NATURE

SATURDAY, SEPTEMBER 24, 1927.

CONTENTS.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.

Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.

Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Imperial Mineral Oil Resources.

A DISTINGUISHING, if not the chief, merit of a periodic congress is the opportunity afforded for taking stock and gauging progress of development, particularly when the terms of reference connote applied science. Even if deliberations produce nothing startlingly new, as is often the case, the inevitable correlation of independent lines of reasoning and research serves as a stimulant to the delegate mind and creates a wider perspective, at the same time tightening the grip on essentials. This in turn has its natural repercussion amongst the greater body of workers, and thus is the spirit of technology constantly enlivened.

Petroleum is a case in point. Its consideration at the second (triennial) Empire Mining and Metallurgical Congress, judged from the papers now available, is largely recapitulatory, but there is clearly apparent the aim at such co-ordination of data as may lead to some solution of the thorny problem of Imperial mineral oil resources and future supplies. The setting for such a discussion, Canada, is singularly appropriate, though paradoxical: while it emphasises the truly Imperial aspect of the question, it throws into sharp relief the unfavourable position of that great Dominion, the contribution of which is less than 0·02 per cent. of the world's petroleum production; like Great Britain, Canada is dependent on foreign sources of supply for her needs.

The problem resolves itself into a dispassionate survey of hard facts: the maximum quantity of petroleum won from truly Empire sources lies between two and three million tons per annum; these limits constitute a reasonable estimate for the future. On the other hand, the total consumption of petroleum products in the Empire amounts to between ten and eleven million tons per annum, and is likely to increase considerably with each successive year. Thus Empire resources are hopelessly inadequate even for present needs. There follows the natural question: What exactly are our Imperial petroleum resources, both actual and potential, and to what extent is the British Empire committed to foreign oil supplies in the future? Failing a satisfactory solution in the shape of technical guarantees, what is the alternative to the existing situation?

In substance these questions are not new; they have been raised a hundred times both on the platform and in print; they have been answered in diverse ways, but always with strong individual bias. The optimistic predictions of undeveloped oil-pools, shale-oil prospects, coal and liquid fuel substitutes, and similar panaceas variously prescribed to meet ultimate contingencies, are well known. In the light of present knowledge, such unbounded optimism is premature. At the moment the circle of argument, like that of the origin of petroleum, is still intensely vicious, but there are signs that this second Congress may be destined at last to break it.

To clear the ground, a distinction must be drawn between truly Imperial oil resources and those, though developed by Imperial interests, situated in extra-Imperial territory; this is a point usually overlooked, but it is all-important to the present issue. Thus in the first category are placed India (with Burma and Assam), Trinidad, Sarawak, Egypt, and Canada; expansion is probable in the first three, extremely doubtful in the two remaining countries; to the same list may be added potential resources of New Guinea and North Borneo. Much is heard of the untapped oil reserves of the main continent of Africa, also Australia and New Zealand; unfortunately, the wish fathers the thought. Technically, the evidence tends to discount the discovery in these lands of *major* oil-pools destined to weigh heavily in the scheme of things; the great red spaces on the map of the world which depict Imperial terrain, lie, with one exception, tantalisingly outside the girdle of prolific oil production.

Imperial petroleum interests in foreign countries are highly ramified and are of supreme economic and political import; they embrace Mexico, Persia, Venezuela, Peru, Argentine, Colombia, Rumania, and Galicia, among others. Russia is a problem unto itself, with oil as with politics; the march of time may determine the resumption of international competition for her undeveloped resources, with British interests reasserted, but prophecy concerning this unhappy country is dangerous. 'Iraq fascinates by its yet unproven possibilities, as also other regions of south-west Asia; Empire commitments here are much entangled with foreign policies, perhaps not disadvantageous in the long run. But the crucial point to remember is this: these countries constitute resources to the Empire only so long as political relationship is stable and international commerce is untrammelled by inimical legislation or actuality of war. Admittedly it is hard to imagine the extreme circumstance in which all these channels of supply would be blocked, especially in the light of experience gained during the War, but there is danger in the position as it stands, which would be intensified a hundred-fold if, for any reason, American sources were made unavailable for Imperial markets.

