African philology and ethnology. Miss Bleek's book, apart from its intrinsic interest, is noteworthy in that it embodies material of a report of an investigation which was undertaken at the request of the Government. It is gratifying to note this official recognition of the fact that these tribes present a problem which is worthy of scientific study.

Miss Bleek classifies the Bushmen of the Kalahari

into northern, central, and southern. The Naron constitute the central group. In structure and in the roots of the vocabulary their language shows affinities with the Nama tongue, but Miss Bleek considers that the differences are sufficient to warrant regarding them as two languages of one group, rather than as two dialects of one language. This is not the only respect in which they show Hottentot influence. It appears in their culture, in their religious belief, and in their physique. Certain elements in culture and physique also show Bantu influence. An obvious instance of the former is the custom of throwing the bones or dice as a method of divination in common use, but on a more elaborate system, among Bantu peoples of South and South Central Africa as a method of divination and witch-finding. It is evidently an importation among the Naron, for Miss Bleek says they seem to know very little about it.

The religious beliefs of the Naron are confused and evidently composite. Hottentot belief is clearly responsible for their hazy views of a supreme being, and Miss Bleek is more than probably correct in thinking that the original form of their religion was worship of the moon, which, by the way, as so often is regarded as masculine. The medicine man, who is both magician and doctor, holds no special position. Quarrels among medicine men lead to the use of 'grass arrows,' imitation arrows four or five inches long. These, when thrown blunt end foremost, against the opponent's karos, cause death by magic.

Miss Bleek's record is one of change, of disintegration, rather than degeneration, thanks perhaps to the fact that they have no intoxicating liquors, not even Kaffir beer. They no longer have chiefs, though the older men remember them. Originally nomad hunters, the game laws are forcing them to become vegetarians; though they retain their nomadic habits of wandering from water-hole to water-hole in small groups. For they do not cultivate, and have no cattle. Marriage was by capture, of which only a vestige remains. The only regulation appears to be that brother and sister may not marry, and polygamy is permissible, though not general. Of their mentality, Miss Bleek speaks favourably, also of their capacity for work. It is clear that their extinction is by no means inevitable, given patient training, and a sympathetic understanding of their inability to endure long uninterrupted periods of employment, which would make it possible for them to supplement their present mode of subsistence, bound sooner or later to prove inadequate.

The School of African Life and Language is to be congratulated on its first publication. Such an excellent beginning should encourage some generous benefactor to supplement the funds, which are at present inadequate to meet the cost of publication on a more extensive scale.

Heat for Students.

Heat and Thermodynamics. By Dr. J. K. Roberts. Pp. xvi + 454. (The Student's Physics, Vol. 4.) (London, Glasgow and Bombay: Blackie and Son, Ltd., 1928.) 30*s.* net.

AN advanced text-book upon heat has been urgently needed. Most of the literature available for honours students which dealt with the wide range of topics that are included under this title has either been too elementary or too specialised, and, in particular, it has been impossible to refer them to any good account in English of the many accurate experimental researches of recent years; whilst it is admittedly important that they should consult original papers occasionally, the pressure of preparation for examinations does not permit of extensive reading of this nature. Dr. Roberts's book fills the gap in a student's library that was present as a result of this state of affairs, and provides in a single volume a reasonably complete account of both the theoretical and experimental aspects of the subject.

The first eleven chapters are mainly concerned with thermal measurements and such theoretical matters as are directly connected with them. Thermometry, the properties of gases, calorimetry, thermal expansion, and the transfer of heat are dealt with more or less in the usual order, but with a range and detail that is new, and makes excellent reading. Considerations of space have made it necessary to omit details of some important and accurate experiments that would find a place in a larger treatise, but Dr. Roberts's choice of typical experiments of each class, based as it is upon his own experience at Teddington and elsewhere, is that of an expert. It is satisfactory to find in this connexion that whilst most weight has naturally been given to recent work in which high precision was the objective, the classical researches of Andrews, Regnault, Rowland, and others have not been entirely ignored. The work of Laby and Hercus on the mechanical equivalent of heat appeared too late for description in full, but the methods and results have been given in outline. The only important alteration that might be desired in these earlier chapters, in fact, is the pro-

vision of even fuller accounts than have been given of the properties of bodies at very low temperatures, and the ways in which they have been studied ; the relevant original publications are scattered, and those emanating from Leyden, in particular, are not to be found in all science libraries.

The remainder of the book is devoted to the more theoretical aspects of heat, thermodynamics being represented by seven chapters, and radiation and quantum theory by three. The thermodynamics has been developed from the two fundamental laws, without recourse to the methods of statistical mechanics. Certain sections are not given so fully as in Preston's "Theory of Heat," which could scarcely be improved upon for its treatment of general principles, but Dr. Roberts has succeeded in presenting thermodynamics as a useful physical tool, and not as a mere branch of mathematics, more than fifty pages, for example, having been alloted to physical and chemical equilibrium and to the Nernst theorem.

The section on the classical theory of radiation, again, is not developed with the rigour of M. Planck's "Wärmestrahlung," the conception of rays being made more use of than that of cones of radiation, but there are complete proofs of the laws of Kirchhoff, Stefan, and Wien, the last being obtained by the help of Westphal's geometrical simplifications. A derivation is also given of the formula for the number of independent vibrations of a continuous medium, whilst there is a chapter on power cycles, and one on the equation of state of solids, the latter being a good introduction to the work of Born, Debye, and Lennard-Jones in this field. An appendix includes a short but useful list of thermodynamic relations, and a few pages on the properties of steam.

It must be emphasised that this is essentially a text-book, and that it is not intended for specialists. It should, nevertheless, interest many who have left the days of examinations far behind them, and its value for these readers will be enhanced by the numerous foot-note references to original papers. With regard to its chief aim, it is very difficult to predict with any certainty whether or not any text-book will appeal to students. The writer has, however, already brought it to the notice of his classes, and so far as can be judged from the short time during which it has been in use, it fulfils its purpose admirably ; there is every indication that Dr. Roberts will have to be congratulated on having produced a book that can be recommended for examination purposes without an alternative.

K. G. E.

British Ferro-Concrete Bridges.

Reinforced Concrete Bridges : the Practical Design of Modern Reinforced Concrete Bridges, including Notes on Temperature and Shrinkage Effects. By W. L. Scott, assisted by C. W. J. Spicer. Second edition, enlarged. Pp. xii + 220 + 26 plates. (London : Crosby Lockwood and Son, 1928.) 25*s*. net.

DURING the past decade a very great extension in the use and art of reinforced concrete construction has taken place. Particularly is this the case in connexion with bridges ; and the considerable number of important bridge structures of ferro-concrete erected in Great Britain within recent years is significant of the activity of development. Generally speaking, the employment of such forms was noticeable at an earlier date both in America and on the Continent, and the foreign literature on the subject is fairly extensive. But the book before us probably represents the only volume published in Britain wholly devoted to the exposition of bridge design and construction in reinforced concrete. As such it is both necessary and welcome.

Reinforced concrete design developed along rather crude empirical lines at first, and under such conditions bridge construction in this material was somewhat tentative and not free from fears as to reliability. Paradoxically, the destruction of bridges during the War provides the best proof of the inherent powers of resistance of this class of construction when well designed and soundly built, the difficulty of completely destroying them having been well demonstrated. In first cost, probably the reinforced concrete bridge does not offer any great advantage over the steel structure, but in upkeep charges it is superior. The present volume does not deal with costs, but it displays considerable power in the art of straightforward exposition of forms and design methods and it covers the range of suitable concrete bridge types very clearly.

After chapters on rolling loads and influence lines, wind pressure and temperature effects, etc., which may be considered preliminary to the main theme, the author proceeds to discuss arch bridges and the elements of their design in detail. The ferro-concrete type lends itself to the arch form of construction most appropriately, and has, indeed, been the chief cause of a considerable development in the theoretical bases of rigid arch design. The book deals with both hinged and hingeless arches, but in the main the details of analysis are limited to the parabolic forms of these. The author presumably considers the development adequate to cover the variations therefrom.

A clear chapter is given on girder bridges and includes consideration of both the parapet girder and the deck slab and beam types. This is followed by a short chapter on the bowstring girder, which, as it has developed in reinforced concrete work, becomes a variant of the arch type, in which is incorporated a horizontal member suspended directly from the rib. The weakness, in reinforced concrete, of the diagonal shear members common in steel girders, is explained.

The remaining part of the book discusses temporary and permanent hinge construction and deals with the problems of foundations and abutments. The last chapter gives brief explanatory descriptions of several characteristic and important constructions. This includes an outline of the difficult and unique Oswald Street Bridge at Glasgow; but does not refer to the Royal Tweed Bridge at Berwick, the main span of which is the largest reinforced concrete span yet erected in Great Britain. There is an appendix dealing with specifications and materials. The diagrams throughout the book are noticeable for simplicity and clearness; while the many excellent photographs of bridges throughout the text and in the last chapter convey a very clear impression of the artistic effects achieved in modern reinforced concrete bridge design.

A New Spider Book.

The Biology of Spiders. By Theodore H. Savory. (A Series of Biological Handbooks.) Pp. xx + 376 + 16 plates. (London: Sidgwick and Jackson, Ltd., 1928.) 16*s.* net.

MR. SAVORY has performed a useful task in collecting together into one volume the main facts of the biology of spiders. The ideal suggested in the preface, that the reader should have no need to look elsewhere for further information on the subject, was, of course, a counsel of perfection, but for most purposes the account is adequate. The student intending to embark on research—on eye structure, for example—will certainly not be content with the sketch here presented, but he will be greatly helped by an excellent bibliography, very conveniently arranged under appropriate headings.

About the section on external and internal structure little need be said. Mr. Savory is a competent zoologist in addition to being a very keen student of spiders, and his summary of morphological facts may be trusted, and will be found sufficiently complete. The illustrative figures are diagrammatic but generally to the point, though we are rather surprised that he should have passed Fig. 37 (p. 54); this is decidedly misleading as regards the œsophagus, which would appear to have no communication with the outside world. We turn with more interest to the subsequent bionomic sections, which the author justly claims to contain certain original contributions to what would otherwise be a mere compilation—useful though such a compilation might very well be.

The chapter on behaviour is interesting, and we commend the author's insistence at the outset on a cautious interpretation of the phenomena observed. The commonest mistake of naturalists is the attribution to the creatures they study of mental powers which they are far from possessing, and we are inclined to agree with Mr. Savory when, on a later page, he suggests that even such practised observers as Bristowe and Locket have somewhat erred in this respect in their interpretation of the phenomena presented by mating spiders.

The chapter on the spider's web is brief, and is chiefly interesting for the author's views on the origin and evolution of the more complicated snares. These views are of course speculative, but they are at all events reasonable. Naturally he starts from what he calls "the drag-line habit," which would necessarily result in the coating of the retreat. The spread of this coating to the immediate neighbourhood would give the sheet-web of *Tegenaria*, which Mr. Savory regards as the primitive type of snare, and the other forms appear to him to have arisen from the need to economise in silk.

Mr. Savory's account of protective coloration and mimicry gives, in a small space, all the important facts, and his acquaintance with current literature is shown by the inclusion of the interesting experiments of Gabritschevsky on changes of colour exhibited by *Misumena vatia*, published in 1927.

In dealing with mating habits, Mr. Savory of course alludes to the classic researches of the Peckhams on the antics of amorous jumping spiders, but he is chiefly concerned with the more recent observations of Gerhardt, Bristowe and Locket on other araneid families. We regard his discussion of these phenomena as among the most interesting and valuable portions of the work.

After reviewing the fossil spiders and the trap-door spiders, the author proceeds to consider the probable course of evolution of the whole order. He figures a hypothetical primitive spider and suggests lines of development resulting in the main divisions now recognised. A full discussion of his views would occupy more space than is at our dis-

posal. Sufficient has been said to give a fair idea of the scope of the whole work.

Mr. Savory's style is clear, if his touch is not conspicuously light. We rather regret his revival of the term 'spiderling' which used to irritate us in McCook, and we now and then find him employing an uncouth term. What, for example, are 'Behaviourists'? The appendix on "Some other Arachnida" will be welcomed by certain of his readers, but we hope that when a new edition is called for, he will supply better figures to illustrate the ticks. Those in the text are, not to put too fine a point upon it, atrocious. C. W.

Birds of Malaya.

The Birds of the Malay Peninsula: a General Account of the Birds inhabiting the Region from the Isthmus of Kra to Singapore with the Adjacent Islands. By Herbert C. Robinson. (Issued by Authority of the Federated Malay States Government.) Vol. 2: *The Birds of the Hill Stations.* Pp. xii + 310 + 25 plates. (London: H. F. and G. Witherby, 1928.) 35*s.* net.

MR. ROBINSON has produced his second volume on the birds of the Malay Peninsula with commendable speed, only one year having elapsed since the publication of the first volume, which contained the "Common Birds of the Malay Peninsula." The present contains descriptions of the "Birds of the Hill Stations," Mr. Robinson having fixed a minimum level of 2500 feet for the purposes of his work.

The title of the volume is perhaps a misnomer, for hill stations in the Malay States are still in their infancy, and the volume might have been called with greater accuracy "Birds of the Hill Ranges." The height of the majority of the main hill-ranges runs to some 7500 feet and, for the most part, they are covered with primitive forest but little cut up by villages and their cultivation, though intersected here and there by grassland and forest streams.

In reviewing the first volume we have already expressed our regret that the author has been obliged to bring out his volumes in the form adopted. The work has been divided into four parts. In the first volume, as already mentioned, he dealt with the "Common Birds of the Malay Peninsula," whilst the two volumes still to come will include "Shore and Water Birds," the "Rarer Birds," etc. Such a method of dealing with the avifauna of any country must necessitate an immense amount of unnecessary overlapping, which makes it very difficult for the would-be reader and student to find his way about in the different volumes. In a vast area such as the Malay Peninsula, birds which are of great rarity in one part are common elsewhere, whilst many are restricted in their habitat to comparatively small areas and are absent elsewhere.

In spite of this one great drawback, the present volume forms a most valuable, interesting, and well-written addition to our knowledge of the avifauna of the Malay Peninsula, and we congratulate its author on its production, which will fill a long-felt want. The classification adopted is on the same lines as that for the past volume. It commences with the game birds, continues with the pigeons, rails, raptores, and owls, and concludes with the Pico-Passeres. The author ignores orders and sub-orders and adopts the easier, and perhaps wiser, course of dividing his birds into families only. On the other hand, he accepts a vast number of genera which are based on very slight characteristics. Thus he resuscitates Hume's name *Athenoptera* for some of the Scops owls of the *spilocephalus* group, though these birds are almost indistinguishable from some members included by him in *Otus*. In the circumstances it is perhaps discreet of the author not to attempt to explain to his readers the characters upon which he relies to distinguish his genera. The 25 coloured plates by Gronvold are of their usual excellence and of a standard worthy of so important a work; the paper used for the text, however, is very heavy, and the large volume therefore somewhat inconvenient to handle.

We are glad to see that Mr. Robinson gives vernacular names to the great majority of forms with which he deals. Many authors omit this important detail on the grounds that trivial names given by Orientals are of no value, as they refer only to classes and not to species of birds. Most of them forget that these class names are nearly always amplified by prefixes descriptive of the particular species described.

We shall look forward with pleasure to Mr. Robinson's future volumes, which we feel sure will be of equal value to the present.

Physics for Non-Specialist Students.

Physics for College Students: an Introduction to the Study of the Physical Sciences. By Prof. A. A. Knowlton. Pp. xix + 641. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 18*s.* 9*d.* net.

PROF. KNOWLTON'S text-book is an attempt to treat the subject matter of physics in such a way as to justify its study by students who do not

need it for future technical work but simply for its general educational value. Having taught physics for twelve years in an engineering college where it required no justification, the author moved to an arts college and was then faced with the question: Why should students study physics? This book is an outcome of his attempts to present the efforts of man to systematise and master his physical environment, in such a way that the question is satisfactorily answered. In order to do this, he has had, inevitably, to drop the usual more or less logical presentation of physics under separate headings of mechanics, heat, etc.; and further, to add the necessary spice, he has included a good deal more of the 'new physics' than is the custom in such text-books. This entails leaving out certain portions, chiefly accounts of the older classical experiments, and methods of measurement, the latter being left to the laboratory course: the book is thus kept a reasonable size; there are fifty chapters, each meant to be read comfortably at one sitting.

The first chapter explains the place of physical science in modern civilisation and gives an excellent account of scientific method and attitude of mind and the distinction between facts and hypotheses. Starting from the notion of 'work,' since "work is the most general and important article of commerce in the modern world," the author leads up to the concept of 'energy,' which is the central theme of the book. This accounts for the early introduction of chapters on the measurement of energy in its various forms and on the connexion between matter and energy. In the thirteenth chapter the sun is considered, as an introduction to the study of the sources and modes of distribution of energy, and this leads to the treatment of the motion of falling bodies, the production of motion, spectra, magnetic and electric fields, and atomic structure. Then after wave motion comes radiation, leading up to X-rays, relativity, and quantum theory. The remaining fourteen chapters deal with the physics of the air, including sound; properties of matter, solid and fluid; some simple thermodynamics; and, finally, some more advanced magnetism and electricity with their practical applications.

The obvious advantages of this method of presenting a subject like physics are that it enables students, after the first few chapters, to have a mental background against which further knowledge can be viewed, and it also allows what Prof. Knowlton calls a cyclic arrangement, that is, a constant reiteration of fundamental facts and principles. The attempt made throughout to utilise, in explanation, things familiar in everyday life is specially noticeable in the list of examples which follow each chapter, which are graded as to difficulty. In fact, some of the problems are so attractive as to be almost irresistible, which is saying a good deal. There are also timely paragraphs on scientific accuracy, measurement of quantities which vary irregularly, physical 'laws,' etc.; and nowhere has true scientific caution been sacrificed to enthusiastic stimulation of interest. The illustrations are good, especially the photographs in the optical section.

Prof. Knowlton has certainly succeeded in producing a text-book which justifies its own study; and it is with no surprise that one learns that it has already met with "marked student approval."

Zoology for Indian Students.

An Elementary Text-Book of Zoology for Indian Students. Adapted from "An Elementary Course of Practical Zoology," by Profs. T. J. Parker and W. N. Parker. Second edition. By B. L. Bhatia. Pp. xii + 684. (London: Macmillan and Co., Ltd., 1928.) 15*s.* net.

SOME nine years ago the excellent "Elementary Course of Practical Zoology," by T. J. and W. N. Parker, was taken in hand by Mr. B. L. Bhatia, of the Government College, Lahore, and adapted to the special needs of Indian students. The book in its new form, entitled "An Elementary Text-Book of Zoology for Indian Students," has now deservedly reached a second edition. While the plan follows in general that of the Parkers' original book, it has been modified so as to make it less of a mere description of 'types' and more of a general text-book.

Part I., occupying about a third of the volume, remains as before—a description of the frog, forming an admirable introduction to vertebrate anatomy, histology, and physiology. There are various improvements in detail, as, for example, in the figure of the frog's heart, which is still capable of improvement, as is also the account of the physiological action of the conus arteriosus.

Part II. shows more alteration. A good account of the malarial parasite is given; the student is told how the mosquito "not only sucks blood but also spits into the wound," and his attention is further gripped by his being made to realise how India was the scene of Ross's original discoveries, and how practically important to India is the successful prevention of malarial disease.

In the list of special types, various changes have been made to suit Indian conditions. The earthworm is no longer the familiar *Lumbricus*, but the

Indian *Pheretima posthuma*, which, while in many respects equally suitable, suffers under the great disadvantage from the teacher's point of view that its nephridial organs are of extreme complexity and accordingly much less suitable than those of *Lumbricus* for driving home certain of the important general principles of the morphology and physiology of renal organs. The crayfish of the Parkers' book is replaced by the prawn *Palæmon*, so far as external features are concerned, and the cockroach; while, as is entirely suitable, a short sketch is given of the life-history of a mosquito. The freshwater mussel as a type has been cut out, while on the other hand there have been added to the book chapters dealing with more general aspects of zoology. The main groups of the animal kingdom are briefly reviewed, and the volume concludes with three chapters dealing with cytology, embryology, and evolution.

Here and there are details which should be looked into when the next edition is being prepared—such as the references to 'true bone,' air-bladder, and conus arteriosus of fish; and the absence of nephrostomes in the metanephros. In the chapter on evolution there is still apparent the tendency to think in terms of organs or parts of organs instead of in terms of individual animals; while many teachers would regard it as an improvement to drop entirely the terms 'acquired character' and 'mutation'—the first because its use seems at once to cause confusion of thought in certain minds, the second because its use by different writers in different senses has caused it to lose its value as a precise scientific term.

Apart from such minor blemishes in detail, the book is a thoroughly good one and may be warmly recommended to Indian teachers and students of zoology. It is well illustrated, and the descriptions of the various animal types are accompanied by excellent directions for their practical investigation by the student.

A Bibliography of Bibliographies.

Bibliography—Practical, Enumerative, Historical: an Introductory Manual. By Henry Bartlett Van Hoesen, with the collaboration of Frank Keller Walter. Pp. xv + 519. (New York and London: Charles Scribner's Sons, 1928.) 27*s.* 6*d.* net.

THIS work is based upon a series of lectures delivered annually at Princeton University since 1923. Its principal object is to train the graduate student in the use of bibliographies, and to inculcate the value of method in his practice. The backbone of the work is a bibliographical appendix covering some eighty pages and enumerating more than two thousand bibliographies, and the first eleven chapters of this work are in the nature of a commentary upon the bibliographies listed.

The authors rightly stress the fact that their manual is introductory rather than complete, and that their aim has been to set the student's feet on the right path of investigation rather than to load him with descriptions of all necessary material. Within these limits we consider that the work has been carried out successfully. The selection of bibliographies is judicious and singularly free from national bias, and the critical commentary proves that the authors are skilled craftsmen. Omissions, of course, there are. Archive searching should have been given a separate chapter, and the "Official Guide to the Public Record Office of Great Britain" should have been included. Under 'technology,' again, we find an entry for the "Catalogue of the German Patent Office," but none for that of the British Patent Office, or for its numerous "Guides" and "Subject Lists." A more serious defect is the weakness of Chapter ii. on practical bibliography. The nature of research is insufficiently explained, and the collection of bibliographical material and the rules for compiling bibliographies are treated together although the two subjects are entirely distinct. Most collectors err on the side of false economy and pay for it in after life by having to recopy or remount their collections on paper of larger size. The modern 'ringbooks' appear to offer one satisfactory solution of the problem.