The predominating position of the United States in the economics of world-supply and consumption of petroleum products has been defined so often as to be common knowledge; further statement is therefore superfluous here. To-day the Empire's dependence on that country for oil is as great as ever, for increased consumption more than balances increased production from extra-American sources. So long as one country is responsible for more than 70 per cent. (80 per cent. if Mexico is included) of the total annual output of a vital commodity, so long must it be the keystone of the whole economic structure, national and foreign, on which the relevant industry is reared. The free distribution of American oil supplies to Empire markets can only be disturbed by two eventualities: curtailment of exports to conserve national resources, or declaration of war. The first is feasible, in fact ultimately probable; the second is unthinkable, at least to the present generation. In any event, the fact that Imperial resources are totally insufficient to meet present necessities, much less any possible emergency arising from diminished trans-Atlantic supplies, serves only too well to indicate the real state of affairs. Moreover, in no other part of the world is it possible to predict, with confidence based on all available knowledge, the existence of undiscovered petroliferous territory of the magnitude and persistence of that possessed by the United States; geological work all over the world, though the detail of remote regions may still be lacking, is at least sufficiently comprehensive to justify that assertion.

Thus hopes of independence of foreign sources of oil production vanish quickly when the situation is carefully examined. In the course of his address to the Congress, Sir Thomas Holland stated the case succinctly: "Under normal conditions we must depend on outside sources for a seriously large part of our petroleum products;" and again, "It is important to remember that in case of temporary isolation, even the Empire sources of crude oil may not be accessible. In any event, they would be quite insufficient even if they were available to the full. . . ." It is quite impossible to encourage the slightest hope that the consumption-factor of eleven million tons or more of petroleum products per annum within the Empire can ever be attained by the utilisation of indigenous supplies. Thus technical guarantees fail and we are thrown back on alternative remedies.

Sir Thomas Holland invited the Congress to consider six points which we may summarise as follows: (1) Prospects of maintaining or extending Empire production of crude oil, (2) the extent to which oil-shale exploitation may supplement mineral oil supplies, (3) prospects of obtaining oil from low temperature carbonisation, (4) possibilities of oil substitutes obtained by processes similar to hydrogenation of coal, (5) prospects of alternative liquid fuel, *e.g.* alcohol, and (6) increased production of light oils by cracking processes, etc.

The value of these headings lies in the fact that, as set out, they take nothing for granted; they presuppose no immediate remedy to be applied the moment emergency arises; they sponsor no premature optimism. The merit of the discussion along such lines lies in getting at the root of the whole matter; it is tantamount to saying, "Let us get clear for the moment from mere experimental data, from small-scale ideas which have scarcely transgressed the academic border-line. What are the large-scale possibilities of these alternatives? Which are, and which are not, of commercial application, from which a definite solution of the problem can alone spring?" Prof. Nash's paper on "Possible Auxiliary Sources of Liquid Fuels" should do much to focus attention on the true perspective of this subject; he is impressed with the many technical difficulties to be overcome before substituted fuels can compete with petroleum products, especially at current prices.

The problem thus debated is bound to open out along the right lines. Economic policy and military security of the Empire demand some tangible solution to the fuel question in the near future. It is useless to leave things to chance; it is unworthy to allocate the task to posterity. The suggestion has been made that standing committees should be formed in each Dominion to watch commercial petroleum developments, to inspire technical activities, and to translate results in terms of Imperial requirements. Nothing should be allowed to hamper the fruition of any scheme to this end. Organised research, conceived and executed on a large scale, or at least with the view of commercial requirements, should receive all the backing from the governments concerned that it is possible to give; the need for this was proclaimed loudly at Wembley in 1924; it is clear that the second Congress has vigorously affirmed this demand; it is to be fervently hoped that its efforts will not be in vain. H. B. M.

Flame and Combustion.

Flame and Combustion in Gases. By Prof. William A. Bone and Dr. Donald T. A. Townend. Pp. xvi + 548 + 30 plates. (London: Longmans, Green and Co., Ltd., 1927.) 32*s.* net.

THE world to-day simply lives upon explosions: it moves and has its very being, in the air and on the roads, upon and under the waters, through the agency of flame. The publication of a book dealing comprehensively with a subject of such public importance, by a master-worker, is therefore most opportune. It is so well-written that it should rank as a 'best-seller' with Ludwig's "Napoleon" and gruesome "Jew Süss," being as readable and exciting as a "Greenmantle" or a Mason 'shocker': though unfortunately the situations opened up are usually left unsettled and mayhap, even when 'continued in our next,' will still remain problematical. The plot, in fact, is seemingly one of fearful complexity and the detectives engaged in unravelling the story have been far from possessed of the logical training and mental agility needed to dissect out its many threads: still, that definite pathways are being cleared through the maze cannot be doubted.