Again, the student should be warned against undertaking work for which he lacks the necessary technical equipment. An engineering subject demands an engineering training. Jenkins's "Power Locomotion on the Highway," 1896, and Hopwood's "Living Pictures," 1899, are fair examples of successful bibliographical work by competent men. The bibliographer should also be advised that, in whatever order he elects to publish his bibliography, he should at some period of its compilation sort his entries in chronological order and submit them afresh to critical examination; for chronological order solves many questions of authorship, priority of statement, and other bibliographical problems. We think that in this chapter the authors have leaned too heavily upon outside opinions, which are often contradictory and far from helpful.

The final chapters of this work are careful compilations of the histories of writing, printing, and book production. They form interesting reading, but add little to the practical value of the work.

Our Bookshelf.

Archæology.

Oraon Religion and Customs. By Rai Bahadur Sarat Chandra Roy. Pp. xv + 418 + 20 plates. (Ranchi: *Man in India* Office, 1928.) 12 rupees.

ETHNOLOGISTS are indebted to Sarat Chandra Roy for his valuable book "The Oraons of Chota Nagpur" (1915), and now he has provided a study of Oraon religion and customs which should be read by all those who are interested in primitive religions. The Oraons (or Kurukhs) are immigrants on to the plateau which they share with the aboriginal Mundas and other tribes.

The especial value of this book is not merely in the detailed accounts of socio-religious and religious rites and ceremonies and magical practices, but in the very suggestive religious transformations that have occurred since the Oraons arrived, and the process is still continuing. The original religion centred round (1) the supreme spirit, or spirit of good, Dharmes, who was formerly the sun-lord, the author, preserver, controller, and punisher of men, gods, and spirits, and (2) the 'evil-eye' and 'evil-mouth' as representing the spirit of evil. Most of the village gods and spirits were appropriately borrowed from the Mundas, who had long been settled on the land, and a few have been borrowed from their Hindu neighbours. There are also ancestor-spirits whom the deceased Oraon joins on the annual 'great marriage' or 'bone-drowning' day; apparently these were formerly considered to be mischievous, but now are mainly beneficent. The most important annual ceremony is the spring festival of the 'marriage' of the village priest with his wife, in token of the marriage of the sun god with the earth goddess, so that the earth may fructify; probably it is a survival of a festival of the food-gathering stage in their history. The licentiousness permitted on this occasion is believed to stimulate the fertility of the earth.

The germ of the Bhakti cults was very ancient, but under Hindu influence it was fructified as reverent faith in and loving adoration of a personal deity; thus was the way prepared for Christianity, which was introduced in 1845. Hindu organisations have tried to bring the Oraons into the official Hindu fold by giving them ceremonial purification, but with little effect.

Chivalry: a Series of Studies to illustrate its Historical Significance and Civilising Influence. By Members of King's College, London. Edited by Prof. Edgar Prestage. (The History of Civilisation Series.) Pp. xv + 231 + 24 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1928.) 15*s.* net.

A VOLUME composed of a series of lectures delivered by a number of individuals must necessarily lack the unity of outlook of a book by a single author. This is a serious defect in dealing with so important a factor in the history of western civilisation as chivalry. However great an authority each of the authors whose lectures are included here may be on his special branch of the subject, the description of the characteristics of chivalry of countries—England, France, Spain, Portugal, and so on—misses the interpretation of the facts which is the function of a history of culture such as this series aims to be. Hence apparent discrepancies in the attribution of chivalry as a characteristic outcome of the temperament of now one, now another, nation.

A broader treatment would have brought out the fact that chivalry was an expression of the ideals, temperament, and culture of the Nordic peoples who had imposed themselves as rulers over a great part of Europe. Hence the paradox of chivalry that its ideals prevailed within the caste only, and did not affect relations with the community, who, in fact, were a subject population. Subject to this reservation, this book is an addition to the literature of chivalry which is to be valued, especially where it breaks new ground. The illustrations, as nearly as possible contemporary, have been particularly well selected.

The Ancient Wells, Springs, and Holy Wells of Gloucestershire: their Legends, History, and Topography. By R. C. Skyring Walters. Pp. xiv + 194 + 62 plates. (Bristol: The St. Stephen's Press, 1928.) 12*s.* 6*d.*

GLOUCESTERSHIRE, owing to its geological formation, is a county exceptionally rich in springs and wells. The remote character of much of its countryside has tended to preserve the memory of the sacred character attributed to water by early man, which in modern times survives in the association of the well with a Christian saint. In his descriptive account of the numerous sacred wells of Gloucestershire, Mr. Walters, while constantly recognising that paganism lies at the root of the esteem in which the wells have been held, does not as a rule offer any suggestion as to the origin of the specific cults, or trace it further back than the dedicatory saint. The custom of offering pins, rags, and coins to the well he attributes to the Romans; but the distribution of the custom in Great Britain and its prevalence in Ireland point to a more remote origin. Mr. Walters admits Wandswell as "at least one survival of paganism," the name being connected with Woden, but to speak of "Christian well-worship" is a contradiction in terms unless Christian is used merely in a chronological sense.

The Vampire: his Kith and Kin. By Montague Summers. Pp. xv + 356 + 8 plates. (London: Kegan Paul and Co., Ltd., 1928.) 15*s.* net.

LIKE his books on witchcraft, Dr. Summers' study of the vampire combines a vast erudition with a complete acceptance of the orthodox theological point of view. Some knowledge of the history of

controversy relating to witchcraft and demonology is requisite in order that the reader may not dismiss the book as merely credulous and not, as it is, a real contribution to the literature of the subject. Yet it may not be uninstructive to mention one minor matter which brings out clearly the author's point of view. He accepts the real existence of the vampire. That is a matter of authority. He doubts that a nurse was in attendance when Bram Stoker's play "Dracula" was presented in London. Yet this was a statement of fact and could have been verified by inquiry. If, however, the reader is prepared not to exact a scientific spirit of scepticism, Dr. Summers' book will be found a mine of information relating not only to the vampire belief, but also to the abnormal pathological states which, without doubt, gave rise to the belief—a gruesome but nevertheless instructive field of inquiry.

Biology.

Faune de France. 18 : *Diptères (Nématocères)* ; *Chironomidæ*, III. *Chironomariæ.* Par M. Gœtghebuer. Pp. 174. 32 francs. 19 : *Hyménoptères vespiformes*, II. (*Eumenidæ, Vespidæ, Masaridæ, Bethylidæ, Dryinidæ, Embolemidæ.*) Par L. Berland. Pp. viii + 208. (Fédération française des Sociétés de Sciences naturelles : Office central de Faunistique.) (Paris : Paul Lechevalier, 1928.) 36 francs.

THE "Faune de France" series of monographs is now familiar to most zoologists and the separate parts already issued have been noticed at intervals in our columns. The two most recent fascicules that have come to hand form Nos. 18 and 19 in that series ; No. 18, by M. M. Gœtghebuer, is concerned with midges forming the tribe Chironomariæ of the family Chironomidæ; and No. 19, by M. L. Berland, deals with the true wasps, together with certain related groups commonly united to form the family Bethylidæ. The method of arrangement adopted in these two parts is similar to their predecessors ; namely, a short introduction on structure and biology followed by generic keys : under each genus is a key to the species, while each species is separately described, its general distribution indicated, and any important facts known relative to its biology are recorded. The numerous illustrations and full bibliographic references are also noteworthy. We commend these two monographs to the notice of English entomologists, since the French fauna includes most of the British species in the groups concerned. A. D. I.

Gilbert White : Pioneer, Poet, and Stylist. By Walter Johnson. Pp. xvi + 340 + 4 plates. (London : John Murray, 1928.) 15*s.* net.

MANY commentaries on the writings of Gilbert White have been published, but none has worked out in such detail the aspects seized upon in this volume. In analysing the matter and the method of presentation of White's observations, the author has naturally lost the very essence of the attractiveness of the original works, but he has made a scientific appreciation which will be valued by those who would understand the place of these observations in the light of modern knowledge.

The disconnected studies of "Selborne" and other works are here grouped and classified in their due relationship, ecology, birds, other vertebrates, insects, botany, geology, meteorology, and the like, and there are excellent chapters on the man, the scope of his work, and the distinctive quality of his prose style. Throughout the work the reader is brought in close touch with the meticulous observation, glimpses of far-seeing speculation, simple and clean-cut phraseology, which have made "Selborne" the most widely read of Nature books. The author claims that all the information of scientific value not previously printed from White's MS. has now been transcribed and made public in this volume.

Organographie der Pflanzen : insbesondere der Archegoniaten und Samenpflanzen. Von Prof. Dr. K. von Goebel. Teil 1 : *Allgemeine Organographie.* Dritte, umgearbeitete Auflage. Pp. ix + 642. (Jena : Gustav Fischer, 1928.) 30 gold marks.

THIS new edition of the general section of a well-known text-book has increased considerably in size, and the new material has not been simply interpolated, but the balance of the book has gradually changed with the maturing views of its veteran author as whole sections have been rewritten and reduced or increased in prominence. The tendency seems still to be towards a stressing of the interrelationship of environment and organism during development. This side of organ development receives much attention in the general introduction, and is the special subject of the last ninety pages. The book remains an invaluable mine of information, especially upon experimental morphology. The illustrations in the new edition have increased in number from 459 to 621, most of them the work of the author, his colleagues and students.

Chemistry.

Symbols and Formulæ in Chemistry : an Historical Study. By Prof. R. M. Caven and Dr. J. A. Cranston. (Manuals of Pure and Applied Chemistry). Pp. ix + 220. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1928.) 15*s.* net.

SYMBOLS and formulæ have been used incessantly from the early days of alchemy down to these modern times in which a radiating atom of sodium is represented by the scheme $^2S_{\frac{1}{2}} - {}^2P_{\frac{1}{2}\,\frac{3}{2}}$. The title selected by the authors therefore provides them with a convenient excuse for drilling a bore-hole through the whole of the strata in which the history of chemical theory is embedded. The samples which they have extracted are naturally not the same as if they had been concerned with the general history of chemistry, and many obscure details are brought into the light of day ; but the reader will find that the atomic and molecular theories, the earlier and later theories of molecular structure, including stereochemistry and co-ordination, fall

within the scope of the volume, as well as the modern electronic theory.

The reader has thus an opportunity of taking an unfamiliar course through familiar fields of study, and will be well repaid for doing so. It is a pity, however, that the cost of this sectional history is greater than that of a more comprehensive text-book, since many readers who would purchase the latter will be content merely to borrow the former.

T. M. L.

Fixation of Atmospheric Nitrogen. By Frank A. Ernst. (Industrial Chemical Monographs.) Pp. ix + 154. (London: Chapman and Hall, Ltd., 1928.) 12*s.* 6*d.* net.

THE author of this book points out in the preface that it is not written for the scientific specialist, but "for the teacher and student, for the business man and banker." The book deals first with the sources of nitrogen and the need for its fixation from the atmosphere, and then considers in detail the arc process, the cyanamide process, the direct synthetic ammonia process, and ammonia conversion products. The material is well presented, and is especially valuable on account of the full statistics given not only throughout the text and the chapter entitled "Statistics," but also in the tables at the end of the book. A fair bibliography is also included. The chapter dealing with "Economic Considerations" indicates clearly a number of economic problems that arise in the commercial fixation of nitrogen. At the beginning of Chapter ii. (p. 11) Bertholet is mentioned instead of Berthollet, and Sir Humphry Davy's name is spelt incorrectly. No mention is made of MacDougall and Howles, who first worked the arc process in Manchester, and whose patent (1899) preceded that of Bradley and Lovejoy (1902), on the basis of which the author (p. 12) claims that "the industrial fixation of nitrogen thus had its birth in the United States."

The Problem of Fermentation: the Facts and Hypotheses. By M. Schoen. With an Introduction by Prof. A. Fernbach. A Monograph of the Institut Pasteur, translated from the French by H. Lloyd Hind, and revised and enlarged by the Author. Pp. xii + 211. (London: Chapman and Hall, Ltd., 1928.) 21*s.* net.

THE author gives an interesting account of the present position of the problem of fermentation and traces its development from the time of Pasteur to the present day. The whole range of the subject is covered: alcoholic and lactic acid fermentation, the place of pyruvic acid and acetaldehyde in alcoholic fermentation, the function of phosphates and the effects of changing the reaction of the medium. Analogous processes in animal tissues are frequently referred to, such as the function of lactic acid in muscular contraction or in malignant growths. The references are given at the foot of each page and are also collected into a bibliography of some forty pages, which in addition serves as an index of authors' names. This is a volume for the specialist, but should be widely read also by those interested in related subjects for the light it frequently sheds on processes which bear some analogy to alcoholic fermentation itself.

The Determination of Hydrogen Ions: an Elementary Treatise on Electrode, Indicator, and Supplementary Methods, with an Indexed Bibliography on Applications. By Prof. W. Mansfield Clark. Third edition. Pp. xvi + 717. (London: Baillière, Tindall and Cox, 1928.) 30*s.* net.

PROF. CLARK'S standard work on the determination of hydrogen ions is too well known to require any introduction. The third edition, recently issued, has been thoroughly revised and brought up-to-date. The author points out that the number of papers on this subject has rapidly increased in recent years, so that, in spite of revision and enlargement, the work probably covers the field less completely than the first edition. In spite of this, few except the advanced specialist will fail to find details required within its pages on the colorimetric or electrode methods of determination. The subject is treated from both the practical and theoretical points of view, and forms a very complete treatise. As the question of hydrogen ion activity enters into most biochemical problems to-day, selected portions of the book will be of value to most biochemists and physiologists, and can be studied with profit. There is an extensive bibliography and a list of definitions of common terms.

Scent and All About It: a Popular Account of the Science and Art of Perfumery. By H. Stanley Redgrove. Pp. viii + 100. (London: William Heinemann (Medical Books), Ltd., 1928.) 3*s.* 6*d.* net.

THE careful reader of Mr. Redgrove's booklet will gather many unusual items of information, such as the natural sources of ambergris, frankincense, opoponax ("a name for perfumers to conjure with"), and civet. He will notice that the civet used in Great Britain comes mainly from Abyssinia, packed in ox-horns; that the odour of Jockey Club is that of the sweet wild flowers wafted over Epsom Downs; that diphenyl oxide develops an odour of geranium leaves only in dilute solution; that labdanum, the nearest approach to ambergris in the plant world, is gathered by shepherds from the fleeces of sheep which browse on the hills of Cyprus and Crete; and that the garden musk (*Mimulus moschatus*) of the present day has lost its odour, possibly owing to the fragrant plant of our ancestors having been a 'form' which has since died out. Within its modest limits this little book amply fulfils the author's purpose of providing the general reader with a popular account of the science and art of perfumery.

J. R.

Inorganic Chemistry. Vol. 1: *Non-Metals.* By Dr. G. H. Bailey and Dr. D. R. Snellgrove. Pp. viii + 488. (London: University Tutorial Press, Ltd., 1928.) 6*s.* 6*d.*

THIS book, together with the companion volume, "Inorganic Chemistry. Vol. 2: Mainly Metals," is intended to cover the course for an intermediate

university examination, and is well produced for its price. The style is clear and interesting, but a lack of original and more inspiring illustrations does not aid its favourable comparison with some other recent text-books of similar character. The statement is made on p. 198 that the absorption of bromine vapour by iron filings produces ferrous bromide, $FeBr_2$; the compound formed is Fe_3Br_8, and is an important source of potassium bromide. The paragraph on sulphur heptoxide, S_2O_7 (p. 347), gives the impression that no further work has been carried out since Berthelot's supposed discovery in 1877.

An Introduction to the Chemistry of Plant Products. By Dr. Paul Haas and Dr. T. G. Hill. Vol. 1: *On the Nature and Significance of the Commoner Organic Compounds of Plants.* Fourth edition. Pp. xvi + 530. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 18*s.* net.

NOTWITHSTANDING the systematised courses in biochemistry which are now available in many centres, the new edition of this book will continue to subserve the authors' original aim of providing students of biology with an account of the chemistry and physiological significance of some of the more important substances occurring in the plant. It contains sections on fats, oils, and waxes, aldehydes and alcohols, carbohydrates, glucosides, tannins, pigments, nitrogen bases, the colloidal state, proteins, and enzymes; there is also an appendix on hydrogen ion concentration. It has been brought up-to-date, and although necessarily it contains a good deal of somewhat elementary matter, one may suggest that it could be read with profit by organic chemists who are wishful to view their subject from a biological outlook. J. R.

Engineering.

Foundations: the Examination and Testing of the Ground preliminary to the Construction of Works—Methods and Appliances. By William Simpson. (The Glasgow Text-books of Civil Engineering.) Pp. xviii + 256. (London: Constable and Co., Ltd., 1928.) 18*s.* net.

THIS book is the latest addition to the well-known series of civil engineering text-books produced under the general editorship of Prof. Moncur, of the Royal Technical College, Glasgow. Its scope is well indicated by the sub-title. It is wholly concerned with the study of the ground and of those methods of examination and test to be followed in the collection of essential data on which to base the design of the foundation arrangements for heavy structural work. The first chapters deal with the features of geological surveys, and, indeed, the whole book gives a very clear impression of what the author refers to as "the intimate relationship which exists between Structural Geology and Civil Engineering." The development of the subject proceeds through a very complete discussion of boring and test shaft methods under all conditions, both on land and under water. The final section provides a clear treatment of the procedure and appliances necessary for testing the bearing capacity of the ground by direct loading on open areas, and by test pile or exploratory tube methods in deep foundations.

The book throughout is concerned with the practical problems, apparatus and operations of search. There is no collection or classification of specific ground data; but the care with which the detail appliances and methods are explained, the descriptive excellence of the text and the clearness of the diagrams, combine to make the book eminently suitable for students.

Television. By Alfred Dinsdale. Second edition. Pp. xx + 180 + 33 plates. (London: Television Press, Ltd., 1928.) 5*s.* net.

IN a foreword to this little book, Dr. J. A. Fleming recommends it to those who desire an all-round view of the art of television as it exists at present, and of the problems and difficulties which still face the inventors in this novel field of adventure. We entirely agree with him. He also points out that in all inventions like the telephone, radio telegraphy, and television, there are two stages of development. First of all an idea strikes some one; then various people try to realise it in practice. The next stage is when an inventor like a Bell, a Marconi, or a Baird, makes an invention or discovers a device, sometimes very simple, which opens up a new pathway, and then progress is rapid. When the right clue is obtained, success follows, provided financial aid is forthcoming and systematic experiments are undertaken. The history of the past furnishes many similar cases.

The reader, even although his knowledge of physics is limited, will have little difficulty in understanding this book. There is a great demand by the public for anything new, for anything which contributes to the convenience of life, to entertainment, and to the dissemination of instruction and news. The physical importance of the new discoveries and inventions is considerable, and unlike many theories they are built on a sound experimental basis. The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music.

A Text Book of Telegraphy: Theoretical and Practical. By A. E. Stone. Pp. vii + 455. (London: Macmillan and Co., Ltd., 1928.) 20*s.* net.

THIS book can be recommended to the student who has some previous electrotechnical knowledge. He will find that it is easy to understand. The descriptions of the apparatus and the systems in practical use can be readily grasped as only essential parts are shown in the diagrams. Special attention has rightly been given to multiplex systems and to type-printing telegraphs. Only the most modern methods are described. Alternating currents, the transmission of signals, submarine and radio telegraphy, are all touched on and the main theorems in connexion with them are given. The mathematical proofs in several

cases are novel, and to be commended. We were unable, however, to follow the proof of the self-induction of two parallel wires forming a loop (p. 82). However, the answer given is correct, which is the main thing from the practical man's point of view. The distinctions between the capacity of a condenser, the capacity of a conductor, and the capacity between two parallel wires, are not clearly explained. In proving the formula for the latter, the assumption is made that the charges can be concentrated along the inverse lines of the two cylinders. A proof of this should have been given. As a rule, the symbols have been happily chosen. On p. 47, however, Z is used to denote a current; this use we think quite inadmissible. On p. 402 it denotes impedance, a use which has international sanction.

Geography and Travel.

Antarctica: a Treatise on the Southern Continent. By J. Gordon Hayes. Pp. xv + 448 + 16 plates. (London: The Richards Press, Ltd., 1928.) 42*s.*

THE knowledge of Antarctic matters has grown at so great a rate during the twentieth century, owing to the intensive scientific exploration of several areas, that a comprehensive work bringing together in one volume the results achieved cannot fail to be of value. This is part of the task that Mr. Gordon Hayes has set himself. In addition, he gives a critical estimate of the value of recent expeditions, and attempts some forecast of profitable lines of discovery. Beyond all this there are a number of appendices, a bibliography, many excellent illustrations, and a few maps.

There can be no doubt that Mr. Gordon Hayes has brought industry and enthusiasm to his task; and though he has no personal experience of polar work, he has at least the advantage of being an impartial critic of all expeditions. Yet it must be admitted that the book has several omissions and not a few inaccuracies, and falls far short of being a treatise on Antarctica. Some of his criticisms, such as of transport by man-haulage, are of value, but his strictures of the Wilkes expedition are somewhat severe, and his basis for judging the success of an expedition by the length of coast-line discovered is most unscientific. His list of casualties, which he calls the Antarctic Roll of Honour, is incomplete.

It is on the scientific side, however, as apart from the record of discovery, that the book falls far short of its author's aim. This is not surprising when it is realised from the author's list of works consulted that his material is derived mainly from the popular narratives of expeditions. These are not designed to give the scientific results. They are for popular reading. Of the many volumes of scientific reports of recent expeditions, practically the only ones mentioned are those of the *Terra Nova* and a few papers on the work of the *Endurance*. Moreover, there is almost entire omission of French and German works even of a popular nature. If Mr. Gordon Hayes does not make use of the available sources of material, he cannot claim to have written an authoritative treatise.

The People of Tibet. By Sir Charles Bell. Pp. xix + 319 + 57 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 21*s.* net.

SIR CHARLES BELL has written a most interesting and very well illustrated book on the mode of life and domestic customs of the Tibetans which may be accepted as authoritative. The shepherds and herdsmen are probably the purest specimens of the race. The inclement conditions, especially hail-storms, render the peasants' life a hard one. There is a great gulf between these classes and the nobility: the trading community forms a middle class, but with little power; the foreign trade is in their hands, and even the nobility have their commercial agents, for the Tibetan is a born trader. Begging is a hereditary profession, but the monks who go a-begging are on a different footing. There are few countries where women have so good a position, and they are active and shrewd in business matters. Monogamy, polygyny, and polyandry are all found in Tibet, but on the whole monogamy is more prevalent.

The daily life of the gentry is permeated with ceremonial and etiquette, and the usages of courtesy in all its branches are carefully taught to the young. Many of the troubles of travellers here and elsewhere have been due to non-observance of etiquette. Tibet does not lack land fit for cultivation, but lacks the men to till it. The population is decreasing owing to various causes, perhaps more especially to the large number that live celibate lives in monasteries instead of rearing families.

Geology and Mineralogy.