The book is most happily dedicated, by the authors, to Prof. H. B. Dixon, of Manchester, whose school is responsible for the greater part of the English work which is described. The issue he raised in 1880, while but a reader in Oxford, in showing that carbonic oxide was rendered incombustible even by moderate drying, underlies the whole narrative and remains unsettled to the end. It seems to be a Snark that cannot be caught—pursue it as we may and rouse it even with the high potentials the electrician of to-day has placed at our disposal, not merely with jam and judicious advice, this last being perhaps the least acceptable to its non-conformist nature. Carbonic oxide is the most elusive customer we have in chemistry.

Facing the title page, the authors most appropriately quote the passage from Carlyle's "Hero as Divinity," one of the most characteristic of his essays, ending with the words, "From us too no Chemistry, if it had not Stupidity to help it, would hide that Flame is a wonder. What is Flame?" They carefully withhold the answer but, reading between their lines, we can see fairly clearly what a wondrous amount of stupidity has been displayed in seeking one: in fact, a large part of the book is a veritable comedy of errors. A deal of sack with very little bread. A wealth of experimental skill is displayed but backed by a parlous deficiency of acute theoretic dissection.

Our science and our music seem indeed to be in similar quandary and but muddle through. Concertos are not concerted. Players are not playing their parts in the orchestra with effect, because of the lack of common rehearsals and the absence of skilled conductors. Verily is chemistry, at present, nought but an empiric art. We cannot be too grateful, therefore, to the authors for having set forth the evidence so clearly. If not all, they have put most of their cards upon the table and thereby challenged us to play them: it is for us to take as many tricks as we can and they must not squeal if we are found to hold the trumps: frankly, their hand is a rotten one, their theory worse than threadbare.

The purpose of the book is a review of the principal inquiries into the phenomena of combustion, from the time of Robert Boyle onwards to the present day, more particularly those of the period dating from about 1880, when Mallard and Le Chatelier and Berthelot and Vielle, in France, began the study of explosive combustion and were followed, in England, by H. B. Dixon, Smithells, Lewes, Dugald Clerk, Bone and his pupils and others. As the principal landmark in the survey is Dixon's theatrical discovery, over which we are still disputing, the period may well be spoken of as the carbonic oxide period. Of the five sections into which the work is divided, the first is introductory and historical, a brief but interesting survey of the work done mainly before 1880; in this, of course, Davy's and Bunsen's primary contributions are specially considered. The subjects discussed in the remaining four sections are:

II. The Initiation and Development of Flame and Detonation in Gaseous Explosions (chaps. viii. to xviii.).

III. Gaseous Explosions in Closed Vessels (chaps. xix. to xxiii.).

IV. The Mechanism of Gaseous Combustion (chaps. xxiv. to xxxiii.).

V. Catalytic and Incandescent Surface Combustion (chaps. xxxiv. to xxxvi.).

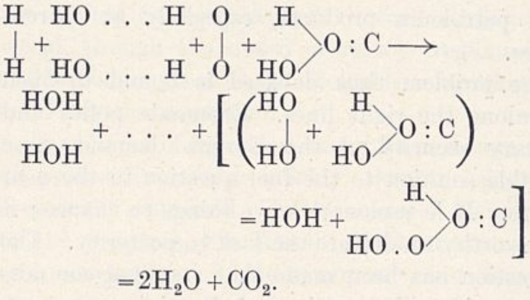
The work is profusely illustrated and contains a number of very beautiful photographs, showing the propagation of explosive waves, reproduced from Prof. Bone's communications in the *Proceedings of the Royal Society*. For the first time, an opportunity is given of appreciating the inventive skill and ability of the workers of the school which he has so happily called into being at South Kensington.