Kohlenpetrographisches Praktikum. Von Dr. Erich Stach. (Sammlung naturwissenschaftlicher Praktika, Band 14.) Pp. iv + 196. (Berlin: Gebrüder Borntraeger, 1928.) 10·80 gold marks.

DURING the last twenty years great progress has been made in the study of coal. Instead of treating it only as a material which on combustion gave certain products, investigators have been studying the material itself, its constituents, their mode of occurrence and association, and their probable method of origin. Coal is a rock rather than a mineral, and much of the progress that has been made has come from its examination by petrological methods. These methods have been developed independently in England, America, and Germany, and their results have been described in many widely scattered publications, consequently a brief summary of the work with a full list of references is very valuable.

The present work is probably more valuable as a survey of the field than as a practical handbook. In the preparation of coal specimens for microscopical examination there are so many technical difficulties and so many 'tricks of the trade' that it is doubtful whether anyone could be sure of success by simply following descriptions of the methods employed. But after describing methods, the author gives a brief but impartial statement of some of the results achieved, illustrated with many

excellent photographs, and followed by a bibliography of nearly 300 titles. The book can therefore be used as an introduction to the subject.

The author differs from most British coal petrologists in recognising only three chief constituents in bituminous coal. He considers that there is no fundamental difference between the clarain and vitrain of Stopes and other authors. He seems to favour the view that the characteristic bodies in Boghead coals probably represent algal colonies.

Some omissions were probably necessary in a work of this type, but we notice no reference to methods of bleaching or reducing the colour of coal sections. The work of Lilpop (Cracow, 1917) on this subject is worthy of mention.

The book should help students in the early stages of research work on coal, and we ought to have many more workers on this subject in England.

H. Hamshaw Thomas.

Bau und Bewegung der Gebirge in Nordamerika, Skandinavien, und Mitteleuropa: Forschungen in den Jahren 1924 bis 1927, ausgeführt mit Unterstützung der Notgemeinschaft der Deutschen Wissenschaft. Von Hans Cloos. (Fortschritte der Geologie und Paläontologie, herausgegeben von Prof. Dr. W. Soergel, Band 7, Heft 21.) Pp. viii + 241-327 + 6 Tafeln. (Berlin: Gebrüder Borntraeger, 1928.) 14 gold marks.

Those interested in theories of crustal drift will find much to their taste in this small work. Prof. Cloos extends his conceptions of 'granite-tectonics' to cover block-faulting and the like. His personal observations and remarks on the granite-tectonics of the Sierra Nevada, on block-faulting in Europe and America, and on the structure of the Western States, are of permanent value, whatever may be the fate of his deductions from them.

The theory advanced is that certain tectonics of the crust result from a world-wide northward flow of subcrustal material against obstacles. One expression of this appears in the wedge-form of the continents arising, as it were, from erosion by such a current. Again, the structure of western America is explained by a south to north Pacific stream impinging on the continental margin. Part of this stream is deflected to the north-west, part passes beneath the continent, and both give rise to correlated tectonic effects. Geologists who favour Wegener's continental drift theory would do well to compare it with these speculations of Cloos. To one not particularly attracted by either hypothesis, the continents appear to be becoming embarrassingly mobile.

The printing is excellent and the plates good, especially one showing the fault-plane of the Christiania trough.

The Nomenclature of Petrology: with References to Selected Literature. By Prof. Arthur Holmes. Second edition. Pp. v + 284. (London: Thomas Murby and Co., 1928.) 7*s*. 6*d*. net.

The second edition of Prof. Holmes's extremely useful "Nomenclature of Petrology" is chiefly notable on account of its reduction in price from 12*s*. 6*d*. to 7*s*. 6*d*. This no doubt will be welcomed by students and research workers, who will find the volume a comprehensive and handy work of reference.

While the author has made a few corrections and slight modifications, there still remain a few inaccuracies, and one still looks in vain for one or two well-established terms. During the eight years that have elapsed since the first edition, many new words have been introduced into petrological nomenclature. The author points out that these are, for the most part, of minor importance. Nevertheless, for this reason their usage is likely to be unfamiliar. It is therefore regrettable that, on the score of the expense, it has not been found possible to incorporate them in the new edition. The deficiencies of the book are trifling, however, and do not appreciably detract from its general utility.

Medicine.

The Blood-Plasma in Health and Disease. By Dr. J. W. Pickering. (Monographs on Medical and Surgical Science.) Pp. xi + 247. (London: William Heinemann (Medical Books), Ltd., 1928.) 12*s*. 6*d*. net.

The author has performed a useful service in collecting within the pages of a single volume what is known about blood-plasma as distinct from the formed elements of the blood. Much has been written about the physiology and pathology of the different blood corpuscles, but the results of work on the plasma have heretofore remained scattered and uncorrelated. In brief, this book treats of the composition of the plasma proteins and their relationship to each other, and of blood coagulation, the physiology of the process and how it can be aided or retarded, with the known pathological alterations in its mechanism.

Upwards of 900 papers are referred to, and it is probably the brief accounts of these investigators' researches following each other in succession from page to page which makes the book rather difficult to read. This is not to say that the author does not attempt to summarise the work quoted and to indicate what in his opinion is the most probable conclusion. Thus the author's view of the process of blood coagulation may be briefly stated as follows: Part of the prothrombin of the plasma is loosely bound, but the greater part is firmly bound, the various proteins being looked upon as a colloidal co-ordinated complex rather than as separate fractions independent of each other. The loosely bound prothrombin unites with protein-phospholipin (cephalin) complexes from disintegrated platelets, to form thrombin, which rapidly unites with fibrinogen, releasing the firmly bound prothrombin, to react further with cephalin. He also considers that there are at least three methods by which plasma can be converted from a sol to a gel, and that it is a mistake to assume that one single process is always responsible for the formation of the fibrin clot.

The theoretical aspects of the subject are made the basis of correlating our knowledge of the

pathology and treatment of abnormal bleeding, and a useful appendix is given of the composition and actions of, and indications for, a variety of commonly used hæmostatics. The work will be of interest both to physiologists and clinicians, and further volumes in this series of monographs will be welcomed.

On Rous, Leucotic, and Allied Tumours in the Fowl: a Study in Malignancy. By Dr. J. P. McGowan. Pp. vii + 99 + 11 plates. (London: H. K. Lewis and Co., Ltd., 1928.) 10*s.* net.

THE observations recorded by Dr. McGowan in this book are a sequel to his study of pernicious anæmia and allied blood diseases, in the course of which he investigated leucosis of fowls and noted sporadic cases of sarcomatous tumour. A detailed examination of these tumours and of the Rous sarcoma No. 1 now lead up to a study of the etiology of malignant growths, with the conclusion that sarcomatous tumours of fowls, including those of a leucotic nature, are probably caused by various non-specific irritants. Evidence is produced to support the thesis that these tumours are manifestations of disease of the hæmatopoietic tissues, the pathology of which is discussed in considerable detail.

Whether the evidence justifies the author's conclusions must remain at present a matter for individual opinion, but whatever this may be, it will be agreed that careful research such as Dr. McGowan describes cannot but assist in elucidating the problems of malignancy.

Metallurgy.

Impurities in Metals: their Influence on Structure and Properties. By Dr. Colin J. Smithells. Pp. xi + 157 + 23 plates. (London: Chapman and Hall, Ltd., 1928.) 18*s.* net.

EXACT knowledge of the effects of impurities on the properties of metals is of fundamental importance to the metallurgist and engineer as well as to the physicist or chemist who uses metals as the subject of his researches. There is, therefore, ample justification for the publication of a volume treating specifically this aspect of metallurgy. Until the author took the subject in hand, no such book had been produced, but whether the present treatise is the one for which metallurgists have been unconsciously looking is quite another matter. The author himself states that he would have preferred to use the term 'minor constituent' instead of impurity, and it is certainly very difficult to justify the application of the word 'impurity' to, for example, the large amount of chromium deliberately added to the stainless steels, to which addition in fact these materials owe entirely their characteristic properties.

The effects of impurities on the mechanical properties of metals are quite inadequately treated. Industrially, the most important metallurgical impurities are probably sulphur and phosphorus in iron and steel. Of these, the former is dismissed in a few lines, and the latter scarcely mentioned. From the historical point of view, too, one would have expected at least a brief reference to the pioneer researches of Roberts-Austen and Arnold and Jefferson on the effects of impurities on copper and gold. None of these workers is even mentioned.

Although much interesting and useful information is made available in a handy form, the work leaves one with the impression that the range of the author's knowledge is too circumscribed to fit him for the task which he has undertaken. The book as a whole is disappointing, and the subject still deserves and needs a far more complete and balanced treatment. It is to the author's credit, however, that he had made us aware of the real need for a book treating as a whole the subject, some parts of which he has himself considered.

Cast Iron in the Light of Recent Research. By W. H. Hatfield. Third edition, revised and enlarged. Pp. xv + 340. (London: Charles Griffin and Co., Ltd., 1928.) 16*s.* net.

IN spite of the extensive use of cast iron as a structural material, its scientific study has lagged conspicuously behind that of steel. Until quite recently, the knowledge of its constitution has been almost entirely empirical, and success in its use has been due to the practical skill of foundrymen rather than to an understanding of the factors which determine its constitution. Since the first edition of Dr. Hatfield's book was published, there have been determined efforts to remove this reproach, but a careful compilation such as this brings out the fact that even now we are very imperfectly acquainted with the constitution of cast iron, and therefore with the means of scientific control of its properties. For example, the relations between the sulphur and manganese contents of the iron are of the greatest importance in determining the degree of chill under given conditions, but the evidence is contradictory, and published work on the subject goes little beyond the knowledge of practical foundrymen. Even the relations between graphite, combined carbon, and silicon cannot yet be represented in a simple and intelligible diagram, and arbitrary assumptions have to be made concerning them.

Dr. Hatfield has included almost all that has been done on the subject, except in regard to the so-called 'pearlitic' irons, which might have received fuller treatment, and the new edition is valuable as a work of reference on a much neglected field of metallurgy. Unfortunately, the references in the foot-notes are frequently incorrect, probably through imperfect proof-reading, and the student who attempts to consult original papers may find himself at a loss. Apart from this defect, however, the book is to be commended to metallurgists as a compendium of facts. When the fourth edition is called for, it may be hoped that such progress will have been made in the scientific knowledge of cast iron that a systematic presentation of its metallography is possible.

C. H. D.

A Bibliography of Metallic Corrosion: comprising References to Papers on Ferrous and Non-Ferrous Corrosion (including Methods of Protection) published up to end of 1927. Greatly enlarged from a Bibliography prepared for the British Non-Ferrous Metals Research Association and privately issued to its Members. By Dr. W. H. J. Vernon. Pp. xi+341. (London: Edward Arnold and Co., 1928.) 21*s.* net.

THE literature of corrosion is extensive and at the same time widely scattered, so that a student of the subject feels the need of a bibliography more than in most branches of applied physical chemistry. Several attempts at such a compilation have been made, but certainly with less success than in the present work, which is likely to prove of great value to chemists and to metallurgists. At first sight it may be thought that the classification which Dr. Vernon has adopted is not the simplest, since there is no alphabetical index of authors, and the arrangement is one of many sections, each of which covers a definite part of the subject. After using the book for a short time, however, it is found that there is no difficulty in tracing any required paper the author of which is known, whilst a thorough system of cross-references ensures that the papers likely to have a bearing on any particular question can be traced with little effort. The bibliography has responded well to the test of looking for known memoirs.

There is no attempt to give the exact title of each paper, a short indication of the subject being given in English, but the original reference is accompanied by references to abstracts in the most accessible English and American journals. When necessary, a brief abstract is added, and this part of the work has been done judiciously, so that the reader is guided to essential papers without having to consult a large mass of material of no importance to his immediate subject. Dr. Vernon is to be congratulated on having performed a useful task with success.

C. H. D.

Miscellany.

History and Historical Research. By C. G. Crump. Pp. x+178. (London: George Routledge and Sons, Ltd., 1928.) 5*s.* net.

THIS is a delightful and stimulating little book. Mr. Crump held an important position in the Public Record Office for many years, but he writes in a spirit which would be equally becoming in a scientific laboratory. In fact, his essay is one of the best proofs we have seen of the essential similarity between all forms of work which aim at increasing knowledge of a living kind. Almost everything he says might be said with equal truth about scientific research.

Mr. Crump starts with the primary and fundamental necessity of an inquiring mind. Every researcher must be possessed with the desire to know. In this he only shares the characteristic which Aristotle assigned to the human species as a whole; when he adds to this the mark of wanting to know something new, or more about something than anyone else knows, he takes rank among original researchers—those who add to the sum of human knowledge. But in order to do this he must at starting be provided with a considerable equipment of general knowledge, and no part of Mr. Crump's book is better than where he dwells on the supreme importance of a well-trained mind in judging of the likely field for research and of the value of evidence, and in presenting it in a lucid and well-ordered form.

Two other admirable features stand out in this manual for the young researcher. One is the insistence on self-reliance. The choice of subject must be individual, and the professor, or older and more experienced colleague, should assist as friend and equal, not as dictator or superior. All the details of his method—the note-taking, and arrangement, the planning and writing of the book—will be subordinate to the main idea, and grow under his hand as he works. In short, the researcher, be he historian or man of science, is master of his own fate, and no one can make or mar it but himself.

Another attractive feature of the book is the style in which it is written, and the constant quiet humour which irradiates the whole. There is no better example of this than the analogy of the choice of a subject with the chase of a lion. The researcher has first to delimit the area in which he may find his quarry. This in itself demands wide knowledge and careful preliminary survey: by these the true haunts of the subject are ascertained. The searcher then advances, slowly and steadily testing and securing all the means of approach; and when at last the noble object of his quest stands before him, he is just as likely to be devoured by the quarry as to make it his own. The former indeed may seem as fine and fitting a reward as the latter.

F. S. M.

The Evolution and Classification of Soils. By Dr. E. Ramann. Translated by Dr. C. L. Whittles. Pp. xii+127. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1928.) 7*s.* 6*d.* net.

STARTING with a definition of soil, the author brings together many of the ideas and systems which have been developed throughout the world for its scientific classification. After discussing briefly the advantages and disadvantages of various methods of classifying soils, a system is adopted which, although almost too wide for general use, is not subject to the serious limitations of most of the older classifications. A soil is classified in accordance with its 'zone' (latitude and longitude) and its 'region' (depending on height, position, humid or arid climate, etc.).

Most soil workers nowadays have a little knowledge of the Russian pedological classifications and nomenclature, and this has proved in many cases a dangerous thing. Those who want to know the exact meaning of *podsol*, *tschernosem*, and similar terms frequently used and mis-used in recent works

on soils will find an excellent discussion on the subject in this book, although the author wisely avoids too drastic a use of modern Russian systems. Soils are but short-lived things compared with their geological neighbours, and our knowledge of their characteristics in bygone times is still scanty—but the paragraph on "Relic Soils" whets our appetite for more.

The translation, in spite of great difficulties, reads easily. Only one slight improvement might well have been made; it would have been better to have anglicised the transliteration of Russian names—the German transliterations offend the eye in an English book and are very apt to be misleading.

The Great Betrayal (*La Trahison des clercs*). By Julien Benda. Translated by Richard Aldington. Pp. x+188. (London: George Routledge and Sons, Ltd., 1928.) 7*s*. 6*d*. net.

THE thesis of M. Benda's book is that the European *intelligentsia* have gone over to the enemy; that is to say, they have deserted the idealist ranks and joined the great army of the Philistines. It is not merely that the *intelligentsia* have become sceptics: they have actually transferred their allegiance, and devote themselves to detract and deride every form of idealism. For example, they lend themselves to "the intellectual organisation of political hatreds," and preach the doctrine of "sacred egotism." They display "the scorn for argument, the excess, the hatred, the fixed ideas" which we are accustomed to associate with the lowest forms of political propaganda. In short, they have prostituted their powers, and have become the militia of materialism. Even internationalism, which assumes imposing idealist airs, is inspired by bankers, industrialists, and trade unionists, whose aims are by no means disinterested.

The most notable betrayal has been an attack upon the intellectual ideal of truth itself, since "truth is a great impediment." There is now, for example, "a bourgeois truth and a working-class truth," and truth varies with frontiers. "Recently certain French thinkers waxed indignant that the doctrines of Einstein were accepted by their compatriots without more resistance." There is doubtless much ground for M. Benda's onslaught in some continental countries. But we do not think that British men of letters or of science have yet reached this stage of cynical barbarism. Yet the book is well worth reading. The translation is good.

J. C. H.

Physics.

Modern Physics. By Prof. H. A. Wilson. (The Student's Physics, Vol. 6.) Pp. xiv+381. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1928.) 30*s*. net.

PROF. H. A. WILSON is best known for his experimental researches, but this book shows that he is also able to give clear expositions of the more theoretical aspects of modern physics. As he has himself recognised, the title is elastic, and not everyone will agree with his interpretation of it. In particular, most examinations demand a greater knowledge of the newer experimental methods and less of mathematical physics than is given here. The outlines of electromagnetic theory and electron theory are especially good, and furnish an excellent introduction to more pretentious treatises, whilst the two chapters on relativity are complete in themselves. The sections on the conduction of electricity through gases are good so far as they go, especially the chapter on flames, but too great weight has been given to the work of the Oxford school, and the treatment of the glow-discharge could well have been entirely replaced by an account of the precise methods for studying ionised gases at low pressures that have been developed in the last few years at Schenectady and at Princeton, the potentialities of which have still to be properly recognised.

The same general criticism applies to the other parts of the book that have an experimental bias. What is given is, nevertheless, concise and accurate. We have noticed only one incorrect statement: the photographing of the artificial disintegration of a nitrogen nucleus is erroneously attributed to Chadwick in the text (p. 225), an obvious slip, since the proper acknowledgment is made to Blackett on the corresponding plate (p. 131).

An Introduction to Physical Science. By Dr. Ivor B. Hart. Second edition. Pp. xii+406. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 4*s*.

An Introduction to Physical Science. By Prof. James Rice. (Benn's Sixpenny Library, No. 115.) Pp. 79. (London: Ernest Benn, Ltd., 1928.) 6*d*.

THOUGH of the same title, these two books differ widely in treatment and in aim. The former, now in its second edition, has already proved useful for beginners in experimental science. Mechanics, heat, light, sound, and magnetism and electricity all find a place in its pages, the young student being introduced to these sections in some fifty experiments which he is himself to work through. Descriptions of numerous demonstrations and applications are also included, the whole being put together in a perfectly natural manner which cannot fail to attract. The arrangement is excellent, and the book is cheap at the price.

Prof. James Rice's book reads more like a retrospect than an introduction. To comment adequately on all the main branches of physics within seventy small pages requires very close packing. We cannot help feeling that the little book would demand a greater effort of concentration than the majority of uninstructed laymen would be willing or able to make. It does, however, provide a pleasant evening's reading for one who already knows, and it might with advantage be put into the hands of students at about the intermediate stage, for the purpose of providing a general survey of past work.

An Introduction to Advanced Heat. By Dr. Ivor B. Hart. (Bell's Natural Science Series.) Pp. vii + 336. (London: G. Bell and Sons, Ltd., 1928.) 7*s*.

THE title of this book has been chosen to indicate a standard beyond that usually reached in schools but somewhat below that expected of candidates for the highest honours in the first university degrees. The author assumes that his readers really know their elementary work; and even so they must draw a deep breath before plunging into the first chapter, which deals fully with the various scales of temperature.

Avoiding the snare of descriptive writing, the author sticks rigidly to his purpose of developing the theory of the subject until he has dealt adequately with the expansion of gases, both from the kinetic and the thermodynamic points of view. All this makes rather stiff reading, but the conscientious student can scarcely fail to have the satisfactory feeling that he is really plumbing the depths of his subject. He will find himself rewarded, at the end, by some more readable chapters, of which perhaps the best—certainly the most novel—is one relating to convection in the atmosphere.

Dr. Ivor Hart has already achieved prominence as a writer of more elementary books and as a biographer. In this latest excursion he is likely to be equally successful.

Intermediate Electricity and Magnetism. By Dr. R. A. Houstoun. Pp. x + 170. (London: Longmans, Green and Co., Ltd., 1928.) 4*s*. 6*d*.

THE title clearly indicates the scope of this book. Although it is written on conventional lines, there are many points in the arrangement which make for the orderly development of the subject in a student's mind, the sequence of the reading being unbroken by tedious descriptions of experiments and by reiteration in applications and examples. By concentrating in the earlier portion of the book upon the elucidation of main principles, the author has removed from the pupil the difficulty of sorting out the grain from the chaff—it is all good stuff. The technical applications of electricity, radioactivity, and 'wireless' are reserved for the end of the volume, after the fundamental ideas have already been formed. A good collection of questions and examples, inconspicuously printed, help to make up a really useful book.

An Outline of Physics. By Prof. A. E. Caswell. Pp. xiv + 773. (New York: The Macmillan Co., 1928.) 18*s*. net.

THIS book is an elementary introduction to physics which is very pleasant to read. It is written to appeal to non-mathematical students and to all who are willing to show a passing interest in physics. The conceptions necessary to modern physics appear quite early in its pages, and by gradual stages the reader is introduced to many of the most striking and most important results of modern research. Analogies are given freely—perhaps too freely, it may be felt, in one or two instances; but the author is always clear, and his final chapter, on the theory of relativity, is exceptionally well written.

War Office. Elementary Notes on Optics and their Application to Service Instruments. Compiled for Use in the Rangefinding Branch, Military College of Science, Woolwich, 1927. Pp. 128. (London: H.M. Stationery Office, 1927.) 3*s*. net.

A USEFUL little book which should fulfil its purpose very well, and give the military student of optics the guidance he needs in understanding the construction of his instruments. It may be suggested that the treatment of simple lenses is a little brief; a fuller discussion of the magnification at various conjugate distances would have been valuable when dealing with variable power telescopes. Also, in spite of the limitations of space, a few remarks on spectacles and on colour filters would have been useful to the service student.

Primary Physical Science. By William R. Bower. Pp. ix + 302. (London: Sir Isaac Pitman and Sons, Ltd., 1928.) 5*s*.

THE book deals with the rudiments of mechanics, heat, and chemistry along the lines laid down for the examination in preliminary technical science of the Union of Lancashire and Cheshire Institutions. For the most part the treatment is conventional, but good historical and biological notes are included. The book suffers from a certain lack of continuity in the reading, as is almost inevitable when a work serves the purpose of a laboratory manual, a text-book, a history of science, and a book of exercises, all in one.

Laboratory Physics: a Short Course. By H. W. Heckstall-Smith and B. A. Fletcher. Pp. vii + 224. (Oxford: Clarendon Press; London: Oxford University Press, 1928.) 4*s*. 6*d*.

THIS book is intended for use in all the laboratory work in physics which is necessary for the higher certificate examinations. Although there is little that is novel in the experiments which are described, the whole book is excellently arranged and it should tend towards good, orderly work in a school laboratory. It would also serve as a useful guide in any school where an advanced course in science is being developed.

Physiology.

A Text-book of Physiology. By Prof. William D. Zoethout. Third edition. Pp. 664. (London: Henry Kimpton, 1928.) 18*s*. net.

Laboratory Experiments in Physiology. By Prof. W. D. Zoethout. Pp. 251. (London: Henry Kimpton, 1928.) 10*s*. 6*d*. net.

THESE two books may be considered as complementary. In the text-book the author has set out to give an account of physiology suitable for dental students, and has attempted to steer his course between the larger text-books and the shorter elementary treatises. The work has reached its third edition in the course of a decade and has been thoroughly revised; it appears to be well up-to-date. The selection of material for such a book must be largely a matter of opinion, and depends in part on the courses required of the

students for whom it is intended; it may be recommended to all those who do not wish to read one of the larger works.

The other volume gives a fairly detailed account of experimental class physiology, including also a short section on chemical physiology. The experiments, however, are often unsuitable for a practical course in Great Britain, since they require the use of anæsthetised animals as subjects; some, doubtless, with suitable modifications could be carried out on the surviving carcass. Apart from this objection, the experiments described appear to cover the ground fairly completely and are probably more detailed than required by the average medical student. A number of the illustrations are taken from Jackson's "Experimental Pharmacology."

The A B C of Vitamins. By John Pryde. (The Vanguard Series.) Pp. 128. (London: John Hamilton, Ltd., 1928.) 2*s.* 6*d.* net.

THE aim of this short readable volume is to give the non-scientific reader a simple account of our present knowledge of the vitamins in non-technical language. The author appears to have succeeded very well in conveying the essentials of a complex subject to its pages, and the book should enable the numerous people who take an interest in their diet to choose appropriate foodstuffs or to exercise discrimination in their selection of a proprietary 'vitamin food.' We note that the author refers to vitamin B_2 as the growth-promoting fraction of vitamin B; as a matter of fact, animals, young rats for example, will fail to grow unless vitamin B_1 is supplied in the diet as well as vitamin B_2, so that both fractions are necessary for growth. Also it is stated that mammalian liver contains vitamins A and D: it appears probable that the latter is absent from mammalian liver, although fish livers provide a rich source of this vitamin. These criticisms, however, detract in no way from the usefulness of the book to those who wish to regulate their diet; but people should not be advised to give themselves ultra-violet irradiation in their own homes, owing to the dangers of possible over-exposure. The book is quickly read and can be recommended to the intelligent layman for perusal.

Übungen aus der vergleichenden Physiologie: Atmung, Verdauung, Blut, Stoffwechsel, Kreislauf, Nervenmuskelsystem. Von Hermann J. Jordan. Unter Mitwirkung von G. Chr. Hirsch. Pp. viii + 272. (Berlin: Julius Springer, 1927.) 18 gold marks.

THIS manual gives the course of laboratory exercises in comparative physiology which the authors have evolved for students of biology in their laboratory at Utrecht. Experiments have been selected which are readily performed by the student and require only easily obtainable biological specimens and apparatus, wherever possible, of a simple rather than of a costly character. The book deserves the attention of zoologists, since it is primarily biological and not merely an adaptation of medical physiology.

Psychology.

An Historical Introduction to Modern Psychology. By Dr. Gardner Murphy. With a Supplement by Dr. Heinrich Klüver. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xvii + 470. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 21*s.* net.

A PRELIMINARY glance at this very substantial volume—one of the largest in the important series to which it belongs—might cause one to wonder at certain of its features. Why, for example, should several pages be devoted to Alexander Bain, and only a few words to James Ward? The answer to this question reveals one of the many limitations which the unquestionably learned author has imposed upon himself. Bain stood strongly for the physiological approach, whereas Ward's contribution, though equally distinctive, consisted in applying evolutionary concepts to introspective analysis; and Dr. Murphy's main concern is to trace the changes which have led to an increasing emphasis upon the objective method of study, which has passed from the physiological to the experimental and quantitative methods so assiduously cultivated to-day. It is for this reason that such a thinker as Ward does not come much into Dr. Murphy's picture. The author has provided a most interesting and satisfying account of modern psychological developments in Europe and America. In a supplement, Dr. Klüver shows how recent German psychology has proceeded on lines of its own.

Practice, Fatigue and Oscillation: a Study of Work at High Pressure. By J. C. Flügel. (*British Journal of Psychology*, Monograph Supplements, 13.) Pp. v + 92. (Cambridge: At the University Press, 1928.) 8*s.* 6*d.* net.

THIS is the latest addition to the series of monograph supplements issued in connexion with the *British Journal of Psychology*, and is a good example of the kind of work which is being done by the scientific or objective school of psychologists at the present time—a school which has found great favour in America, but less in Great Britain. 'Fatigue' and 'practice,' and the relations between them, are familiar subjects of experimental investigation. By 'oscillation' is meant those short-period variations in efficiency usually referred to as fluctuations of attention.

Mr. Flügel's object has been to experiment, on a larger scale than has hitherto been attempted, with the view of discovering any general characteristics of these three functions, and also to apply statistical methods to the study of their interrelationships. The thoroughness of his procedure, the extreme caution with which inferences are drawn, and the frank admission, or rather insistence, that complete success was not achieved in carrying out a rather ambitious programme, are all in the most exacting spirit of scientific method. It is on such studies as these that an important group of modern psychologists have hopes of real advance.

The Child in Primitive Society. By Prof. Nathan Miller. (Library of Educational Psychology.) Pp. v+307. (London: Kegan Paul and Co., Ltd., 1928.) 12*s.* 6*d.* net.

THE scientific study of childhood assumes several different aspects, of which the physiological and the psychological have received much attention for several decades past. The sociological study of the child has not come so definitely to the front, although A. F. Chamberlain's book, "The Child: a Study in the Evolution of Man," stands as a good specimen of what could be done in this field a generation ago. Dr. Nathan Miller's is a timely addition to contemporary literature on the subject.

For the educator the value of the work before us lies in the fact that the position of the child in a modern complex society is made clearer by an examination of the part he plays in primitive society. From the broad scientific view such a study is of value because of the light it throws upon the mechanism of social heredity, for in the absence of a written language the child has necessarily been the chief means of perpetuating culture from one generation to another. Dr. Miller has used the method employed by Spencer, Frazer, Tyler, and others—the method of drawing upon the immense body of facts collected by trained observers, and by travellers among people of simple cultures. A most interesting and stimulating treatise is fortified by an extensive bibliography.

Technology.

Practical Color Simplified: a Handbook on Lacquering, Enameling, Coloring, and Painting, with special attention to Mixing, Choosing, Harmonising, Matching, Lighting, Testing, and Designation. By William J. Miskelle. (Practical Finishing Series, Vol. 1). Pp. xiii + 113 + 10 plates. (Chicago: Finishing Research Laboratories, Inc., 1928.) n.p.

THIS book sets out to provide a guide to a great many problems for the practical colourist, but in spite of its somewhat ambitious presentation of a colour circle, mixing triangle, harmonising triangle, and so on, there will be little to be gathered beyond the usual elementary facts of subtractive colour mixture that could not be very much more effectively learned by a really scientific approach to the subject. Arbitrary directions to mix so many parts of 'red' with so much 'blue' are apt to be misleading unless the mixer knows something about the red and blue to select. A knowledge of the spectral transmission or reflective coefficients of pigments, some notions of their relative staining powers, and the like, would form a very much sounder basis on which to build a discussion of real colour mixture.

The writer brings in some discussion of 'wavelengths' (he should note that μ stands for one micron, *not* a milli-micron) and has something to say on nearly everything from 'Shakespeare' to 'Old Glory,' but when in his chapter on "Colour Photography" (which ought to be headed "The Photography of Colours") he laments that "panchromatic plates are not generally available for the use of either roll film cameras or the amateur photographer," he must be prepared to make readers of NATURE somewhat nervous of his leadership. The book may be of some help to those who are prepared to accept his interesting methods of selecting colour harmonies.

Photographic Art Secrets: with a General Discussion of Processes. By Dr. Wallace Nutting. Pp. x+133+105 plates. (London: Chapman and Hall, Ltd., n.d.) 12*s.* 6*d.* net.

"THE author has made many millions of photographs," although he confirms the statement that "there are only two perfect photographic days in the year," and in this volume gives his experiences in a series of ejaculatory statements of facts and opinions, but unfortunately does not distinguish between the two. He acknowledges that his *secrets* "may not be secrets to all who use cameras," but finds that the average amateur photographer does not know, or at least does not use his knowledge, of these matters. Scientific facts given are very few, this side of the art being evidently weak with the author; for example, he says "a plate consists of microscopic particles of nitrate of silver in an emulsion of gelatine." The author condemns exposure meters as requiring judgment in their use, "bothersome also because to consult it requires time," and "it is often impossible to use." Instead, he gives a table of proportional exposures according to the time of day and year, climatic conditions, and the character of the subject. We cannot indicate all the topics dealt with, as there are forty-two of them; these and the numerous illustrations, many of which are very nice and bear evidence to the author's skill, form a book that contains many useful suggestions that will inform the ignorant and refresh the memory of others.

The Finishing of Jute and Linen Fabrics. By Thomas Woodhouse. Pp. xxi+346. (London: Macmillan and Co., Ltd., 1928.) 18*s.* net.

THE second edition of this standard work, which was originally published at 8*s.* 6*d.*, now makes its appearance at a considerably increased price. Unfortunately, a careful comparison of the new and old texts does not reveal as much new treatment of the original subject matter as one is led to expect from the preface. Nevertheless, several new features appear in connexion with recent developments in the various kinds of machines which are described, particularly in the case of bag sewing machines. References are made to modern applications of electric driving and heating, to safety devices, and to improved methods of mechanical adjustment. In addition, the chapter on waterproofing and fireproofing has been almost completely rewritten.

The author's work is usually characterised by excellent diagrams and illustrations, and this book is no exception.

Forthcoming Books of Science.

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Ernest Benn, Ltd.—The English Grass Orchard, A. H. Hoare; Farm Crops, A. W. Oldershaw and J. Porter. *Jonathan Cape, Ltd.*—A Modern Herbal, edited by Mrs. C. F. Leyel, 2 vols. *Chapman and Hall, Ltd.*—The Structure and Life of Forest Trees, an English translation of "Bau und Leben Unserer Waldbäume," Prof. M. Busgen, third edition, revised by Prof. E. Mñnch, translated by T. Thomson. *Gurney and Jackson.*—The Crop-Grower's Companion, J. Porter. *Macmillan and Co., Ltd.*—Text-Book of Tropical Agriculture, Sir H. A. A. Nicholls, second edition, revised by J. H. Holland.

Anthropology and Archæology.

G. Allen and Unwin, Ltd.—Memories of My Life, Prof. E. A. Westermarck; The "Soul" of the Primitive, Prof. L. Lévy-Bruhl, translated by Lilian A. Clare; The Origin and Development of Nationality, Dr. B. Joseph. *Cambridge University Press.*—Our Forefathers: The Gothonic Nations, G. Schütte. *Jonathan Cape, Ltd.*—The Heritage of Man, H. J. Massingham; Modern Chinese Civilisation, Dr. A. F. Legendre; The Story of the Gypsies, K. Bercovici. *Longmans and Co., Ltd.*—Race and Population Problems, Dr. H. G. Duncan; Poverty, R. Kelso (Longmans' Social Science Series). *Methuen and Co., Ltd.*—Studies of Savages and Sex, A. E. Crawley, edited by T. Besterman. *Oxford University Press.*—The Danube in Prehistory, Prof. V. Gordon Childe; Ashanti Law and Constitution, Capt. R. S. Rattray; Examples of Maya Pottery in the Museum and Other Collections, edited by the late G. B. Gordon, Part 2; Rock Paintings of Southern Andalusia, the Abbé H. Breuil and M. C. Burkitt, with the collaboration of Sir Montagu Pollock, Bart.; Biblical Anthropology, compared with and illustrated by the Folklore of Europe and the Customs of Primitive Peoples, H. J. D. Astley. *Kegan Paul and Co., Ltd.*—The Mongol in Our Midst: a Study of Man and his Three Faces, Dr. F. G. Crookshank, new edition; Witch Hunting and Witch Trials, collected and edited, with an Introduction, by C. L. Ewen; Greek Thought, and the Origins of the Scientific Spirit, Prof. L. Robin; The Court of Burgundy, O. Cartellieri; Life and Work in Prehistoric Times, Prof. G. Renard (The History of Civilisation Series). *Williams and Norgate, Ltd.*—The Antiquity of Man, Sir Arthur Keith, 2 vols., new edition; Further Discoveries in the Antiquity of Man, Sir Arthur Keith.

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Technology.

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neglected by Dalton. The formulæ used by Higgins are also more related to modern formulæ than were those of Dalton.

SIR ERNEST RUTHERFORD delivered the first of a course of four lectures on "Molecular Motions in Rarefied Gases" on Mar. 2 at the Royal Institution. In recent years, much experimental work has been done in this interesting field of inquiry, and the results obtained are not only of theoretical importance but also of practical and industrial interest, as the construction and operation of high-speed pumps for production of the lowest vacua and the measurement of the minute pressures depend on an accurate knowledge of the motion of rarefied gases. An account was first given of the historical development of the kinetic theory of gases, with special reference to the early work of Waterston and Joule and the rapid development of the theory in its modern form by Clausius and Maxwell. Further progress has been made in recent years by Jeans and Chapman, while the experiments of Knudsen on gases of low pressure have resulted in notable contributions to our knowledge. It is only in the last few years that a definite experimental proof has been given of the velocity of molecules in a gas, and of the correctness of Maxwell's famous law of distribution. In the lowest vacua obtainable to-day, a molecule can travel more than 100 metres without a collision, even though there may still remain 40,000 millions of molecules in every cubic centimetre of the gas.

AN experimental Friday evening discourse was given on Mar. 1 at the Royal Institution by Sir Robert Robertson. After discussing the limitations of other methods of investigating infra-red radiations, a modern spectrometer, fitted with thermopile and galvanometer, was described; and by its means an absorption band of a gas (ammonia) was mapped. The origin of oscillation and rotation bands was then discussed. Oscillation bands are due to vibrations of the atom in a molecule. These are reflected in the main bands found in the infra-red both in emission and in absorption spectra, and frequently have a harmonic relationship with one another. Rotation of the molecule is shown by bands in the far infra-red and in the near infra-red by fringes imposed on the oscillation bands. From the difference in frequency of these fringes the moment of inertia of the rotating molecule can be calculated, from which values for the length of the molecule agreeing with those reached by totally different methods can be obtained. Mention was also made of the importance of infra-red spectra in the study of radiation given off in the processes of combustion and of explosion, in the investigation of stellar radiation and temperature, and the secular effects of differences in climate due to changes in intensity of solar radiation. Not only does this study afford valuable data for the theoretical physicist from the points of view of the quantum theory and wave-mechanics, but also it is becoming increasingly useful for determining chemical structure and suggesting molecular models. The dynamical behaviour of atoms in the molecule, and of the molecule itself as revealed by the study of this region of the spectrum, is a subject worthy of much more attention than is being given to it in Great Britain.

AT the annual general meeting of the Institute of Chemistry of Great Britain and Ireland, held on Mar. 1, Dr. Harold G. Colman presided in the absence of Prof. Arthur Smithells, who is on a visit to South Africa. The Report of Council showed that the roll of membership of the Institute at the end of January consisted of 1855 fellows and 3703 associates, in addition to nearly 700 registered students. The Meldola Medal for 1928 was awarded to Dr. J. A. V. Butler; the Sir Edward Frankland Medal and Prize to Cyril Fryer; and the Pedler Scholar for the year is Mr. George Morrison Moir. The chairman read an address from Prof. Smithells, in the course of which he stated that he considers the notion of making chemistry a closed profession is entirely impracticable. The Institute has been definitely entrusted with the duty, and already affords the means, of maintaining a register of chemists on which the Government, industry, and the public increasingly rely, but it does not adopt an unsympathetic attitude towards those outside its ranks who can usefully pursue a chemical calling. The Institute has every variety of chemist within its ranks and is truly representative of the profession. It is a living and growing thing, unconstrained by the rigidity of what is called machinery, and those who have sat at its Council table know that its work is pervaded by common sense and warmed by human feeling. The following officers were elected for the ensuing year: *President:* Prof. Arthur Smithells; *Vice-Presidents:* Mr. Arthur J. Chapman, Dr. G. C. Clayton, Mr. Ernest M. Hawkins, Prof. G. G. Henderson, Dr. R. H. Pickard, and Prof. J. F. Thorpe; *Hon. Treasurer:* Mr. Patrick H. Kirkaldy.

Two items of exceptional interest are recorded in Mr. Leonard Woolley's report on recent excavations at Ur (*Times*, Feb. 26). The first is a royal burial chamber of the First Dynasty in the form of a complete underground house, 40 ft. by 26 ft. In it there are four intercommunicating rooms with domed and corbelled roofs. The tomb had been plundered, but its importance lies in the fact that it is a new feature in Sumerian funerary custom and, as Mr. Woolley suggests, explains the large number of attendants slaughtered at a royal funeral; clearly it was intended that the royal mode of life should be continued in the next world in every particular. The second find, which holds out promise of future discovery, is a number of clay nodules with written tablets and clay jar-stoppers with archaic sealings. Although not so old as the pictographic tablets of Kish, they belong to a period hitherto represented only by rude clay figures of animals and men. They were found in a mass of rubbish stretching down from the walls of the earliest Sumerian settlement to the marsh or river. In such conditions there is reasonable expectation of finding pictographic material as early as that from Kish. The completion of the excavation of the great temple has now laid bare its vicissitudes for the whole period of the 2500 years of its existence.

THE electric meter has now been brought to a wonderful pitch of perfection. Considering the

hundreds of thousands of them that are continually rotating in Great Britain, it is wonderful that such a minute percentage ever have an average inaccuracy so great as two per cent. So accurate are they that they are sometimes used, with the addition of voltage and current transformers, to measure the power delivered by supply companies to tramway and manufacturing companies, meter bills of which amount to hundreds of thousands of pounds per annum. In this case, an error of one per cent means thousands of pounds per annum, and hence great precautions have to be taken to secure accuracy. Sometimes as many as six meters of various types are put in series and the average reading is taken as the true value. Possibly in this way a maximum inaccuracy not exceeding the half of one per cent can be assured. In order to secure sustained accuracy in service, it is necessary that the brake magnets remain constant and that the rotor bearings do not wear away. The latter problem is considered in a valuable paper read to the Institution of Electrical Engineers on Mar. 1 by W. Lawson. He gives a large number of experimental and statistical data on worn bearings. Various jewels which rank high in the scale of hardness have been utilised for the footstep bearing. Garnets, which were formerly used, are now discarded, and rubies and sapphires are generally used. It is claimed that artificial rubies and sapphires are more uniform in quality and slightly harder than the natural stones. In some cases the hardest known natural substance—diamond—is used and its use is increasing. The bearing surface is cupped as in other stones. Its manufacture in this form is a highly specialised art. The Birmingham Supply Corporation now uses these bearings for its large meters. For the last thirty years also they have been used in America.

IN his annual report to the Department of Overseas Trade (London : H.M. Stationery Office, 5*s*. net) J. R. Cahill, Commercial Councillor at H.M. Embassy in Paris, gives an interesting account of the electrical industry in France. Much of the prosperity of the country is due to the rapid development of this industry. In the manufacturing industry, combination has reached an advanced stage. Three or four groups of factories control the whole market. Competition, therefore, is not severe, and prices consequently decline at a slower rate. The electrification of French railways, particularly the Midi Railway, is making rapid progress. In April of 1927 the Midi Railway stated that electrification saved it 130,000 tons of coal every year. It now operates 500 miles of its system electrically, and aims at electrifying a further 687 miles in the next five years. The total capacity of French power stations is five million kilowatts, of which more than a third is due to water power. It operates more than 2000 miles of power transmission lines at pressures not less than 100,000 volts. The line connecting Bordeaux and Toulouse, which is 250 miles long, works at 150,000 volts. It is interesting to notice that water power is not developing so rapidly as thermal power. Possibly this is due to the fact that the prices for hydro-electric energy are State controlled. The possibilities in connexion with the extensive lignite deposits not far from Bordeaux for large steam stations are being considered. About 30,000 people are now employed for manufacturing radio apparatus. Although French exports of radio apparatus at present considerably exceed the imports, yet a considerable amount of radio accessories, particularly loud speakers, of British and American manufacture, are sold. In telephony, the automatic system is being adopted and many long-distance multi-core cables have been laid. As in Great Britain, the rapid progress of telephony has affected adversely telegraph traffic.

A CONVERSAZIONE and exhibition will be held in connexion with the coming-of-age celebrations of the Institute of Metals at the Science Museum, South Kensington, S.W.7, on Thursday, Mar. 14.

DR. E. J. ALLEN, F.R.S., secretary of the Marine Biological Association of the United Kingdom and director of the Plymouth Laboratory, will deliver the Hooker Lecture before the Linnean Society on Mar. 14, taking as his subject "The Origin of Adaptations."

AT the annual general meeting of the Quekett Microscopical Club, held on Feb. 12, the following officers were elected for the session 1929-1930: *President :* Mr. John Ramsbottom; *Vice-Presidents :* Mr. D. J. Scourfield, Sir David Prain, Dr. C. Tierney, and Dr. W. T. Calman; *Treasurer :* Mr. C. H. Bestow; *Secretary :* Mr. W. S. Warton.

IN commemoration of the bicentenary of Josiah Wedgwood in 1930, the Ceramic Society proposes to publish a volume of essays, for which two prizes are offered. The competition is not limited to members of the Society. All papers must reach the secretary of the Ceramic Society, North Staffordshire Technical College, Stoke-on-Trent, by Mar. 31, 1930.

A SPECIAL display of the film "With Cobham to the Cape" will be shown in the Empire Marketing Board Cinema at the Imperial Institute on Mar. 17 at 2.45 P.M. and 4.15 P.M., and on Mar. 18–20 daily at approximately 10.15 and 11.35 A.M. and 2.15 and 3.35 P.M. Admission is free, but schools in organised parties are requested to make application for seats to the Secretary, Imperial Institute, South Kensington, S.W.7, as early as possible.

THE Royal Society of Arts is offering two prizes under the Thomas Gray Memorial Trust for the improvement and encouragement of navigation; one, of £150, is for an invention in the years 1928 and 1929 of an improvement in the science or practice of navigation; and the other, £50, is for an essay on the navigation of a low-powered steamer in a revolving storm. Full particulars can be obtained from the secretary of the Royal Society of Arts, John Street, Adelphi, London, W.C.2. The competition closes on Dec. 31, 1929.