If we are ever to acquire merit by securing 'theoretic command' of the internal combustion engine, we must understand the so-called mechanism of combustion—hitherto, our treatment of the subject has been soulless. The authors deal with it at length but perfunctorily, particularly in discussing the combustion of carbonic oxide and of hydrocarbons. It is my fate to figure as the villain in the piece. First, under carbonic oxide (p. 337), as follows:

"H. E. Armstrong, who always contends that chemical interactions cannot occur between two perfectly pure substances but require an electrolyte to form a 'closed conducting circuit,' supposed that the presence of steam, which he regards as being rendered conducting by association with some traces of an electrolytic impurity, provides the necessary conditions for the passage of the current, the oxygen playing the part of depolariser, as follows:

Before			After	
CO	OH_2	O	CO_2	H_2O
CO	OH_2	O	CO_2	H_2O

"According to this view, the molecules of oxygen and a combustible gas are in all circumstances absolutely inert towards each other. Indeed, quite recently, Armstrong declared carbon monoxide to be '*per se* an incombustible gas,' adding that '*an explanation may be found in the assumption that when a moist carbon monoxide mixture is sparked or fired some hydrone is decomposed and sufficient hydrogen set free to act in a depolarising circuit together with the oxide, as thus*:



"This is perhaps the most elaborate and extreme form which any chemical explanation has hitherto taken, although all of them involve the assumption that in the combustion of carbonic oxide steam is continuously decomposed and regenerated."

Again, under hydrocarbons:

"Another alternative, namely, that the initial stage of the oxidation of a hydrocarbon might conceivably involve the transient formation of an unstable 'oxygenated' molecule, which, according to circumstances, would decompose more or less rapidly under the influence of heat, giving rise to simpler 'intermediate' products, had been suggested by H. E. Armstrong but never explored experimentally. For on p. 417 of a new edition of Miller's 'Organic Chemistry,' published in 1880, he had visualised such oxidation processes as primarily involving 'hydroxylation.' In our next two chapters, we shall see how this idea ultimately furnished a solution of the problem."

The issue to-day, as the authors recognise, is whether water be *essential* to the process of combustion.

On this first count I am said to come out badly, because I have 'ignored' "that there are *well established* cases (cyanogen, carbon bisulphide) in which *apparently* [I like the caveat and take it as evidence of a latent, uneasy conscience in the writers] combustion does not depend upon the presence of moisture." Also, because "any chemical view postulating that carbonic oxide cannot be burnt in flames except by the intervention of steam, which is continually decomposed and regenerated in the process, is countered by the spectroscopic evidence." One might use Mantalini language about spectroscopic evidence. I will only say: it leaves *me* cold; mercury, for example, as is well known, may be present in relatively large amount in a vacuum tube and yet be neither seen nor heard in the spectrum of the discharge. Carbon bisulphide is probably one of the liquids that is impossibly difficult to dry. The cyanogen used may even have been Bone-dry but no proof has been given that it was free from hydrogen cyanide. Go to, friend Bone, your 'well-established cases' may well go hang.

> "Nay, an thou'lt mouth,
> I'll rant as well as thou."

You, in your turn, ignore the prime fact, that the heat of combustion of carbonic oxide is *below* that of hydrogen; also—as shown by Grove—that carbonic oxide cannot be substituted for hydrogen, in the gas cell. It cannot, therefore, be oxidised by steam.

These are two nasty little facts which rather spoil your speculation: it hasn't the ghost of a theory about it. Your Bone-dry gas, after all, was not yet *dry*. Drying is an equilibrium process: some moisture will have been left upon the surfaces enveloping the gases. A vast amount of 'punch' has to be put into the discharge to get it through—and yet combustion is far from complete. What happens when and as the discharge gets through? Is it not almost certain that hydrogen, imprisoned in the platinum electrodes and also platinum motes, are extruded into the gas? The photographs show that the explosive wave only 'gets up steam' gradually. As combustion is set up less and less readily as drying proceeds, drying being never complete, is it logical to assume that another second process comes into play towards the end rather than that that initially in operation is dying out? The efficiency of your supposedly 'dry' process is so low, moreover, that the idea is not worth even provisional protection. No Comptroller could or would pass such a claim to an invention.

> "Tempted by extremes,
> The soul is most secure:
> Too vivid loveliness blinds with its beams
> And eyes turned inwards perceive the lure."
> . . . .
> "Who seeks the shadow to the substance sinneth."