THE Council of the Iron and Steel Institute has this year awarded the Bessemer Gold Medal of the Institute to the Honourable Sir Charles A. Parsons, in recognition of his distinguished services in advancing the science of engineering as applied to the manufacture of iron and steel. The Williams Prize, of the value of 100 guineas, which was founded for the

encouragement of papers of a practical character by Mr. Illtyd Williams on his retirement in 1926, has been awarded in equal portions for the two papers, "Blast-Furnace Practice in Natal," by Messrs. J. E. Holgate and R. R. F. Walton, and "The New Plant of the Appleby Iron Co., Ltd.," by Messrs. A. Crooke and T. Thomson.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A junior engineer under the Safety in Mines Research Board in connexion with research on colliery wire ropes—The Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (Mar. 15). An assistant for work in connexion with research on water pollution—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (Mar. 20). A temporary junior forestry inspector under the Government of Northern Ireland—The Secretary, Civil Service Commission, Northern Ireland, 15 Donegall Square West, Belfast (Mar. 23). An assistant agricultural chemist at Institute of Agriculture, Kirton—The Principal, Institute of Agriculture, Kirton, near Boston, Lincs. (Mar. 27). A principal of the new farm institute of the Kent Education Committee at Borden—The Agricultural Organiser, Springfield, Maidstone (Mar. 30). A senior lecturer in psychology at the Rhodes University College, Grahamstown—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (April 1). Male cartographers in the Hydrographic Department of the Admiralty—The Secretary, Civil Service Commission, Burlington Gardens, W.1 (May 23). A research chemist at the Cardiff City Mental Hospital—The Medical Superintendent, Cardiff City Mental Hospital, Whitchurch, near Cardiff. A director of research under the J.A.C. Committee, with graduate qualifications in agriculture, botany, and chemistry, and some experience in conducting field experiments—N. Hackett, Kingswood, Bingley, Yorkshire. A junior assistant under the directorate of explosives research, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

Our Astronomical Column.

JUPITER AND VENUS.—On Mar. 14 a conjunction of Jupiter with the new moon will be very interesting for two reasons, namely, the near approach of the two bodies, and the convenient hour at which it happens. The event will take place on Mar. 14, at about 10 P.M., at which time Jupiter will be apparently distant from the north limb of the moon about four-tenths of a degree only. The picture afforded by these objects so near together will be enhanced by the presence of the brilliant planet Venus lying about 10 degrees north-west of the others. Jupiter is now becoming fainter with increasing distance from the earth, but Venus will attain its maximum brilliancy on Mar. 15, and shine with striking lustre amid the twilight of the north-west. This planet is now travelling sunwards and will disappear from the evening sky after the middle of April, but will return to view in the morning twilight of May.

MARCH METEORS.—There are no special displays of meteors recurrent in March, but fireballs are fairly prevalent. Though meteors are not abundant they will deserve special attention, for March and the other spring months have been much neglected in past years. A few careful observations in March are, therefore, worth a large number obtained in the summer or autumn months when investigations in this field have been already conducted to a considerable extent in past years.

During about the third week in March, meteoric radiants at 161° + 59° and 312° + 79° have been occasionally exhibited, and there are really a great number of feeble systems slightly manifested, but possibly many of these are relics of ancient displays now very attenuated by frequent encounters with the terrestrial atmosphere in past ages.

AURORA BOREALIS.—On Wednesday evening, Feb. 27, an unusual and striking display of aurora was observed from various parts of Great Britain. It has been described as the Zodiacal light, but the exhibition appears to have been of too brilliant a character to be considered as formed by the latter phenomenon. A correspondent at Burnham-on-Sea noticed the strange light just before 10 P.M. Its aspect was that of an intensely coloured band stretching across the northern horizon. It remained some time and passed slowly in a direction far to the westward. The beam was strikingly luminous and finally disappeared soon afterwards.

Accounts have come from many stations descriptive of the event and of the change in position and location which the chief feature assumed. Several people thought it a remarkable meteoric fireball with very slow motion and long duration.

From the south coast of Devonshire, and from Wiltshire and other stations, observers refer to the vivid nature of the spectacle. It was first detected at about 9.30 P.M. and had nearly disappeared from view 20 minutes afterwards. Mr. B. G. Hoare, writing from Inverness, states that the display was visible from 8.30 P.M. until midnight. At some stations streamers of pale light ascended from the horizon to considerable heights and were traceable at the zenith. Changes constantly affected their intensities and positions. The cloud or luminous band was the most conspicuous feature and its variations were very notable. It drifted westwards, and in its transit passed over numbers of the stars, which, however, remained distinctly visible in many cases.

THE CATANIA ASTROGRAPHIC CATALOGUE.—The Catania Observatory undertook the zone between North Decl. 46° and 55° in the Astrographic Catalogue. It has had many difficulties to surmount through deaths of directors and shortage of funds, but is now issuing instalments of the Catalogue at short intervals under the direction of Prof. G. A. Favaro. The two latest instalments (vol. 7, part 2, decl. 52° to 54°, R.A. 3^h to 6^h; and vol. 8, part 2, decl. 53° to 55°, R.A. 3^h to 6^h) have lately been issued; it will be seen that decl. 53° to 54° is common to both volumes. The catalogue gives both the rectangular co-ordinates and the R.A. and Decl. for 1900·0 for every star. Most of the observatories limit themselves to rectangular co-ordinates, but Catania having once embarked on the more ambitious programme is unwilling to relinquish it. It has of course many conveniences; the separate determinations for each star are immediately comparable without any reduction. The faintest magnitude included is 12·0.

Research Items.

THE TEETH OF ABORIGINAL CALIFORNIANS.—Dr. R. W. Leigh has made a study of pathological conditions in the teeth of three hundred crania of Californian Indians in the University of California Museum of Anthropology, which is published as No. 10 of Mem. 23 of the University's *Publications in American Archæology and Ethnology*. The specimens were derived from pre- or early post-conquest times when food habits had not been materially affected by Caucasian contact. Although food varied according to area, acorns and small seed food constituted a larger part of the diet than any other food. The grinding process for acorns, seeds, etc., was universal, and apparently this had deleteriously affected the teeth. The habitual eating of tobacco, especially when mixed with lime and mussel shells, and its use as an emetic, also affected the teeth. Other causes affecting the teeth were leaching of food with sand and cooking with hot stones. Much abrasive material was thus introduced into the mouth, and attrition, with its sequelæ, is the conspicuous dental lesion in the majority. Seventy per cent of persons more than forty years of age had the pulp of one or more teeth exposed. Dental caries occurred in 25 per cent, though specimens from the shell mounds showed the low rate of 12 per cent. As a result of pulp exposure and necrosis, 52 per cent showed dissolution of continuity of bone surrounding the apices of the teeth—a result of attrition. Few teeth were lost before middle life—only ten dying at less than forty years of age had lost any teeth, and most cases were well over fifty years. More superior than inferior teeth were lost.

WOODEN DOLLS FROM WEST AFRICA.—In *Man* for February, in the course of notes on the Wamakonde of Portuguese West Africa, Mr. H. D. Collings describes some remarkable little dolls of wood. The Makonde are very clever wood carvers, and these dolls are among the best things they made. They range in height from one to two feet. Their use is unknown, but coast natives state they were used in dances. They are carved in a soft white wood with a large central hole which is filled with pith. The wood is worked when green. Of two figures which are illustrated, one about 16 inches in height represents a woman. The upper lip is distended by the lip ornament, an ebony ring, and the face is covered by the usual tribal marks. The front teeth are pointed as are the teeth of the Makonde—a tribal mark. Real human hair had been driven into the head by a screwdriver-like implement. A small piece of wood has been left to join the left hand to the body, a peculiarity noted in nearly every specimen. The male figure has no tribal marks and the hand is not connected with the body. This figure is stained red with some vegetable substance, the eyes being left white. The models stand upright alone when placed on their feet. They are not common, and few natives know how to carve them. The smoking pipes of this people are also of some interest. They are of the water-container type, the container being a young coconut shell which is fitted with two bamboos, one of which has a movable pottery bowl. In a more elaborate form which is described, a curved central strengthening piece of wood is carved with decorative designs very similar to the tribal marks.

NESTING HABITS OF OROPENDOLAS.—The oropendolas build long pendant nests in colonies, and although they are familiar enough in tropical America, no connected study of their habits has been made. Frank M. Chapman has repaired this omission by an intensive study of the oropendolas (*Zarhynchus wagleri*) of Barro Colorado Island (*Bull. Amer. Mus. Nat. Hist.*, vol. 58, 1928). In the nesting colonies, which set to work very regularly about the first week in January, females outnumber males by about six to one, and yet it would appear that each male has only one mate—at a time—and that in view of the abundance of choice there is no marked display of sexual jealousy. The males take no part in the selection of the site, in the gathering of building material, the construction of the nest, the incubation of the eggs, or the feeding of the young. But they guard the females from the attacks of hawks during nest-building and generally act as watchmen. The long swinging nest hangs from the upper branches of a tree, and the building of the bag, woven of tendrils, fine strips of bark, and plant-fibres, with its contained nest proper, occupies one month. The male never enters the nest, but the female sleeps there, and lays two eggs which hatch after an incubation period of 17 days. A month later the young leave the nest. There is no attempt at concealment, either in the position of the nest or in the bright colours of the birds themselves. Their safety depends on a constant vigilance, and on a spontaneous dive headlong into the dense vegetation, which is never far distant, when the alarm note is sounded.

NEW ZEALAND FISHES.—In a paper entitled "Studies in New Zealand Fishes" (*Proceedings of the New Zealand Institute*, vol. 59, Part 2, 1928), Mr. L. T. Griffin, assistant curator of the Auckland Museum, describes several little-known fishes and two new species. These include a large eel, *Gymnothorax nubilis*, the only specimen so far recorded from New Zealand, previously known from Norfolk Island and the Indian Ocean and Archipelago. This individual measures 640 mm. in length. *Serioella amplus* n. sp. is interesting, as it apparently does not vary as do the other species of the genus. It is a fine fish and very plentiful, which makes it all the more curious that it has not been described before. The mackerel described, *Scomber australasicus*, is said to be very common in deep water beyond the Hauraki Gulf, moving about the coast in large shoals, and is also common in Australian seas. The specimen of the striped angler, *Antennarius striatus*—a most grotesque creature with two pyramidal humps on its head and a lure resembling a three-fronded piece of alga—was found hiding in a bunch of seaweed. Most of the species of this genus live in seaweed floating in tropical seas, and by filling the spacious stomach with air are able to keep near the surface of the water. In this way they can live in the open sea as well as near the coast, but they are very poor swimmers and drift with the currents into various places. This paper is exceptionally well illustrated by good original drawings.

THE ANATOMY AND HABITS OF THE LOPHOGASTRID CRUSTACEA.—The Lophogastrida, including the genera *Lophogaster* and *Gnathophausia*, have long been regarded as among the most primitive Mysidacea, and Miss Manton (*Trans. Roy. Soc. Edin.*, vol. 56, pt. 1, No. 5, 1928) has examined specimens of these genera in the light of the recent work on the feeding mechanisms of the Malacostraca which we owe to Miss Manton herself and to Prof. H. G. Cannon. Miss Manton finds that *Gnathophausia* has mouth parts of the typical filtratory form, and must, therefore, be at least a partial filter feeder. The mechanism is, however, more primitive than in any other living Malacostraca by reason of the absence of an auxiliary food current

created by the thoracic exopodites. Locomotion is effected by the abdominal pleopods entirely, and the thoracic exopodites mainly cause currents of water bathing the gills. *Lophogaster*, on the other hand, is a bottom living form, incapable of filter feeding. The mouth parts are modified for feeding on large food masses, and the modifications resemble those found in the higher Peracarida which have given up filter feeding. The mandibles of the Lophogastrida compared with those of other Malacostraca appear to be primitive in form, and to show the origin of the *lacinia mobilis*. The author has also investigated the segmentation of the abdomen and the muscular system of the terminal 'segment' in *Lophogaster* and *Gnathophausia*, and finds that the groove across the last 'segment' of the abdomen in the Lophogastrida represents the junction between the incompletely fused sixth and seventh segments. In a previous paper the author has shown that the last abdominal segment in the adult of *Hemimysis* is formed by the complete fusion of the separate sixth and seventh segments present in the embryo. In the Lophogastrida the fusion between these segments is therefore incomplete. This interesting observation brings the segmentation of the Eumalacostraca into line with that of the Leptostraca (*Nebalia*), where a completely separated but limbless seventh segment in the abdomen is a feature of the adult condition. Miss Manton concludes that the Lophogastrida are the most primitive living members of the Malacostraca.

PHILIPPINE WOODS.—In the May number of the *Philippine Journal of Science* Mr. Josè C. Espinosa, of the Bureau of Science, Manila, discusses "Strength Properties in relation to specific gravity of Philippine Woods." The paper, which is illustrated by five text figures, is of a technical nature and designed for research workers in this branch of investigation. The strength properties of wood have a certain definite relation with its density or specific gravity. Newman and Wilson have carried out an analysis of 200,000 tests at Madison for American timbers, and L. G. den Berger in the Dutch East Indies has worked on teak. Mr. Espinosa has carried out about 45,000 tests for some of the more valuable Philippine timbers and presents their relationships both in graphical and in equation form.

GLACIAL DRIFTS AND ERRATICS.—The Yorkshire Geological Society and Sir Sidney Harmer have laid British geologists under a debt of gratitude for making possible the posthumous publication of a paper on "The Distribution of Erratics and Drifts" in England and Wales, accompanied by a beautifully layer-coloured contoured map on which the distribution is effectively displayed, both paper and maps being the work of the late F. W. Harmer (*Proc. Yorks. Geol. Soc.*, November 1928, pp. 79-150, and sold separately by John Bartholomew & Son, Ltd., Edinburgh. 10*s.* with folded map, or 11*s.* with unfolded map on a roll). Mr. Harmer had a personal familiarity with the drift deposits extending over some sixty years, which was unrivalled in extent and achievement, and the invaluable result of this long service to geology is the first detailed mapping of erratics in England and Wales. The map itself is on the 1/*M* scale and measures about 20 in. × 25 in.; it includes southern Scotland south of Peebles and Lanark. The contour interval is 100 ft. up to 600 ft.; thereafter the contoured levels are 1000 ft., 1500 ft., and 2000 ft. By the use of an ingenious system of twelve distinctive symbols printed in heavier colours than those used for the contour intervals, the following varieties of drifts and erratics are recorded: North Sea; Chalky Boulder Clay (chalk matrix); Chalky Boulder clay (Jurassic matrix); Pennine (Carboniferous); Pennine (Silurian); Welsh; Lake District; Cheviot and Galloway; Bunter Pebble; Charnwood; Eocene of Herts; and Neocomian (erratics of large size). The map is a masterpiece of clarity and accurate registration. The very high cost of reproduction has been made possible by the generosity of Sir Sidney Harmer and his co-trustees under his father's will. It will interest many readers to know that the original map has been presented to the Geological Survey and Museum in Jermyn Street.

IRRIGATION IN INDIA.—The Triennial Review of Irrigation in India, of which the issue for 1924–27 has now been published by the Government of India, contains much useful statistical information. It recounts the progress of irrigation in the various provinces of British India, and gives financial statistics for all the irrigation works. The irrigated area is now a little more than twenty-eight million acres. In productive irrigation works every province shows an improvement compared with the previous triennium. The irrigated area is as much as 88 per cent of the total cropped area in Sind, and averages for the whole of British India 12·8 per cent, being naturally very low in Bengal, Bombay, Orissa, and the Central Provinces. Not the least valuable part of the pamphlet is the account given of the various irrigation projects in each province.

THE ORIGIN OF MAGNETISM.—The issue of the *Physikalische Zeitschrift* for Dec. 15 contains an account by Dr. O. V. Auwers of recent work on the question why certain substances are magnetic and others not. According to Heisenberg, each atom of a magnetic element must have at least 8 neighbouring atoms of the space lattice at equal distances from it. According to the author, an examination of magnetic elements furnishes no direct contradiction to this law. But when magnetic α-iron passes into non-magnetic β-iron, or magnetic α-nickel into non-magnetic β-nickel between 700° and 800° C., there is no distinct change in the space lattice of either. Alloys of two of the magnetic elements, iron, nickel, and cobalt are sometimes non-magnetic although the space lattice suggests by Heisenberg's rule that they should be magnetic. On the other hand, iron pyrites and magnetite are both magnetic, although they do not conform to the rule. At present, therefore, we appear to have no satisfactory explanation of the origin of magnetism.

ABSORPTION OF PENETRATING RADIATION.—The only method yet devised for analysing the spectrum of the cosmic rays is to find by experiment how their intensity falls off in their passage through matter, and then to calculate the wave-lengths which correspond to the observed coefficients of absorption by making use of some specific theory of the interaction between radiation and electrons. The two principal absorption formulæ which have been employed are those associated with the names of Prof. A. H. Compton and of Dr. Dirac, but recently a relation with a better theoretical basis has been proposed by Klein and Nishina (see NATURE, vol. 122, p. 398). In interpreting the absorption curves it is also necessary to consider precisely what is registered by a γ-ray electroscope, and a new analysis of the problem by L. H. Gray (*Proceedings of the Royal Society*, vol. 122, p. 647, Feb. 4), in which all of these factors have been taken into account, has shown that the wave-lengths which had previously been accepted as correct are probably in need of considerable revision. The formula of Klein and Nishina is not only the most satisfactory of the three theoretically, but it also agrees best with the somewhat meagre data which are available concerning the absorption of γ-rays of known frequency. If this is adopted, the principal rays in the spectrum of the

penetrating radiation work out to be of even shorter wave-length than Prof. Millikan and Dr. Cameron had supposed, and have quanta of 90, 360, and 920 millions of electron-volts respectively. The last number corresponds to the annihilation of a mass almost exactly equal to that of a proton, whereas Prof. Millikan and Dr. Cameron had suggested that it arose from the catastrophic condensation of a number of hydrogen nuclei and electrons to form the nucleus of an atom of silicon, magnesium, or aluminium.

RADIO ACOUSTIC POSITION FINDING.—In order to construct the nautical charts used in the navigation of ships it is essential that accurate hydrographic surveys be periodically made. In this way sunken rocks, reefs, and wreckage are accurately charted. One of the methods, developed during the War, of locating objects is to utilise the difference between the speed of radio waves and under-water sound transmission. Many difficulties had to be overcome, such as the failure of sound to carry under certain conditions and the interference at shore stations. The U.S. Coast and Geodetic Survey has published a useful booklet (*Special Publication* No. 146, price 20 cents) giving a clear and full account of the method and details of the instruments used by the survey ships operating on the Pacific Coast of the United States. Radio acoustic control has been used for the last four years and has proved of great value. It can be used regularly up to a distance of 70 miles from the shore, but in special cases it has been used at 200 miles. It is independent of fog, but during storms the noise of the waves breaking on the beach sometimes causes difficulty. The under-water sound is obtained by exploding a bomb, and the noise is picked up by a suitably placed receiver connected through an amplifier to a relay, both the sound and the radio signals being amplified. A chronograph with two pens marks the instants when the sound and the radio signals are received. The time taken by the sound travelling through the water to two stations on the coast is observed. Hence since the velocity of sound in sea water of known salinity and at known temperature is given by tables, their distances can be found, and the ship's position obtained. Sometimes the noise made by fishing boats anchored near the sunk hydrophone makes it impossible to distinguish which are the bomb noises. The only remedy is to remove the boats. Another source of trouble was traced to fish bumping against the hydrophone box and to crabs climbing over it.

CHEMICAL EFFECTS OF CATHODE RAYS.—The *Journal of the American Chemical Society* for December contains three papers on the chemical effects of cathode rays. The first two papers, by A. L. Marshall, deal with the formation of ozone and the union of hydrogen and oxygen effected by cathode rays from a tube operated at 200 kv. and 0·001 amp. Cathode rays bring about the ozonisation of oxygen and also the decomposition of ozone, the reaction taking place entirely in the gas phase. A steady state is reached corresponding with a concentration of 1 molecule of ozone to 1700 of oxygen. The silent discharge produces a concentration of 1 in 12, but has a much smaller decomposing effect than the cathode rays. The reaction is uninfluenced by the nature of the walls of the containing vessel. In the reaction between hydrogen and oxygen brought about by the rays, it was found that the primary products are hydrogen peroxide, water vapour, and ozone. The rate of formation of the peroxide is independent of concentration, whereas the rates of formation of water vapour and ozone, which parallel one another, are both changed by variations in concentration. It is suggested that both water vapour and ozone are produced by the same primary mechanism. The third paper, by W. F. Busse and F. Daniels, is concerned with the chemical effects of the rays on oxygen, air, nitric oxide, and carbon dioxide. These effects were expressed as the ratio of molecules produced per electron crossing the cathode ray tube, and were: nitric oxide decomposition 230, ozone from oxygen 100, ozone from air 44, nitric oxide from air 14, carbon dioxide decomposition 3. The results described in all three investigations show that there is a close similarity in the chemical behaviour of cathode rays and α-particles.

ATOMIC WEIGHT REPORTS.—Since the International Committee on Atomic Weights has not provided a table since 1921, the Report and Table of Atomic Weights prepared by the Sub-Committee of the Chemical Society (*Journal of the Chemical Society*, pp. 216-219; 1929) and those prepared by the German Atomic Weight Commission (*Berichte*, vol. 62, pp. 1-23) afford an interesting basis for comparison. It is satisfactory to note that of the eighty-four elements tabulated, only fourteen differ in more than one unit of the last significant figure in the heights assigned to them by the two tables. Of these, the more important are carbon, sodium, phosphorus, and arsenic, for which the English Sub-Committee adopt the values $12{\cdot}003_6$, 23·000, $30{\cdot}98_2$, and $74{\cdot}93_4$, respectively (last figures are uncertain), on the basis of the results obtained by Aston with the mass-spectrograph; the German values are 12·000, 22·997, 31·62, and 74·96 respectively. For magnesium (24·30, 24·32—the English value is given first in each instance), calcium (40·09, 40·07), chromium (52·04, 52·01), manganese (54·95, 54·93), niobium (93·3, 93·5), gadolinium (157·0, 157·3), and tantalum (181·3, 181·5), the English value is that recalculated by F. W. Clarke in 1919, since when there have been no new determinations. There remain silicon (28·08, 28·06), copper (63·55, 63·57), and thorium (232·15, 232·12), with which there is no immediately obvious reason for the slight differences. Interesting features are, in the German Report, the provisional atomic weight 188·71 for the newly discovered element rhenium (Re), which has been investigated by Walter and Ida Noddack, and in the English report the arrangement, for the first time in an annual atomic weight table, of the elements in the order of their atomic numbers.

FLAMES IN NITROUS OXIDE.—The normal infra-red spectrum derived from a flame is usually that of the products of reaction and not of the reacting gases. This may arise from the fact that in most cases the supporter of combustion is oxygen or air, which are without characteristic infra-red spectra. In the *Journal of the Chemical Society* for January, Bailey and Lih describe experiments on the emission spectra of gases burning in nitrous oxide. In the case of carbon monoxide and coal gas, the anticipated spectra of water vapour and carbon dioxide were found, but a different result was obtained with hydrogen. The flame of a mixture of this gas with nitrous oxide is very complex and consists of at least five zones, but the normal type of spectrum due to water vapour is shown. When, however, a hydrogen jet is burned in nitrous oxide, a new spectrum appears, some bands of which appear to correspond with known absorption bands of nitrous oxide. This new spectrum is not exhibited by carbon monoxide or coal gas in either mode of burning, and is probably due to some form of stimulation by burning hydrogen molecules. It does not appear in the coal gas flame and is then probably inhibited by the carbon monoxide present. Hence the stimulation is probably not merely thermal.

British and Foreign Ammeters and Voltmeters.

AT all electric generating and distributing stations large numbers of ammeters and voltmeters are fixed on the switchboards so that the attendants can see at a glance how the various electrical machines are working. The manufacture of these instruments is quite an important industry, and we are glad that the manufacturers in Great Britain are thoroughly aware of the necessity of continually improving the design and accuracy of their instruments in order to meet foreign competition. One sometimes hears from an engineer that a particular foreign instrument maker makes the best instruments, but there is no general agreement as to which foreign firm makes the 'best,' or in what respect these instruments are better than those made in Great Britain. An investigation was therefore initiated by some of the members of the British Scientific Instrument Research Association to find out whether there was any foundation for these reports. It was thought also that a careful comparison of the types of instruments made in America, Europe, and Great Britain would be of value, as it might suggest to makers improvements in the design of their instruments.

To bring the inquiry within manageable limits, it was decided to restrict the investigation at first to permanent magnet moving coil instruments, and we have received a synopsis of the detailed report circulated to members of the Research Association. For obvious reasons the names of the manufacturers are not mentioned, but the instruments are classified under the headings of British and foreign, and a critical and impartial account is given of their design and performance.

The manufacture of these instruments has lasted over so many years that the general lines of their design have become almost universal. To obtain certain characteristics, however, different methods are adopted, and it is necessary to make compromises at almost every point in their manufacture, the instrument being judged on the general 'balance' obtained. Users of instruments have generally definite preferences due to a liking for some particular detail in the design. Not infrequently these preferences have no specific foundation and are merely personal.

The instruments tested for the Association were 'dial type' switchboard ammeters and voltmeters varying from six to eight inches in diameter. They were examined for rapidity of indication, accuracy, effect of temperature, internal construction, nature of the springs and of the magnetic system, appearance, and kind of pointers and dials used.

In some of the instruments examined the damping was much too small. When switched into the circuit the pointer moved over the scale in its first swing and struck violently against the stop at the upper end of the scale. In some cases, also, there was a tendency for the pointer to stick at the upper end of the scale. In other cases the pointer oscillated for some time before coming to rest. The conclusion is arrived at that in the best instruments the damping should be almost but not quite critical; that is, that the pointer should swing slightly beyond its final position but return rapidly to it.

Of the instruments examined, 60 per cent were accurate to within 1 per cent, 30 per cent had errors between 1 and 2 per cent, 8 per cent had errors between 2 and 3 per cent, and one instrument had an error of more than 9 per cent. The general level of the accuracy of the British instruments was at least as high as that of the foreign instruments.

The instruments were affected in very varying degrees by temperature. Some of them were specially compensated for temperature. In one of the British instruments the compensation was practically perfect from 10° to 50° C., the sensitivity of the instrument being constant to within one or two parts in one thousand over this range. It appears that compensation for temperature can be provided to a satisfactory extent by a proper choice of the materials used in the moving coil circuit, control springs, shunt, etc. The arrangements for zero adjustment were very varied. In one case it was necessary to open the front of the instrument case to make the adjustment, but in another the arrangement was very neat and efficient.

The practice of fitting resilient supports to the jewels is to be commended, as it affords considerable protection against the risk of damage due to vibration or mechanical shock. The instruments of two British manufacturers who follow this practice have a distinct superiority in this respect over all the others. Some of the manufacturers use copper wire for their coils and others aluminium. The use of aluminium has certain advantages, but it is difficult to solder. Phosphor bronze springs were used by all the manufacturers for their instruments. Only in two of them was the position of the zero reading of the pointer found unchanged after they had been in circuit for seventy-two hours. The pointers came back to their original zero positions after intervals varying from a few minutes to twenty-four hours. It was found that instruments with large air-gaps in their magnetic circuits were not necessarily inferior to those having smaller air-gaps. It is necessary, however, to maintain a proper relation between the magnetomotive force of the magnet and the reluctance of the magnetic circuit.

So far as the external appearance of the instruments is concerned, it is best that only the scale and the pointer should attract the eye. Full white dials and bright lacquered brass cases are not desirable. It was found that certain scales were easier to read than others, and this was attributed to a better balance between the thickness of the gradations and their height. The instruments were not tested to determine the extent to which their indications were affected by external magnetic fields. We think that this was a pity, as many switchboard instruments are seriously affected in this way. It is stated, however, that inspection of the instruments showed that some would be affected much more than others.

In conclusion, the report says that the best of the instruments examined, both British and foreign, were well suited for the purpose for which they were designed. Two pairs of instruments of British manufacture were open to criticism in respect of certain details of construction, and two pairs of foreign instruments were distinctly inferior both in design and construction. None of the instruments showed an outstanding superiority over all the others in every particular. If the instruments are placed in order of merit as assessed on some particular criterion of excellence, the instrument placed first would in many cases be a British one. Certain of the British instruments examined would occupy high positions whatever criterion were chosen. The consistently high positions occupied by certain British instruments in the tests described above leads to the conclusion that the best-known British instruments of the kind examined are quite equal to the best-known corresponding instruments of foreign origin.

The Timber Resources of the British Empire.

ACTING under a resolution of the Imperial Conference which sat in London in 1928, an Imperial Economic Committee was appointed consisting of nominees of Great Britain, the Dominions, India, and the Colonies and Protectorates. The Imperial Conference directed the Economic Committee to prepare for the consideration of Government a list of raw materials suitable for inquiry on the lines of the Committee's reports dealing with foodstuffs. In 1927 the Governments of the Empire agreed that the Committee should prepare such a report on timber. This report (*Rep. of Imp. Econom. Committee*—Tenth Report—Timber. London: H.M. Stationery Office, 1928) has been recently published. It is based on the examination of a number of witnesses representing producing, marketing, and manufacturing interests; and on the expressed opinions of experienced officials and scientific workers.

The authors of the report give their reasons for confining themselves to 'timber' and omitting other forest produce in the following: "We have excluded from our enquiry the wide range of articles frequently described as 'minor forest produce,' including grasses, canes, gums, and tanning materials. We have only referred to the imports into the United Kingdom of manufactured wood, of wood pulp and of cellulose for the purpose of indicating the total demand made by the United Kingdom on the sources of wood supplies. We took some evidence on the import trade in manufactured wood, but found that this raised very large issues, an examination of which would have prevented the production of this report in time for the forthcoming Forestry Conference. We therefore deemed it advisable to confine this Report to the raw material —timber. The timber trade is a very important one, and the Empire resources are extensive and varied."

One of the chief points, perhaps of equal interest and importance, which emerges from the evidence taken by the Committee, is the difference of opinion on the subject of world timber supplies of softwoods which exists between the members of the timber trade and forest authorities "all the world over" as the Committee expresses it—although it is doubtful whether there is such a universal consensus of opinion as this statement would appear to indicate. However, the forest authorities are said to regard the world supplies of softwoods with anxiety, whereas the authors state: "We must, however, record the fact that in the course of our enquiry we have not found this feeling of apprehension shared generally by the members of the timber trade in the United Kingdom. Adequate supplies have always been readily available in the past, and it is possible that the trade has been lulled into a feeling of security for the future which the world position may not warrant. The commercial point of view is that a scarcity of supplies will adjust itself by an increase of prices which will bring within an economic radius fresh forest areas hitherto untouched." Many forest officers would say that the local timber traders have as good knowledge of the local forests' resources as they have themselves; it is at least open to doubt whether the statement in the report that "the outlook is more fully realised by those concerned with organised forest management and conservation" can be accepted without considerable reservations.

Although the examination of forest resources does not fall within the purview of the Committee in the present report, the necessity for systematic investigation of the rate at which the softwood resources of the world are being depleted is strongly urged. It is well known that Canada contains practically the only supply in the British Empire of such materials, and probably the estimates of existing amounts are fairly trustworthy. The remaining resources are chiefly in European countries, and "systematic investigation" into their rate of depletion is not a practical possibility. We have to rely upon published figures—trade and otherwise; and on reports and information with which the officials of these countries courteously supply us.

The second point in the report is of Empire importance, and in it is embodied the entire value of statistics on Empire resources. The authors write: "If the interest of the timber trade and of the general public is to be enlisted for the conservation and development of the Empire forest resources and the lesser known varieties of Empire grown timber are to secure wider utilisation, statements regarding the world and Empire position must be supported by statistics based on precise knowledge and not on information of a general character." This goes to the root of the whole matter.

For the first British Empire Forestry Conference, held in London in 1920, a tabular form was drawn up, it is believed in London, and sent to forest authorities in countries of the British Empire asking for estimates of the total forest resources of these regions, distinguishing areas containing merchantable timber (exploitable forests) from non-merchantable. Some of the forest authorities produced figures for which they accepted no responsibility; others refrained. In Canada, at the Conference held in 1923, the same request was put forward, and in the report here under review the authors state: "Thus it is anticipated that in the autumn of the current year [*i.e.* after the meeting of the Empire Forest Conference in Australia] information on the timber resources of the Empire will be forthcoming more complete than any at present available." This latter is a possibility. But the statistics "will not be based on precise knowledge," which is what the Economic Committee rightly demands. How could they be? When a conservator of forests, in charge of one of the Empire provinces containing extensive tropical and sub-tropical forests, receives the form alluded to above, he sends copies to his several divisional officers. These men may have charge of an area of anything from 500 to 2000 sq. miles of forest (or more), in many cases much of it unknown and unexplored. They have a staff small in size and partially trained. How are they to produce any figures of stocking, either in proportion of species or volume per unit of area? Even the map areas of the forests are perhaps only rough ones. To anyone who has held charge of similar areas, the possibility of obtaining any figures but those based on guess work will be perfectly obvious. Yet a large proportion of the tropical and sub-tropical forests of the British Empire are in this position. Very much stronger trained staffs and opening up of the forests will be necessary before the value of the returns on the timber resources of the Empire are based on "precise knowledge" as against "information of a general character." Outside the Empire there are extensive areas of tropical and sub-tropical forest (in South America, for example) which are as yet under no true forestry management at all.

We are in full agreement with the writers of the report "that it may be found necessary to make arrangements for the systematic collection and revision of World and Empire consumption in relation to supplies." But the primary basis for those preparing reports in London and suggesting work to be carried out, at any rate where forests and forestry are in question, is to remember that the unit of area is the square mile, the type of forest tropical or sub-tropical, the vegetation often dense and difficult to get through,

whilst the topography of the countryside often offers considerable obstacles to easy or rapid travelling. The young British forest officer minds none of those things. But knowledge, a trained staff, plenty of time (which entails much larger staffs), and an adequate equipment are required if the figures obtained for the total forest resources of the Empire (even for merchantable timber) are to be of a practical value. We find no reference to this part of the problem in the report under review.

The suggestion for co-operation amongst the owners of woods in Great Britain for improving their woodlands and in marketing the produce are to the point; also on the important subject of the introduction of new Empire hardwoods on to the home markets. In this latter matter the forest officer is practically powerless. It is a question for the timber merchant, and as the writers of the report rightly say, the introduction of new timbers "involves risk and expense which exporters, with or without Government aid, must be prepared to undertake"; and they add: "We advocate a policy of restraint in regard to the number of varieties of new Empire timbers which are concurrently introduced into the British market."

This report is a valuable piece of work, covers a wide range of outlook in the timber problems of the British Empire, and its perusal may be strongly recommended to all who are in any way interested in timber supplies.

The Four Component System in Peace and War.

DR. F.A. FREETH, of Imperial Chemical Industries, Ltd., honorary lecturer in the theory and practice of heterogeneous equilibria at University College, London, gave his inaugural address on Friday, Mar. 1, on "The Four Component System in Peace and War."

The particular type of four component system with which Dr. Freeth dealt is known as the reciprocal salt pair, or as a double decomposition. One of the latest and best-known examples of this is the conversion saltpetre process, whereby potassium chloride and sodium nitrate are converted into potassium nitrate and sodium chloride. The subject was developed along the lines of Meyerhoffer, one of the pioneers of this field, who published his paper about thirty years ago, but the method of representation used to explain the original arguments was that developed by Prof. Janecke, of the Technical High School, Hanover.

The method of representation takes the form of a cube the base of which represents all the possible mixtures of the salts whilst water is plotted vertically. Considering the base of such a cube only, that is to say, the relative proportions of the salts, such base can be considered as being divided into four areas, each of which represents saturation with respect to one of the four salts under consideration. If by any means a solution can be obtained within an area representing saturation with respect to a particular salt, then generally speaking it is possible to obtain that salt in a pure condition.

The famous reciprocal salt pairs of commerce were then considered, particular attention being paid to the ammonia soda process which was developed in Great Britain by the late Dr. Ludwig Mond. Several other well-known working processes were also discussed, notably the caustification of sodium carbonate by lime giving caustic soda. All these old commercial processes were developed empirically, and it is generally found that current practice corresponds very closely with the optimum conditions predicted by a stringent theoretical treatment.

Reactions of this character played a very important part in the War. Fixed nitrogen is essential for modern explosives, both for propellants and for the high explosives used for bursting charges in shells. Until the War, the main source of fixed nitrogen was Chile nitre; treatment of this nitre with sulphuric acid yields nitric acid, which can be converted into high explosives like tri-nitro-toluene, propellants such as cordite, and by neutralisation with ammonia can be made to yield ammonium nitrate. Germany obviously could not depend indefinitely on the Chile supplies, so the Haber and the Ostwald processes were developed. The Haber process makes ammonia, using coke, air, and water as raw materials; the Ostwald process, by burning ammonia with a limited quantity of oxygen, converts it into nitric acid. After these processes were once developed on a sufficiently large scale, Germany was automatically independent of any outside supplies of fixed nitrogen. Both processes, more especially the Haber process, required very considerable advances in technique.

On the outbreak of war in 1914 it soon became manifest that immense supplies of fixed nitrogen would be required by Great Britain. Even assuming that the productive capacity, making nitric acid on the old lines, would have been sufficient, there was a shortage of toluene for the necessary quantity of T.N.T. had that explosive been exclusively used. It was speedily discovered that T.N.T. could be diluted with no less than four times its weight of ammonium nitrate without impairing the high explosive properties of the mixture. The supply of ammonium nitrate, therefore, became of vital importance. Lord Moulton, the director of Explosive Supply, was faced with the following dilemma: Should he attempt to erect Haber and Ostwald plants of the necessary size, or should he attempt to make ammonium nitrate by double decomposition, using Chile nitrate as his source of fixed nitrogen? He decided on the latter course, for the very good reason that he considered the enormous calls on technical men of every kind rendered it almost out of the question to develop what was, in Great Britain, an entirely novel process.

Three double decomposition processes were used in the War period, and nearly all of them had been considered as technically impossible after practical trial. These processes were:

(1) The ammonia soda reaction on sodium nitrate giving ammonium nitrate and sodium bicarbonate. (2) Conversion of the waste calcium chloride of the ordinary ammonia soda process into calcium nitrate by double decomposition with sodium nitrate and the subsequent decomposition of the calcium nitrate with ammonium carbonate yielding ammonium nitrate and calcium carbonate. (3) Double decomposition of sulphate of ammonia and sodium nitrate giving ammonium nitrate and sodium sulphate. This latter process, after initial failure, afterwards became successful; it was worked on a very large scale in Great Britain and upon a still larger scale in the United States. All these processes were developed both theoretically and practically in the research laboratories of Messrs. Brunner Mond and Co., Ltd., of which Dr. Freeth was the head.

Finally, Dr. Freeth paid tribute to the extraordinary help which those engaged in developing this process had received from theoretical work of the Dutch school, notably of Prof. Schreinemakers in Leyden, while the germ of all the theories involved goes back to a most distinguished American mathematical philosopher—Willard Gibbs—probably one of the most detached men who ever lived.

Fauna of the Paraguayan Chaco Swamps.

A SERIES of papers on the fauna of the tropical swamps of the Paraguayan Chaco were read at the meeting of the Linnean Society on Jan. 3. Messrs. G. S. Carter and L. C. Beadle, in a preliminary paper, dealt with the relation of the fauna to the physico-chemical conditions of the environment. These swamps cover large areas of the plains to the west of the Paraguay River on the latitude of the southern tropic; those in the neighbourhood of the station of the South American Mission Society at Makthlawaiya (58° 19′ W., 23° 25′ S.) were investigated. They are shallow, frequently dry, and are filled with much aerial vegetation in all parts. During eight months (October 1926–June 1927), observations were made at regular intervals of several characteristics of the water in the swamps. The most striking observations were: (1) The high temperature which the surface-layers of the water were sometimes found to reach (42° C.); (2) the large quantities of phosphates always present (up to 10 mgm. per litre); (3) the low tension of dissolved oxygen, not more than 2-3 c.c. per litre in the surface layers, while below the upper 4-6 in. there was scarcely ever more than 0·2 c.c. per litre during the hot weather. This low oxygen content is believed to be due partly to the poverty of the aquatic flora, partly to the great activity of decay at the high temperature, and partly to the absence of convection currents caused by the cooling of the surface layers at night. The behaviour and distribution of the fauna show that the shortage of dissolved oxygen in the water is the greatest bionomic factor.

Dr. R. Gurney submitted a report on the Branchiopoda of the expedition. Dr. Carter's collections include five species, of which three appear to be undescribed. Four of them are Conchostraca, and include the remarkable *Cyclistheria histopi*, which is found also in Africa, India, Ceylon, and Australia.

Mr. E. Meyrick discussed the Microlepidoptera which were collected. The nature of the region would probably not be very favourable to Microlepidoptera. The number of species in identifiable condition is 32; of these, 2 genera and 22 species are described as new. Of the remainder, 3 are horticultural pests introduced with their food-plants, 1 a widely spread American insect, 2 are found also in the Argentine, and 4 in the Amazon valley. The new species are generally of Guiana and Amazon types.

Messrs. Carter and Beadle described their observations on the habits and development of *Lepidosiren paradoxa*. The subsoil of clay, which occurs everywhere in the parts of the Paraguayan Chaco inhabited by this fish, preserves water in the burrow used in dry weather, thus keeping its skin moist. Oxygen is normally absent from the water surrounding the nest of the *Lepidosiren*, and the manner in which the respiratory needs of the eggs and young larvæ are satisfied is discussed. The normal rhythm of the contraction of the pigment cells of the skin of the larvæ at dusk and their expansion at dawn is preserved for some days when the larvæ are kept in the dark continuously.

Dr. J. Stephenson dealt with the Oligochæta. Oligochæta have been collected from the northern and more remote part of Paraguay only twice previously, and then only in small numbers; hence the present collection contains a large proportion of new species. Limicoline forms are in the majority. A considerable part of the interest of the present collection lies in considerations of geographical distribution.

Dr. W. A. Cunnington reported on the Argulidæ of the expedition, which belong to the genera *Dolops* and *Argulus*. The two species of *Dolops*—*Dolops striata* (Bouvier) and *Dolops geayi* (Bouvier)—are of interest, as certain specimens are larger than any hitherto recorded. The single species of *Argulus* appears to be new to science.

Mr. H. W. Parker discussed the Amphibia and Reptilia which were collected. Dr. Carter's collections contain two tadpoles and a half-grown example of the frog *Ceratophrys lævis* (Budgett). The tadpoles, hitherto undescribed, have mouth-parts of a kind unique amongst the Salientia, and, as their food is exactly similar to that of some other species of *Ceratophrys*, this suggests that *lævis* is not closely genetically related to the other members of the genus in which it is at present included.

University and Educational Intelligence.

CAMBRIDGE.—D. J. Watson, Downing College, has been appointed to the Frank Smart University Studentship in Botany. J. C. P. Miller, Trinity College, has been elected to the Sheepshanks Exhibition.

THE Chadwick Trustees invite applications from British subjects between twenty-five and thirty years of age who are graduates of a British university or of equivalent standing, for two travelling scholarships of £400 each, to enable the holders to travel abroad during one year to study methods adopted in other countries for the prevention of disease and the improvement of the public health. One scholarship will be for sanitary science and the other for municipal engineering. Applications must be sent in before Mar. 25; full particulars may be obtained from the Clerk of the Chadwick Trustees at 204 Abbey House, Westminster, London, S.W.1.

PARENT-TEACHER associations have so grown, says the United States Bureau of Education in the November issue of *School Life*, that they have become one of the outstanding forces in American education. Their members, numbering more than a million and a quarter, are organised under the guidance of the National Congress of Parents and Teachers, founded in 1897, for the promotion of a better understanding between parent and teacher with consequent co-operation between home and school and appreciation on the part of all citizens of their responsibility to the younger generation. The Congress executive operates, with the help of the teacher members, an ambitious scheme of adult education in which it has the powerful backing of the federal Bureau of Education, and last September it promulgated a manifesto urging the supreme importance of universal education for parenthood. In this document, which was published in the October issue of *School Life*, it calls upon universities and colleges to develop special courses in this subject in their teacher training, extension and correspondence study departments, exhorts public librarians to organise special facilities for its study, and State and city school officers to plan for bureaux of parent education. The Bureau of Education is supporting this movement by publishing a series of nine articles by eminent authorities concerning parent-teacher associations in their relation to the children and to the schools of elementary, secondary, and higher grade. The first of these, on the Congress programme of parent education, appears in the November issue of *School Life*. Others will deal with pre-school education, the teacher, the parent and the curriculum, recreation as a necessary part of home life, parents and the sex question, parents and high-school students, parents in higher education, books, and parent education in the home.

Calendar of Patent Records.

March 11, 1835.—A patent was granted to Robert Jupe, upholsterer of London, on Mar. 11, 1835, for an improved expanding table in which the width was enlarged as well as the length, the principle being applicable to round or other shaped tables. The table top was divided into a number of sections which could be caused by suitable mechanism to diverge from the common centre, the spaces thus formed being filled by inserting 'leaves.'