The fact is, we have reached the limit to which experimental inquiry into such an issue can legitimately be carried. We need to sit down and calmly and logically worry out all consequences of the observations on record: to call a construction-holiday—even engage Lord Cecil to 'disarm' our laboratories for a time and force workers to put on thinking-caps. We are in danger of making a fetish of laboratory work—the more since literary men have assumed control of the funds devoted to inquiry. The experimenter is apt to think too much of himself—to suffer from *Cephalitis enlargica.* He puts in his thumb and pulling out a plum thinks that he has, therefore, the right to say: 'What a good boy am I.' More often than not, he is a bad boy: the plum is a poor thing, unripe and sour; such plums should never have been made into a pie. This is particularly true in the field of biological inquiry. To experiment usefully, the motive of the experiment must be first visualised and must be logically conceived: its purpose must be clear and it must be carried through and the results punctiliously recorded and judicially interpreted with logical precision. These several ingredients are rarely present and mixed in due proportion in the research pie, nor is sufficient experience and intelligence imported into the operations.

The true art of scientific inquiry is the outcome of genius and acquired only by the few: no attempt is made to teach it, in any considered way. We have to change all this, beginning in the schools. We shall do well to stay experimenting for a time and call in competent accountants—if there be such—to take stock for us and balance our books. We may then realise how ragged a state our business is in and how necessary it is to reorganise it. Our subject is very much in the condition of certain large firms that have recently lapsed into inefficiency through incompetent management. We shall certainly find that much of our stock is worthless and need to scrap a lot. We shall be in a position to say what new stock is most needed. What is good of that we have will make a brave show, when displayed apart from the rubbish with which it is now mixed. The book under notice shows this but also a lot of tares mixed with the wheat. Let us frankly admit that much of the work that is attempted to-day is too difficult for those who undertake it :

> " For, although common Snarks do no manner
> of harm,
> Yet I feel it my duty to say,
> Some are Boojums——"

Passing to the second count, on which I win, as the authors magnanimously admit, I have a bone to pick with them on the ground of historical accuracy : I am an older sinner than they suggest. If they will turn to the first edition of my " Organic Chemistry " (Longmans), *published in* 1874, they will find on p. 216, under Aldehydes, a statement that these are probably formed from alcohols as the result of two distinct changes, the first being

" the production of a compound of the form R′ . CH(OH)(OH), which is subsequently broken up into the aldehyde and water, the former of these changes being brought about either (*a*) by the direct addition of oxygen to the alcohol or (*b*) by the combined influence of the nascent oxygen and water or (*c*) perhaps by the agency of hydroxyl (hydric peroxide $(OH)_2$) itself, thus :

(*a*) $R' . CH_2(OH) + O = R' . CH(OH)_2$
(*b*) $R' . CH_2(OH) + O + OH_2 = R' . CH(OH)_2 + OH_2$
(*c*) $R' . CH_2(OH) + (OH)_2 = R' . CH(OH)_2 + OH_2$
$R' . CH(OH)_2 = R' . COH + OH_2$."

I applied the ' hydroxylation ' explanation throughout the rest of the book and, afterwards, in re-writing Miller's " Organic Chemistry," published in 1880. I may add that I began the study of flame in March 1867, when I first attended a course at the Royal Institution and heard Frankland's lectures on coal gas, in which he disputed Davy's explanation of the luminosity of flames.

The " never explored experimentally " in the quotation before given has an ungenerous twang. In framing my doctrine, I had before me the whole of the evidence bearing upon the ' hydroxylation ' process accumulated up to that time : it was considerable. The work done by Prof. Bone and his fellow workers is of value and importance, as showing the character and course of the changes under these or those particular conditions : not as special evidence of ' hydroxylation.' Drugman's observation, a most important one, that ethylic alcohol may be obtained directly from ethane with the aid of ozone, is the only direct demonstration to be derived from the inquiry, in justification of the view I have long held and advocated, that oxidation, in the first instance, invariably involves hydroxylation.

The intensity of my belief is due to the firmness with which I hold the faith, that every chemical interaction is electrolytic in its origin and in its course and that the interactions in the Grove gas cell are to be taken as prototypical of all combustions. They are summarised in the expression :

H	HO . . . H	O H_2O	. . .	HO
·		· =		·
H	HO . . . H	O H_2O	. . .	HO.

The authors have yet to learn that " faint love never won fair lady." They are not ' real sports.' If they were they would not hedge by saying of the " hydroxylation theory, advanced more than twenty years ago " (*sic*, 1880–1927 = 47, alternatively 1874–1927 = 53) :

> " It should, however, not be interpreted or applied too rigidly, because doubtless in the long run the steady accumulation of new facts will necessitate some modifications and it would be unphilosophical to regard it as more than a serviceable tool for accomplishing further advances. It certainly affords what we believe to be a true explanation of slow combustion."

The authors have their doubts as to its application to flame. The fact is, they have not yet learnt how to apply it. Their oxidation schemes are but skeleton forms—the intimate process is not considered. They visualise *thermal* changes as intermediate operations. Formaldehyde is figured as just breaking down into hydrogen and carbonic oxide : $CH_2O = CO + H_2$. My sheet anchor has always been the belief in the superior charm first exercised by the oxygen atom and I would picture the downfall of formaldehydrol as a complex process, involving both hydroxylation and hydrolysis, at least in part often ending as shown schematically by the expression :

$$H_2C(OH)_2 + 2(OH) = HHC(OH)(OH) \text{ (with } {}^{\diagup OH}_{\diagdown OH} \text{ on C)}$$
$$= 2H_2O + [C(OH)_2 = CO + OH_2)].$$

Carbonic oxide, in like manner, is the product of the hydrolysis of chloroform by caustic soda. If the CH_2 hydrogen were displaced by hydroxyl, formic and carbonic acids would be the products. In this instance, in my opinion, the hydrogen is quietly ' pulled away ' by hydroxyl. The production of carbon from acetylene as well as that of hydrogen from formaldehyde, are also complex, not ' purely thermal ' effects, I am satisfied.

At the close of 1891, the late Sir George Stokes did me the honour to criticise an address of mine to the Junior Engineering Society. We discussed together the interactions occurring in flames. One of my points was that purely thermal changes were unlikely to occur. My attitude was then as conservative as my ignorance was great but all that has happened in the interval of thirty-five years justifies the final plea in my letter (*Chemical Society's Proceedings*, 1892, 22-27):

"Regarding the interactions in flames as consisting in a series of simultaneous and consecutive explosions, of which we can only examine the final steady state, it seems to me that the phenomena are necessarily of an excessively complex character and that their appreciation and successful interpretation must tax our powers of mental analysis in a very high degree. It will certainly be unwise at present to infer that the oxidation of the hydrocarbons or the separation of carbon and also of hydrogen from them, takes place entirely in any one way."

The number of successive interactions involved in an oil engine explosion is almost incalculable, yet there can be little doubt as to their general course. It is impossible here, however, to discuss the subject at the length that would be necessary. The one point I desire to make is, that we not only need accurate experiment but also acute criticism of the results—what we get is worthy only of the nursery, not of the Senate House.

The book under review will have failed in its mission if it have not as result a searching examination of its many propositions.

Henry E. Armstrong.

Science and Religion.

(1) *Evolution in Science and Religion.* By Robert Andrews Millikan. (Published on the Dwight Harrington Terry Foundation.) Pp. v + 95. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1927.) 4*s*. 6*d*. net.

(2) *Science and Human Progress.* (Halley Stewart Lectures, 1926.) By Sir Oliver Lodge. Pp. 187. (London: George Allen and Unwin, Ltd., 1927.) 4*s*. 6*d*. net.

(1) Books about the relation between science and religion are apt to be heavy, but this reproach certainly cannot be levelled against Prof. Millikan's little volume. He gives in a few brilliant pages a sketch of the remarkable change which has come over the modern physical interpretation of the universe. He has been well placed to observe this change, having been, as he tells us, in direct touch with the older masters of the classical physics and having watched step by step and participated in the revolution which was initiated by Röntgen's discovery of the X-rays. He attended Röntgen's first demonstration on Christmas Eve, 1895: "As I listened and as the world listened, we all began to see that the nineteenth century physicists had taken themselves a little too seriously, that we had not come quite as near sounding the depths of the universe, even in the matter of fundamental physical principles, as we thought we had" (p. 10).

This gives the key-note of Prof. Millikan's book, and most of it is a commentary, well documented, on the dangers of dogmatism both in science and in religion. His remarks about the shortcomings of the classical materialistic conception of the universe are amazingly frank. "We can still look," he writes, "with a sense of wonder and mystery and reverence upon the fundamental elements of the physical world as they have been partially revealed to us in this century. The childish mechanical conceptions of the nineteenth century are now grotesquely inadequate" (p. 27). Prof. Millikan has all the enthusiasm of the experimentalist, looking to the continued advance of experimental science for the future progress of humanity. He has a firm belief in progress as "the most sublime, the most stimulating conception that has ever entered human thought"; one respects the belief and its stimulating power, even though it may be, as he admits, an illusion, but one cannot help thinking that if progress be merely "the increasing control over environment," something else is required to make human life fuller, more adequate, and happier.