March 12, 1839.—The patent granted to Job Cutler of Birmingham for an improved method of constructing chains for suspension bridges and other purposes, and dated Mar. 12, 1839, is one of the rare cases in which a caveat against the grant of a patent was entered at the Great Seal, the last stage at which a patent could be opposed. The Attorney-General, on the evidence of John Farey, reported against the grant, but the Lord Chancellor overruled the objection and sealed the patent as of the original date.

March 13, 1561.—The patent granted to Philip Cockeram and John Barnes in 1561 for the manufacture of saltpetre affords the first known instance of an official specification or written description in connexion with a patent for an invention, though the delivery of the description was not a condition of the grant. It appears that Queen Elizabeth agreed to pay Gerrard Honricke, a German, the sum of £300 if he would teach certain of her subjects how to make saltpetre as it was made on the continent and would also give an account of the process in writing. The 'specification' was duly delivered to the Secretary's office on or about Mar. 13, 1561. The Queen thereupon granted a patent to Cockeram and Barnes for ten years, and transferred to them the obligation to pay Honricke the stipulated sum.

March 14, 1769.—On Mar. 14, 1769, within a few weeks of James Watt's steam engine patent being sealed, a patent was granted to Francis Moore, draper, of London, which made Dr. Small write to Watt: "Moore has taken out a patent for moving wheel carriages by steam. This comes of thy delays. . . . At this moment, how I could scold thee for negligence." Watt was not, however, perturbed by the information, and replied that Moore could not make a steam carriage without using his (Watt's) patent, and that if he did use it, Watt would easily be able to stop him. No specification was enrolled with Moore's patent, and the only evidence of his improved carriage shows a horse-drawn vehicle having very large diameter wheels.

March 15, 1784.—The argand burner, the first notable improvement on the primitive oil lamp, was invented by Amié Argand, a French chemist living in London, and patented by him in England on Mar. 15, 1784. Argand was anticipated in France by Ambroise Lange, who had seen the invention in London and gave it to the Paris Academy as his own. Later, the two joined forces, and a French patent was granted in the two names, but this with other similar privileges was suppressed by the Revolution and the invention thrown open to the public. Argand's reason gave way under the series of misfortunes and he returned to England to devote the remainder of his life to an attempt to discover the elixir of life.

March 16, 1744.—A patent was granted to Samuel Sutton on Mar. 16, 1744, for a method of extracting the foul air from the holds and living quarters of ships through pipes heated by the ordinary cooking and other furnaces of the ship. Sutton himself tells that he experienced great difficulty in getting the invention adopted by the Admiralty, but eventually it was installed in a large number of H.M. ships.

Societies and Academies.

LONDON.

Royal Meteorological Society, Feb. 20.—**L. H G. Dines**: The Baker automatic release for dropping the meteorograph from a registering balloon at a predetermined height.—**C. K. M. Douglas**: Some aspects of surfaces of discontinuity. The more important pressure changes on weather maps are due mainly to large-scale horizontal movements at levels round about the base of the stratosphere, considered in conjunction with movements at lower levels. The changing pressure fields cause converging and diverging movements, which influence fronts and produce inversions where the air is subsiding.—**E. Kidson** and **H. M. Treloar**: The rate of ascent of pilot balloons at Melbourne. Atmospheric turbulence is the most important cause of departures from the normal rate of ascent. The greater the turbulence the greater is the mean height. The turbulence due to surface-heating of the air is more effective than wind turbulence in increasing the rate of ascent in the lowest layers. The heat turbulence is effective chiefly near the surface and in light winds. The rate of ascent is less in stable than in unstable air under the same conditions as to turbulence.

Physical Society, Feb. 22.—**L. F. Stanley**: The construction and calibration of a sensitive form of Pirani gauge for the measurement of high vacua. The gauge consists of a manometer and a compensator, the one identical with the other, placed in the opposite arms of a Callendar-Griffiths bridge; each consists, essentially, of a loop of 10 cm. of platinum wire, of 0·001 inch diameter, together with a compensating loop of 2 cm. of the same wire. The symmetry of the circuit makes errors due to thermoelectric effects very small. The gauge follows variations of pressure with considerable rapidity, and its range of measurement is from 2×10^{-3} mm. to 4×10^{-6} mm. approximately.—**Charles H. Lees**: The free periods of a composite elastic column or composite stretched wire. The free periods of the longitudinal oscillations are determined when both ends of the column are nodes, when one is an antinode, and when both are antinodes. A graphical method of dealing with the problems is developed.—**Allan Ferguson** and **J. A. Hakes**: A capillary tube method for the simultaneous determination of surface tension and of density. A capillary tube of radius r is immersed vertically to a depth h_1 in a liquid of density ρ_1. Tube pressure $g\rho h$ required to force the meniscus down to the lower end of the capillary and to hold it there is measured. If h_1 and consequently h be varied, a plot of h against $(h_1 - r/3)$ gives a straight line, from slope and intercept of which the surface tension and the density of the liquid may be inferred.

CAMBRIDGE.

Philosophical Society, Jan. 28.—**Sir Ernest Rutherford** and **J. Chadwick**: Energy relations in artificial disintegration. Experiments on the disintegration of aluminium indicate that the change of energy is not the same for each nucleus, but that it may vary by so much as 5×10^6 electron-volts. Hence, either the mass of the aluminium nucleus or that of the nucleus formed in the disintegration may vary by nearly 0·006 mass units.—**R. H. Fowler**: An analogy for beams of particles of a reciprocal optical theorem due to Helmholtz.—**D. R. Hartree**: The distribution of charge and current in an atom with several electrons obeying Dirac's equations. The approximation is made that each electron can be treated as in a stationary state in the field of the nucleus and the

remaining electrons, and further that this field is spherically symmetrical. An exact formula for the magnetic moment corresponding to a solution of Dirac's equation in a central field is given, and leads to Landé's g-formula when 'relativity effects' are neglected.—**N. Feather** and **R. R. Nimmo**: The distribution of range of the α-particles from radium C′ and thorium C′. Distribution curves relative to 2134 α-particles from thorium C′ and 729 from radium C′ showed that many more had ranges between 6 cm. and 8 cm. of standard air than was expected, and that the excess of short range particles was much greater in the former case than in the latter, where the results agreed satisfactorily with those of Briggs, obtained by the magnetic deflexion method.—**R. M. Gabriel**: Some further results concerning the integrals of moduli of regular functions along curves of certain types.

PARIS.

Academy of Sciences, Jan. 28.—**V. Grignard** and **Tchéoufaki**: The α-diacetylene hydrocarbons. Hydrocarbons of the type $RC\equiv C-C\equiv CR$ can be obtained in good yields by the action of iodine in ether solution upon alkyl magnesium compounds, provided that the conditions laid down are closely followed. In the fatty series, dipentine, dihexine, and diheptine have been prepared by this method, and several aromatic hydrocarbons of the same type are also described. Phenyltriacetylene, $C_6H_5-C\equiv C-C\equiv C-C\equiv CH$, has also been prepared and its properties are given.—**Serge Bernstein**: Orthogonal polynomials.—**Auguste Lumière, Mme. R. H. Grange**, and **R. Malaval**: The pH of arterial blood and of venous blood. Measurements by the electrometric method give pH values of 7·85 for arterial blood and 7·50 for venous blood. The main cause of the variations appears to be the amount of carbon dioxide present.—Georges Birkhoff was elected *correspondant* for the Section of Geometry in the place of the late Ivar Fredholm, and Adrien de Gerlache *correspondant* for the Section of Geography and Navigation in the place of the late Sir Philip Watts.—**Maurice Fréchet**: The distance of two contingent variables.—**Lucien Féraud**: Bundles of conjugated networks.—**Frank Loebell**: The generalisation of a theorem of H. A. Schwarz.—**Nicolas Cioranesco**: The problem of Dirichlet for systems of equations of the elliptic type and the extension of a functional relation of M. Hadamard.—**A. Gay**: The movement of a cylinder in a viscous fluid.—**Jules Baillaud**: The determination of the galactic pole from the data of the selected areas.—**L. d'Azambuja**: The use of the spectro-heliograph for the determination of the level of the vapours of the reversing layer or lower portion of the solar atmosphere.—**H. Pélabon**: Rectification by purely metallic bad contacts. A description of the phenomena observed using as rectifier two similar steel cylinders separated by a thin layer of lycopodium powder or cork dust.—**Henri Gutton**: The effect of a magnetic field on the resonance phenomena in ionised gases.—**P. Salet**: The constancy of the velocity of light. Arguments against the application of the ballistic theory to the explanation of the changes in the intensity of light in certain stars.—**E. Darmois**: The rotatory power of the tartrates of certain organic bases: contribution to the study of strong electrolytes.—**A. Smits**: The allotropic modifications of phosphorus. Remarks supplementing the author's communication of Nov. 29 last, and criticism of the work of Nicolaïeff on the same subject.—**W. Swietoslawski**: A boiling-point apparatus designed for researches under high pressures. A modification of an apparatus previously described capable of being used under pressures up to 25 atmospheres.—**A. Zmaczynski**: A new modification of a boiling-point apparatus used for high pressures.—**M. Prettre** and **P. Laffitte**: The temperature of ignition of combustible gaseous mixtures. The results given in an earlier paper on the temperatures of ignition of mixtures of air and hydrogen are much lower than those given by other workers, and this is attributed to the lower initial pressure adopted. The present paper gives the result of the influence of the preliminary vacuum on the temperature of ignition.—**Mlle. Germaine Marchal**: The action of silica, alumina, and of kaolin on barium sulphate.—**Mlle. Jeanne Lévy** and **A. Tabart**: The relative affinity capacities of various radicals on the course of the isomerisation of the trisubstituted ethylene oxides.—**P. Fallot**: The relations of the sub-Betic with the Betic in the Sierras Tercia and Espuña.—**H. Pollet**: Atmospheric electricity in the course of the sand storms of the north of China. The electric charge on each dust particle is of the order of 100 times the elementary charge of an ion.—**P. L. Violle** and **A. Giberton**: The neutralisation of the oligodynamic power of copper by solutions of electrolytes. Application to mineral waters.—**Georges Truffaut** and **G. Thurneyssen**: The influence of artificial light on the growth of the higher plants. A description of the lighting arrangements by means of which normal beans and strawberries have been produced. The microscopic examination of the leaves of the strawberry plants cultivated in artificial light showed that they were normally provided with chlorophyll and that their palisade tissues exactly resembled the normal palisade tissue of plants raised in daylight.—**Charles Pontillon**: The existence of resins in *Sterigmatocystis nigra*.—**J. Manquené**: The alluvial formations of western Algeria after the inundations of 1927.—**Lucien Daniel**: The accentuation and persistence of symbiotic adaptations in the Jerusalem artichoke grafted on the annual sunflower.—**Mlle. G. Fuchs, J. Régnier, D. Santenoise**, and **P. Vare**: A thyroid hormone regulating the cerebral excitability.—**Paul Wintrebert**: The liquefaction of the internal sheath of the egg in the urodelan Amphibia.—**René Fabre** and **Henri Simonnet**: The comparative study of the value of the biological test and the physical test of irradiated ergosterol. It appears to be premature to attribute to the biologically active product a definite absorption spectrum.—**R. Fosse** and **A. Brunel**: A new ferment. This ferment, named allantoinase, is found in various leguminous seeds and is characterised by its power of hydrolysing allantoin to allantoic acid.

ROME.

Royal National Academy of the Lincei, Nov. 11.—**T. Levi-Cività**: The motion of a body of variable mass.—**G. Fubini**: Further considerations on the transformations of Laplace, Lévy, and Moutard for hypersurfaces.—**G. Abetti**: Anomalies of gravity and deviations of the vertical determinated by the De Filippi expedition in Central Asia (1913–14). The results obtained by this expedition, taken in conjunction with those of the Survey of India to the south of the Himalayas and those of the Russian Geodetic Service in Turkestan and Pamir, show that on these mountain chains the gravitation constant is usually in excess. To the south and to the north it is, however, usually deficient, this being an indication of the probable equality of the conditions of compensation or non-compensation in the Indo-Ganges plain and in the plains of Turkestan.—**F. Vercelli**: Experimental considerations concerning certain geo-electric methods.—**L. Rolla** and **L. Mazza**: Concerning thallium photoelectric cells. The procedure recently described by Majorana and Todesco for the preparation of thallium photoelectric cells

was published by Rolla in 1927 and has been patented. Such cells have been successfully used by the Italian military authorities.—**G. Ascoli**: The singularity of the solution in Dirichlet's problem. A sufficient condition, not of purely geometrical character, but of ready applicability, is given for the validity of the theorem of singularity of the solution in Dirichlet's problem.—**F. Sbrana**: A remarkable group of functional operators. Some of the essential results are given of the author's recent investigations on the calculus of functional operators $f(\Delta)$ with $\Delta = \frac{\partial}{\partial t}$ and t variable and real. This method of calculus, known as operational or symbolic calculus, is finding increasing application in the solution of numerous mathematical physical problems of industrial importance or inherent to modern atomic physics.—**G. Aliprandi**: Determination of the principal triplet (terna)—of Vitali—of a generic surface, considered as an autopolar terna of the geodetic cone.—**A. M. Bedarida**: The algebraic bodies of Galois.—**G. Scorza Dragoni**: Concerning a differential equation.—**M Lelii**: Bernouilli's theorem for homogeneous viscous liquids.—**R. Calapso**: A new transformation of isothermal surfaces.—**E. Čech**: Observations on the quadrics of Darboux.—**G. Sannia**: New definitions of the canonical pencil.—**M. Maggini**: Interferometric measurement of the effective wave-length of double stars and its variation with the zenithal distance. The interferometer is able to replace not only the micrometer where this is ineffective, but also the diffraction grating in the measurement of wave-length, and the photometer in the measurement of extinction.—**E. Adinolfi**: The influence of X-rays on the structural conditions of bismuth and tellurium (3). When absorbed by bismuth during its solidification, X-rays modify the structure of the metal, which exhibits a diminished Hall's coefficient and becomes electropositive towards ordinary solidified bismuth. Under similar treatment, tellurium also assumes a lower Hall's coefficient, but is rendered electronegative with respect to ordinary tellurium. When solidified rapidly from the molten state, both of these elements increase in hardness and acquire an increased specific heat, the latter change occurring also in the case of solidification under the influence of X-rays.—**O. Occhialini**: Low voltage sparks as spectroscopic sources. The procedure to be adopted to obtain these sparks, which are formed at a voltage of 220, is described.—**P. Agostini**: Heats of formation of double cadmium potassium chlorides. The heats of formation of the compounds, KCl, $CdCl_2$, and 4KCl, $CdCl_2$, are found to be +3·65 (3·73) Cal. and +0·989 Cal. respectively.—**G. Bargellini** and **Lydia Monti**: α-Phenylcoumarins. Various α-phenylcoumarins have been prepared by the condensation of aromatic *o*-hydroxyaldehydes with substituted phenylacetic acids.—**G. Bargellini** and **P. Leone**: 3 : 5 – Dichlorophenetidine. The best conditions for preparing this compound by passing hydrogen chloride through an alcoholic solution of nitrosophenol (Jaeger's method) are described, together with several of its derivatives.—**G. A. Barbieri**: New method for the volumetric determination of cobalt. In the green liquids resulting from the decomposition of cobaltinitrites by hot sodium hydrogen carbonate solution, all the nitro groups of the cobaltinitrous complex are present as alkali nitrate, whilst the tervalent cobalt forms part of a cobalticarbonic complex, to which the green colour is due. If the liquid is introduced into permanganate solution acidified with sulphuric acid, the nitrous acid is oxidised quantitatively in the cold to nitric acid and the tervalent cobalt is reduced to the bivalent form, so that eleven equivalents of oxygen are consumed for each molecule of the original cobaltinitrite. These reactions serve as a basis for the volumetric determination of cobaltinitrites and hence of the two elements which can be separated quantitatively as cobaltinitrites, namely, potassium and cobalt.—**G. R. Levi**: Further investigations on catalysis with metals of the platinum group. The catalytic decomposition of hydrogen peroxide by platinum is greatly influenced by the presence of other metals of the group. Iridium and, to a less extent, rhodium depress the catalysis, and palladium seems to act similarly to iridium. Possibly owing to a positive influence of the metal and a negative influence of the oxide, ruthenium is almost without effect on the catalysis. Although the catalytic formation of sulphur trioxide is influenced only slightly and negatively by osmium, the decomposition of the peroxide is very markedly increased in the presence of this metal.—**G. Piccardi**: The Röntgen levels of the rare earths and the derivations from Moseley's law.—**A. Barchiesi**: Ponderal and histophysiological investigations on guinea-pigs and rabbits subjected to injections of lipoid mixtures. Injection of lipoid mixtures affects all the organs and tissues examined and modifies the whole organic metabolism. The results seem to support Serono's assumption that, possibly owing to their special chemical character, lipoids form biological catalysts which induce many complex reactions.—**G. Brunelli**: Biophysical nature of the pitted erosion of the arenaceous rocks of the Tyrrhenian coast. Observations made at Cape Linaro show that the perforation of the rocks is due initially to small shells of *Littorina punctata* and *L. neritoides*, which attack the rock at the points of least resistance. Afterwards the action of the waves affects further destruction of the rock in the perforations initiated by the molluscs, so that the degradation is of mixed, biophysical character. In certain cases *Patella* also plays a part in this phenomenon.—**S. Ranzi**: Relations between organogenetic and histogenetic processes. (Investigations on experimental morphology in the cephalopods.) Considerations of phenomena relating to the development of the embryos of cephalopods indicate that, up to a certain point, histogenetic processes are independent of organogenetic processes. This general principle is in complete accordance with many data obtained from experiments on the culture of the tissues of vertebrates, these showing that, for varying but usually short periods, the cells may retain their differentiation.—**Aldo Spirito**: Regulative processes of the encephalic region of the embryos of *Anura*.—**T. Terni**: Regeneration and super-regeneration of tissue and of organ in the tail of adult urodeles.

SYDNEY.

Linnean Society of New South Wales, Nov. 28.—**G. D. Osborne**: (1) The Carboniferous rocks between Glennies Creek and Muscle Creek, Hunter River District, N.S.W. Comprise representatives of the Burindi Series, a marine series of Lower Carboniferous age, and the Kuttung Series, of Middle to Upper Carboniferous age; the latter are at least 8000 feet in thickness, and have been subdivided into the volcanic and glacial stages. The late Palæozoic diastrophism produced a basin-structure and associated broad folding. Connected with this movement there developed a series of normal faults, one of which—the Brushy Hill Fault—is of great importance. Separating the Carboniferous rocks from the Permian strata is a great fault—the Hunter Overthrust, which is of later date than the normal faults.—(2) The Carboniferous rocks of the Muswellbrook-Scone District, with special reference to their structural relations. This area described

is to the north of that discussed above and has similar stratigraphical and tectonic features. In the north-west is the important Wingen fault, which cuts across the Hunter Overthrust. It then strikes into the Carboniferous rocks, and is marked by a wonderful shatter-zone, up to five chains in width.—**J. R. Malloch**: Notes on Australian Diptera. No. 18. An alphabetical catalogue of genera and species of Tachinidæ.—**A. B. Walkom**: Notes on some additions to the *Glossopteris* flora in New South Wales. Descriptions of (1) a collection of small *Glossopteris* leaves which belonged to the late John Mitchell, (2) two terminal shoots (from the collection of the Geological Survey of New South Wales) which may possibly represent part of the plant which bore *Glossopteris* fronds, and (3) a collection of seeds belonging to Mr. T. H. Pincombe. Some of the latter resemble very closely seeds described from Upper Carboniferous and Permian rocks in Europe.—**Frank A. Craft**: The physiography of the Wollondilly River Basin. To the west of the Illawarra coast there is an area of plateau country forming the basins of the Wollondilly and Nepean Rivers. Behind the coastal scarp over an extensive area this plateau has an elevation of 2000-2500 feet, and is drained by the Eastern Wollondilly system and the Lower Shoalhaven. This gives place in the west to a higher tableland, which rises from south to north. The plateau as a whole presents a mature surface which is being cut up by stream erosion most markedly in the north.

VIENNA.

Academy of Sciences, Nov. 29.—**E. Smreker**: Anastomoses between the dentine channels and cement corpuscles in the chamois.—**K. Menger**: The semi-constancy of arc length.—**O. Wettstein**: Amphibia and reptilia from Palestine and Syria.—**F. Heritsch**: Corals from the Carboniferous of the Yeitsch in Upper Styria.—**H. Hahn**: Continuous extension images.—**F. Dehmer**: Irreducible continua.—**J. B. Niederl** and **R. Casty**: New condensations of ketones with phenols. (2) Further cresol-phorones.

Dec. 6.—**L. Moser** and **O. Brandl**: The determination and separation of rare metals from other metals. (13) Re-examination of the gravimetric analysis of vanadium and two new methods for its determination. There are several lead vanadates; under certain conditions first lead hexa-vanadate and then lead pyro-vanadate is formed. Vanadic acid can be completely precipitated with mercury nitrate again under certain conditions.—**L. Moser** and **F. List**: (14) Separation of beryllium from the metals of the alkaline earths and from the metals of the ammonium sulphide and arsenic groups. One way is by forming difficultly soluble metal tannic acid adsorption complexes, the other by hydrolysis of the beryllium ion by ammonium nitrite and methyl alcohol.—**E. Späth** and **N. Polgar**: A synthesis of non-hydrated iso-quinoline derivatives.—**A. Skrabal**: The varieties of unstable intermediate substances in chemical kinetics. The intermediates during the main period of the reaction may be in equilibrium with the initial or with the final substances.—**F. Hölzl**: Buff's substance and Bunsen's salt. Salts of tetrabasic hexacyano-ferric acid with alcohol as base.—**W. L. Ayres**: Generalisations of Jordan's continua.—**G. Bergmann**: Axioms in elementary geometry.—**B. Finzi**: Ants from Greece and the Ægean islands.—**D. W. Adensamer** and **F. Käufel**: Land and fresh-water mollusca from Greece and the islands of the Ægean.—**H. Strouhal**: Land isopods from Greece and the islands of the Ægean.—**H. Preisner**: Rhyncota from Greece and the islands of the Ægean.