Prof. Millikan's third lecture on "The Evolution of Religion" is scarcely so good as the other two —those entitled "The Evolution of Twentieth-century Physics" and "New Truth and Old"— but English readers will note with interest his view of the Scopes trial. While recognising the menace to freedom of thought implied in fundamentalism, he is inclined to think that the Scopes trial has done more good than harm, by ventilating the problems and making people think.

With Prof. Millikan's conclusions, as summarised in the following passage, few, we imagine, will disagree.

"Physics," he writes, "has at the present moment something to teach to both philosophy and religion, namely, the lesson of not taking itself too seriously, not imagining that the human mind yet understands, or has made more than the barest beginning toward understanding the universe. To-day physics is much more open-minded, much less dogmatic, much less disposed to make allinclusive generalisations, and to imagine that it is dealing with ultimate verities, than it was twenty-five years ago. This generalising farther than the observed facts warrant, this tendency to assume that our finite minds have at any time attained to a complete understanding even of the basis of the physical universe, this sort of blunder has been made over and over and over again in all periods of the world's history and in all domains of thought. It has been the chief sin of philosophy, the gravest error of religion, and the worst stupidity of science —this assumption of unpossessed knowledge, this dogmatic assertiveness, sometimes positive, sometimes negative, about matters concerning which we have no knowledge. . . . If there is anything that is calculated to impart an attitude of humility, to keep one receptive of new truth and conscious of the limitations of our understanding, it is a bit of familiarity with the growth of modern physics" (pp. 93-4).

(2) The same lesson is taught by Sir Oliver Lodge in his Halley Stewart lectures. He also emphasises the great significance for all branches of thought of the revolution in physical concepts which the "younger heretics" enthusiastically support. Everything has been put into the melting-pot, and the creed of science is being reconstituted. With it all, Sir Oliver pleads for a return to simplicity in matters of everyday conduct and experience, to the common-sense view of life, in accepting which the wayfaring man, though a fool, does not err. His lectures, which cover a wide field of practical philosophy, are, we need scarcely say, distinguished by that genius for simplicity of exposition which make them so understandable of, and so useful to, the man in the street. He emphasises, as does Millikan, the danger of dogmatism in any form and the need for freedom and fluidity of belief.

Ultimate philosophy is to some extent a matter of personal conviction and experience; for this reason we do not propose to comment upon Sir Oliver Lodge's acutely dualistic scheme of things further than to express the contrary opinion that a more satisfactory philosophy is contained in the 'organic' view of reality put forward with such skill by Prof. Whitehead. E. S. R.

The Soil and Civilisation.

Soil and Civilisation: a Modern Concept of the Soil and the Historical Development of Agriculture. By Milton Whitney. (Library of Modern Sciences.) Pp. x + 278 + 5 plates. (London: Chapman and Hall, Ltd., 1926.) 15*s.* net.

THE concept that the author sets out to develop is that "the soil is not the dead, inert, and simple thing often referred to as 'dirt.' It is essentially a factory where raw materials are converted into finished products." In other words, the soil must now be regarded as dynamic rather than static, as indeed a living thing having complicated functional activities that react on one another and affect its productive power in the growth of plants. As a logical result, the man who understands his soil and treats it with sympathetic consideration of its individual peculiarities is in a position to get far heavier crops than he who fails to appreciate the possibility of this co-operation between soil and man. It now seems probable that the soil has a regenerative power that will enable it to produce crops indefinitely, subject to the application of knowledge and skill in its working, instead of being liable to become worked out and exhausted unless a supply of plant food elements, such as phosphorus and potash, is returned in amount equivalent to that removed by the crops.

An attempt is made to draw an analogy between the soil and the animal, in view of the concept of the soil as a living entity. The various soil types are illustrated by accounts of the important soils of the United States, indications being given of the crops that are best adapted in each case, with the reasons for this association. A proper balance is necessary between what are termed the respiratory, circulating, and digestive systems of the soil for any particular crop to succeed. Methods of soil control are not confined to the replacement of plant food abstracted by crops, but include the proper rotation and adaptation of crops, suitable methods of cultivation, irrigation and drainage, and adequate balancing of organic and chemical manures. After discussion of the conception of the rôle of manures in ancient and modern agriculture, Whitney claims that the time has come to drop the term "plant food" as applied to fertilisers, and pleads for the recognition of the significance of the biochemical factors of the digestive system of the soil and the interdependence and the correlation which exist for the best effort of the soil, the plant, and the fertiliser treatment. In the earlier days of agriculture the responsibility for the maintenance of productivity in the fields rested entirely on the man, but even nowadays chemical fertilisers are not a substitute for human endeavour; they are simply a means of aiding to maintain agriculture in an economic position.