Dec. 13.—**V. Pietschmann**: New species of fish from the Pacific Ocean.—**F. M. Exner**: Dune studies in the Courland sandhill tongue, with an appendix on river-meanders, clouds, and cyclones arising from friction eddies. Sand waves are explained by horizontal eddies. Small sand waves move rapidly, larger waves slowly.—**F. Sigmund** and **R. Uchann**: The catalytic splitting off of alcohol from acetals (preparation of unsaturated ethers). By using a clay catalyser at 200°-250°; nickel not essential.—**C. Doelter**: Reactions with blue rock-salt.—**C. Zawisch-Ossenitz**: The development of the human femur.—**W. Figdor**: Cone-shaped leaves and the asexual multiplication of *Bryophyllum proliferum*.—**K. Fritsch**: Observations on flower-visiting insects in Styria, 1908.—**G. Ortner** and **G. Stetter**: The use of electronic valve amplifiers for counting corpuscular rays.—**E. Guth**: Systems of linear partial differential equations of the first order, compatible with a given metric, especially Maxwell's equations and Dirac's equations for the electron.—**F. Urbach**: The form of the absorption and emission bands in solids.—**A. Zinke**, **W. Hirsch**, and **E. Brozek**: Researches on perylene and its derivatives (19).—**K. Funke**, **F. Kirchmayr**, and **H. Wolf**: Researches on perylene and its derivatives (20).—**A. Pongratz** and **E. Pöchmüller**: Researches on perylene and its derivatives (21).

Official Publications Received.

BRITISH.

Report of the Commission on Closer Union of the Dependencies in Eastern and Central Africa. (Cmd. 3234.) Pp. 354+5 maps. (London: H.M. Stationery Office.) 6s. net.

Colonial Veterinary Service. Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 3261.) Pp. 44. (London: H.M. Stationery Office.) 9d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 16: The Integration of Light by Photo-Electrolysis. By Dr. W. R. G. Atkins and Dr. H. H. Poole. Pp. 159-164. 6d. Vol. 19 (N.S.), No. 17: A Note on Gas Analysis. By James T. Donnelly, C. Hamilton Foott and J. Reilly. Pp. 165-172. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

The Proceedings and Transactions of the Nova Scotian Institute of Science, Halifax, Nova Scotia. Vol. 17, Part 2, Session 1927-1928. Pp. xi-xix+40+iii. (Halifax, N.S.) 50 cents.

International Federation of University Women. Bulletin No. 10: Report of the Twelfth Council Meeting, Madrid, September 1928. Pp. 103. (London.)

Air Ministry. Aeronautical Research Committee: Reports and Memoranda. No. 1178 (Ae. 342): The Change in Airscrew Characteristics with Height. By A. E. Woodward Nutt. (T. 2594 and a, revised.) Pp. 10+3 plates. 9d. net. No. 1175 (Ae. 339): An Analysis of a Rectangular Monoplane with Hinged Tips. By S. B. Gates. (T. 2578.) Pp. 10+3 plates. 1s. net. (London: H.M. Stationery Office.)

Proceedings of the Fifteenth Indian Science Congress, Calcutta 1928 (Third Circuit). Pp. xxv+420. (Calcutta: Asiatic Society of Bengal.)

Transactions and Proceedings of the New Zealand Institute. Vol. 59, Part 3, September 1928. Pp. iv+429-661+77 plates. (Wellington, N.Z.)

Government of India: Meteorological Department. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1923, under the Direction of Dr. S. K. Banerji. Pp. ii+72+5 plates. (Calcutta: Government of India Central Publication Branch.) 8,8 rupees; 14s. 3d.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 15: William Higgins, a Pioneer of the Atomic Theory. By Dr. J Reilly and D. T. MacSweeney. Pp. 139-157. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Board of Education. Educational Pamphlets, No. 32: The Admiralty Method of Training Dockyard Apprentices. Revised edition. Pp. 19. (London: H.M. Stationery Office.) 2d. net.

Madras Fisheries Department. Fish Statistics for 1925-26. (Supplement to the Administration Report for 1926-27.) Edited by Dr. B. Sundara Raj. (Report No. 2 of 1928, Madras Fisheries Bulletin, Vol. 22.) Pp. 76. (Madras: Government Press.) 14 annas.

Transactions of the Institution of Chemical Engineers. Vol. 5, 1927. Pp. 230. (London.)

FOREIGN.

Carnegie Institution of Washington: Eugenics Record Office. Bulletin No. 26: Birth and Death Rates of the Feeble Minded. By Charles V. Green. Pp. 34. (Cold Spring Harbor, L.I.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský sous le patronage de la Regia Societas Scientiarum Bohemica. Année 1, No. 1, Janvier. Pp. 64. (Prague.)

Annalen v/d Bosscha-Sterrenwacht, Lembang (Java). Vol. 2, 1ste Gedeelte: Die südliche Milchstrasse. Von A. Pannekoek. Pp. A73+6 Tafeln. (Amsterdam: Universiteit.)

Pubblicazioni della Università Cattolica del Sacro Cuore. Serie ottava, Statistica, Vol. 3: Contributi del Laboratorio di Statistica, Serie Prima. Pp. vii+436. (Milano: Società Editrice "Vita e Pensiero.") 50 lire.

Denkschriften der Schweizerischen Naturforschenden Gesellschaft (Mémoires de la Société Helvétique des Sciences naturelles). Band 64, Abh. 2: Nouveau Catalogue des moules d'échinides fossiles du Musée d'Histoire Naturelle de Neuchâtel. Exécutés sous la direction de L. Agassiz et E. Desor par J. Lambert et A. Jeannet. Pp. ii+83-233+2 planches. Band 64, Abh. 3: Zur Frage von der prähistorischen Besiedelung von Amerika mit allgemeinen Betrachtungen über die Stufenfolge der Steinzeit. Von Paul Sarasin. Pp. 235-273+3 Tafeln. (Zürich: Gebrüder Fretz A.-G.)

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1928. (Publication 2978.) Pp. vi+147. (Washington, D.C.: Government Printing Office.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 25, Part 1: Dritter Beitrag zur Ichneumoniden-Fauna Japans. Von Toichi Uchida. Pp. 115+3 Tafeln. Vol. 25, Part 2: The Chemical Studies on the Denaturation of Proteins. First Report, by Tetsutaro Tadokoro and Katsuji Yoshimura; Second Report, by Tetsutaro Tadokoro and Shukichi Watanabe. Pp. 117-149. (Tokyo: Maruzen Co., Ltd.)

Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 5, No. 3, December. Pp. 211-267. (Tokyo: National Research Council of Japan.)

Bulletin of the American Museum of Natural History. Vol. 58, Art. 3: The Nesting Habits of Wagler's Oropendola (Zarhynchus Wagleri) on Barro Colorado Island. By Frank M. Chapman. Pp. 123-166+8 plates. Vol. 58, Art. 4: Diptera of the American Museum Congo Expedition. By C. H. Curran. Pp. 167-187. (New York.)

Proceedings of the American Philosophical Society held at Philadelphia for promoting Useful Knowledge. Vol. 67, No. 3. Pp. 199-318. (Philadelphia.)

Department of Commerce: U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 423: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1927. By Daniel L. Hazard. Pp. 22. (Washington, D.C.: Government Printing Office.) 5 cents.

State of Connecticut. Public Document No. 24: Fifty-first Report of the Connecticut Agricultural Experiment Station, New Haven, Conn., for the Year 1927. Pp. xi+821+xxvi. (New Haven, Conn.)

Annual Report of the Director, United States Coast and Geodetic Survey to the Secretary of Commerce for the Fiscal Year ended June 30, 1928. Pp. iv+47+17 plates. (Washington, D.C.: Government Printing Office.) 75 cents.

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the Years 1926 and 1927. Vol. 19. (Cambridge, Mass.)

CATALOGUES.

Industrial Electric Furnaces with Automatic Temperature Control. Pp. 12. (London: Wild-Barfield Electric Furnaces, Ltd.)

Professor Coker's Photo-elastic Apparatus for determining the Distribution of Stress in Structural and Machine Members. Pp. 28. (London: Adam Hilger, Ltd.)

The Case-Hardening of Special Steels by Nitrogen. Pp. 31. (Sheffield: Nitralloy, Ltd.)

Laboratory Fittings for all Classes of Scientific Research. (List F.) Pp. 16. Electrically Heated Laboratory Apparatus. (Pamphlet No. 231E.) Pp. 16. Comprehensive List of Scientific Text Books. Pp. 12. (London: A. Gallenkamp and Co., Ltd.)

Diary of Societies.

FRIDAY, MARCH 8.

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 3.15.—W. H. Nuttall: Rubber and its Commercial Applications.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—W. H. Moreland: The Indian Peasant in History.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. S. Chapman: Solar Streams of Corpuscles: their Geometry, Absorption of Light, and Penetration.—N. Goryatscheff: Occultations of Stars by the Moon, observed at the Tomsk University Observatory during the Year 1928.—Prof. S. Chapman and V. C. A. Ferraro: The Electrical State of Solar Streams.—Y. Ohman: Astronomical Consequences of the Polarisation of Fluorescence.—W. H. McCrea: The Hydrogen Chromosphere.—C. L. Janssen: Provisional Elements of the Binary System β. G.C. 12307.

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Dr. N. V. Sidgwick: Chemical Linkage.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Clinical Meeting, at University College Hospital), at 5.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. E. Griffiths and J. H. Awbery: The Dependence of the Mobility of Ions in Air on the Relative Humidity.—Prof. A. M. Tyndall: Some Unsolved Problems relating to the Mobility of Gaseous Ions—followed by a General Discussion on the Mobility of Ions.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on the Anatomy and Pathology of "Diverticulitis."

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Hall: Bromide Papers.

MANCHESTER ASSOCIATION OF ENGINEERS (at Engineers' Club, Manchester), at 7.15.—F. B. Holt: Improvements in Driving Textile Mills.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—J. H. Place: Dobbies.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—S. H. Hole: Road Transport (Chairman's Address).

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (jointly with Leicester Association of Engineers) (at Secular Hall, Leicester), at 7.30.—Dr. J. Newton Friend: Science in Antiquity.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University) at 7.30.—W. S. Gifford: Progress in Electric Furnaces.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—S. T. Kinsman: The Fastness to Light of Lake Colours.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 7.30.—L. G. Lawrie: The Microscopical Investigation of Textile Fibres and Fabrics.

INSTITUTE OF TRANSPORT (Newcastle-upon-Tyne and District Section) (at Y.M.C.A. Hall, Newcastle-upon-Tyne), at 7.30.—E. McClelland: Some Aspects of Selling Rail Travel.

KEIGHLEY ASSOCIATION OF ENGINEERS (at Keighley), at 8.—A. G. Springfield: Centrifugal Castings.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. F. Tout: The Place of Women in Later Medieval Civilisation.

SATURDAY, MARCH 9.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Sheffield), at 3.—W. J. Hadfield: The Local Government Act and the Municipal Engineer.

BRITISH PSYCHOLOGICAL SOCIETY (General Meeting) (at Royal Anthropological Institute), at 3.—Prof. T. H. Pear and Miss Edna M. Henshaw: Some Subtler Skills: Conditions for Improvement in Manual Dexterity.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (II.).

MONDAY, MARCH 11.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in Cavendish Laboratory), at 4.30.—N. F. Mott: Quantum Theory of Electronic Scattering in Helium.—H. M. Cave: Note on the Number of High Velocity β-rays.—J. L. Hamshere: The Mobility Distribution and Rate of Formation of Negative Ions in Air.—W. Georgeson: Thermionic Emission through Double Layers.—*Papers to be communicated by title only*:—Dr. C. F. Sharman: Secondary Electron Emission from Solid Metal Surfaces.—J. G. Semple: On Certain Loci of Three Dimensions, Representable on Ordinary Space by Means of Cubic Surfaces, and the Cremona Transformations for Ordinary Space obtained by Projection of such Loci.—G. de B. Robinson: A Geometrical Study of the Alternating and Symmetric Groups.—G. Redington: The Effect of the Duration of Light upon the Growth and Development of the Plant.—Prof. F. E. Fritsch: Evolutionary Sequence and Affinities among Protophyta.—M. Robertson: Life Cycles in the Protozoa.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Rear-Admiral H. P. Douglas: Echo Sounding.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Surg.-Comdr. H. Hill: Post-encephalitis and its Problems in the Service.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration on Specimens illustrating Diseases of the Kidneys.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (at London Day Training College), at 6.—Norman Angell: Teaching Economics by Visual Demonstration.

TEXTILE INSTITUTE (London Section) (at Clothworkers' Hall), at 6.—Dr. W. Gibson: Research Work as an Aid in the Sale of Linen Products.

INSTITUTION OF AUTOMOBILE ENGINEERS (Birmingham Centre) (at Queen's Hotel, Birmingham), at 7.—K. Thomas: Some Investigations into the Performance of Tubular Radiators for Motor Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Ll. B. Atkinson: How Electricity does Things (Faraday Lecture).

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Branch) (at Borough Polytechnic), at 7.—J. H. Bryant: Sprinklers.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (at Hotel Metropole, Leeds), at 7.15.—Prof. C. H. Desch: The Nature of Hardness.—H. O'Neill: The Hardness of Metals.

CERAMIC SOCIETY (at Stoke-on-Trent), at 7.30.—F. H. Rogers: Factory Floors.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Open Discussion.

MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.), at 8.30.—Dr. R. Miller and Dr. W. G. Wyllie: Chronic Dyspepsias of Children over the Age of Infancy.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Cardiff).

TUESDAY, MARCH 12.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section) (Clinical Meeting, at Maudsley Hospital), at 4.30.

ROYAL SOCIETY OF MEDICINE (Therapeutics Section), at 5.—Dr. G. Linder and Dr. C. F. Harris: Treatment of Chronic Tetany with Steatorrhœa in Adults.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (II.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. S. W. Kemp: Antarctic Whaling Expeditions (I.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Dr. E. V. Telfer: Merchant Ship Service Performance Analysis.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates) (at Watergate House, Adelphi), at 7.25.—D. Swallow: Metal Omnibus and Car Bodywork.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—Eng.-Capt. J. C. Brand: Pulverised Fuel To-day.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. Philippa Esdaile: Some Household Pests.

PHARMACEUTICAL SOCIETY, at 8.—Sir Herbert Jackson: The Nature of the Changes which take place in Various Forms of Glass (Lecture).

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—L'Abbé Breuil: Essai de co-ordination des faits géologiques relatifs aux industries paléolo-giques anciens au sud et sud-est d'Angleterre.

WEDNESDAY, MARCH 13.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—Prof. P. Saldau: Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems.—F. Hargreaves and R. J. Hills: Work-softening and a Theory of Inter-crystalline Cohesion.—G. B. Brook and G. H. Stott: The Testing of Electro-deposits on Aluminium.—At 2.—Dr. P. J. Durrant: The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold.—D. Marie L. V. Gayler and G. D. Preston: The Age-hardening of some Aluminium Alloys.—C. Blazey: Brittleness in Arsenical Copper (II.).—Dr. P. J. Durrant: The Haughton-Hanson Thermostat: A Method of Fine Adjustment.—Dr. W. Hume-Rothery and E. Rounsefell: The System Magnesium-Zinc.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (Newcastle-upon-Tyne), at 7.15.—M. Waters: The Problem of High Voltage Measurement.

HALIFAX TEXTILE SOCIETY (at Halifax). at 7.30.—J. H. Edmundson: Treatment for Trade Effluent from Textile Trades.

ROYAL SOCIETY OF ARTS, at 8.—R. P. G. Denman: Loud Speakers.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (jointly with Royal Philosophical Society of Glasgow), at 8.—Dr. J. A. Cranston: Bicentenary Address on Joseph Black.

EUGENICS SOCIETY (at Linnean Society), at 8.—Dr. Margaret Rorke and Mr. Weatherall: Heredity in Education.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—J. W. Perring: Electroplating Plant.

INSTITUTE OF FUEL.—F. W. Goodenough: The Industrial Use of Gas.

HASLINGDEN DISTRICT TEXTILE SOCIETY (at Grammar School, Haslingden).—C. A. Harrington: The Weaving of Artificial Silks.

THURSDAY, MARCH 14.

INSTITUTE OF METALS (Annual General Meeting, continued) (at Institution of Mechanical Engineers), at 10 A.M.—H. C. Lancaster: The Importance of Design, and Setting of Large Kettles used for Refining and Low Melting Point Alloys.—Dr. W. Rosenhain and W. E. Prytherch: An Improved Form of Electric Resistance Furnace.—Dr. F. Campbell: Recent Developments in Electric Furnaces.—At 2.—C. Sykes: Alloys of Zirconium (II.).—Dr. J. Newton Friend and W. E. Thorneycroft: The Resistance of Zinc to Indentation (A Preliminary Account).—Dr. J. Newton Friend: The Solution of Plain and Amalgamated Zincs in Electric Batteries.—Dr. J. Newton Friend and W. E. Thorneycroft: The Silver Contents of Specimens of Ancient and Medieval Lead.

ROYAL SOCIETY, at 4.30.—Discussion on Ultramicroscopic Viruses infecting Animals and Plants (continued).

IMPERIAL COLLEGE CHEMICAL SOCIETY (in Main Chemistry Lecture Theatre, Royal College of Science), at 5.—Prof. C. K. Ingold: The Significance of Tautomerism.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. E. J. Allen: The Origin of Adaptations (Hooker Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—N. S. Koshliakov: Note on the Remainders in the Asymptotic Expansions of Bessel Functions.—D. E. Littlewood: The Quadratic Equation in Quaternions.—C. E. Walsh: The Multiplication of Certain Series.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. E. B. Verney: Polyuria (III.).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Rev. W. H. Draper: The Handling and Interpretation of Metaphor.

INSTITUTE OF CHEMISTRY (Liverpool and North-Western Section) (at Liverpool University), at 6.—R. B. Pilcher: Alchemists in Art and Literature.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—T. N. Riley and T. R. Scott: Electrical Insulating Papers for the Manufacture of Power Cables.—S. G. Brown and P. A. Sporing: The Prevention of Ionisation in Impregnated Paper Dielectrics.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Wing Comdr. G. B. Hynes: Engine Performance Tests.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Annual Meeting) (at Engineers' Club, Birmingham), at 7.—The Chairman and others: Miscellany.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group) (Annual General Meeting), at 7.

WEST CUMBERLAND SOCIETY OF CHEMISTS (at Workington), at 7.—Dr. Briggs: The Preparation of Coal for Sale.

OPTICAL SOCIETY (at Imperial College of Science) (Annual General Meetings), at 7.—At 8.—Ordinary Meeting.—W. D. Wright: A Re-determination of the Trichromatic Coefficients of the Spectral Colours.—Dr. J. S. Anderson: On the Testing of a Novel Photographic Shutter.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—W. Woodiwiss: Distribution.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Cinematograph Demonstration of a Film showing Work on Conditioned Reflexes in Prof. Pavlov's Laboratory, Leningrad.

BRITISH INSTITUTE OF RADIOLOGY, at 8.30.

FRIDAY, MARCH 15.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Sir John Russell: Some Agricultural Problems in Australia.—F. L. McDougall: The Commonwealth Council of Science and Industry in its Relation to Agriculture.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Thunderstorms and the Maintenance of the Earth's Electric Field. Chairman, Prof. S. Chapman. Discussion to be opened by Prof. E. V. Appleton, and continued by R. A. Watson Watt, Dr. G. C. Simpson, Prof. C. T. R. Wilson, and T. W. Wormell.

BIOCHEMICAL SOCIETY (Annual General Meeting) (in Department of Physiology and Biochemistry, University College), at 4.30.—I. S. MacLean: Further Observations on the Sterols of Yeast.—H. J. Channon and A. C. Chibnall: The Isolation of n-nonacosane and di-n-tetradecyl Ketone from Cabbage Fat.—J. G. Davis and A. T. R. Mattick: The Metabolism of a Pigmenting Anaerobic Bacterium.—G. N. Richardson and R. K. Cannan: Reaction of Azine Compounds with Proteolytic Enzymes.—B. C. Guha and Prof. J. C. Drummond: Observations on the Concentration of Vitamin B_1.—Prof. J. C. Drummond, R. A. Morton, and K. H. Coward: A Critical Examination of the Methods for the Assay of Vitamin A.—C. R. Harington and S. S. Randall: Isolation of 3:5-diiodotyrosine from the Thyroid Gland.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION (Annual General Meeting) (at Society of Medical Officers of Health, 1 Upper Montague Street), at 5.—Sir Henry Gauvain: The Combined Education of Children Suffering from Physical Defects.

BRITISH INSTITUTE OF RADIOLOGY (Medical Meeting), at 5.—Urinary Discussion.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Recent Advances in our Knowledge of the Anatomy and Physiology of the Gall-Bladder.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Roberts (Susan Miles) and others: Discussion on Inspiration.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—L. O. Newton: Boiler Feed Water.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. H. Gibson: Mechanical and Transmission Losses in Marine Engines, Shafting, and Propellers.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—C. F. J. Morgan: Wave-form Analysis.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Cardiff Technical College), at 7.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group) at 7.

SOCIETY OF DYERS AND COLOURISTS (Glasgow Section) (at 7 Gordon Street, Glasgow), at 7.15.—F. Asquith: The Necessity of Application of Fast Colours on Textile Fabrics.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30—T. Grime: Locomotive Rating.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. V. M. Goldschmidt: The Distribution of the Chemical Elements.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section).—Short Papers.

SATURDAY, MARCH 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (III.).

GEOLOGISTS' ASSOCIATION (North-East Lancashire Group) (at Blackburn Technical College), at 7.—J. Ranson: The Evolution of the Craven Highland.

PHYSIOLOGICAL SOCIETY (Annual General Meeting) (at University College).

PUBLIC LECTURES.

FRIDAY, MARCH 8.

KING'S COLLEGE, at 5.30.—C. J. Gadd: Assyrian Studies in the Present and Future.

SURVEYORS' INSTITUTION, at 5.30.—Prof. J. S. Huxley: Heredity and Society (delivered in connexion with the Institution of Professional Civil Servants).

SATURDAY, MARCH 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—R. W. Sloley: The Cave-Artists of the Stone Age.

MONDAY, MARCH 11.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.30.—Prof. F. Fülleborn: Some Biological and Epidemiological Aspects of Helminthic Infection. (Succeeding Lectures on Mar. 12 and 13.)

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—F. R. Petherbridge: The Spraying of Fruit Trees.

ROYAL SOCIETY OF ARTS, at 8.—G. Mowlem Burt: The Making of a Modern Building, with Cinema Illustrations (Bessom Gift Chadwick Lecture).

THURSDAY, MARCH 14.

FARADAY SOCIETY (at Chemical Society), at 2.30.—Prof. V. M. Goldschmidt: Crystal Structure and Chemical Constitution, and General Discussion on same subject by Dr. W. T. Astbury, Dr. J. D. Bernal, Sir W. H. Bragg, Prof. W. L. Bragg, Prof. P. P. Ewald, Prof. F. M. Jaeger, Dr. N. H. Kolkmeijer, Mrs. K. Lonsdale, Prof. T. M. Lowry, Dr. H. Mark, Dr. A. Müller, Dr. H. S. Piper, F. I. G. Rawlins, Prof. A. Reis, Prof. E. Schiebold, Dr. K. Weissenberg, and Prof. A. Westgren.

SATURDAY, MARCH 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Saxon Churches and their Remnants.

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