In the cycle of ages, most civilised countries have developed well-organised agricultural systems, many of which have since died out. The cause of this often lay in a change in the character of the people, a substitution of nomadic for sedentary races, as in Asia Minor and Mesopotamia. Engineering works and irrigation systems were essential for the life of agriculture, and failure to maintain these was often the result of political changes, as in Spain after the conquest. In countries where agriculture has survived, no wars of extermination have occurred. China and Japan have maintained the productivity of their soil by sheer hard work, whereas in Egypt the natural irrigation and increased fertility due to the Nile cannot be destroyed. The agricultural literature of the Romans shows that though the soil was never very productive, intelligence was brought to bear upon cultivation with profitable results. The first 1500 years of the Christian era represent the Dark Ages, during which constant warfare precluded agricultural development. After Jethro Tull's advent in 1701 a gradual improvement set in in England, as well as in France and Germany.

Present-day agricultural practice has not advanced greatly over that of the ancients, but more knowledge of material things has been acquired in the last century, as of steam, electricity, chemical elements, etc., and a beginning made in their application. It remains to be seen how the new discoveries will be used. There is every reason to believe we have made only a beginning in the possibilities of research, and it is not outside the bounds of possibility that improvement in important farm crops, as wheat, corn, oats, cotton, may yet be made more commensurate with the development already achieved in animals, in orchard fruits and garden vegetables, by means of intelligent application of the principles of science to agriculture. W. E. B.

The Analysis of the Reflex.

Muscular Contraction and the Reflex Control of Movement. By Dr. J. F. Fulton. Pp. xv + 644. (London: Baillière, Tindall and Cox, 1926.) 45*s.* net.

THE publication of Sir Charles Sherrington's "Integrative Action of the Nervous System" marked the beginning of a new epoch in neurology. Until then attention had been centred mainly on the analysis of the central nervous system into its anatomical components, the fibre tracts, and nuclei. Their different functions were investigated but very little was known of the way in which these functions were carried out. Sherrington used an entirely different method, the analysis of the complex behaviour of the organism into its component reflexes. Taking the reflex as the basic reaction of the central nervous system, he showed how the reflexes are compounded and adjusted to make up the changing pattern of activity which we see in the organism in its natural surroundings.

The analysis of the activity of the central nervous system into the constituent reflexes is and must remain for a long time the most potent method of neurological research; but it was clear that the analysis could be pushed a stage further, for the reflex itself is not an irreducible unit but is made up of a complex of activities in the nerve fibres, synapses, and muscles. Not long after Sherrington's book had focussed attention on the reflex, Keith Lucas began an attempt to work up to the reflex from the unit reactions of the nerve fibre. This work was cut short by the aeroplane accident which deprived physiology of one of its most powerful investigators, but its influence has been far-reaching, and in recent years there has been an increasing tendency to analyse the reflex into the simple reactions of muscle and nerve along the lines which Lucas suggested. This tendency is reflected in the present book, which is written by a pupil of Sherrington's on the basis of work carried out at Oxford during the past four years.

To some extent Dr. Fulton works at a disadvantage, in that there is no very clear picture to present. Much work is still in progress on the physiology of the muscular contraction and of the nervous impulse, and although we can see a good way into the processes involved in the activity of the nerve and muscle fibres, we are still in the stage of collecting information and modifying our hypotheses to suit each new piece of evidence. For this reason there is much that is bound to be speculative in Dr. Fulton's presentation of the facts of muscle and nerve physiology, as, for example, in his discussion of the latent period, the summation of contractions, the neuro-muscular junction, etc. There is still more uncertainty when we come to build up a picture of reflex activity out of what is known of the simpler reactions of nerve and muscle. We are still in the throes of a controversy (very well handled by Dr. Fulton) on the nature of the tonic contraction and the relation of the sympathetic system to it, and we have not advanced beyond the stage of multiple hypotheses on the subject of central inhibition. But for all that, the position is clearing rapidly. We know what goes into the central nervous system and what comes out of it, the messages from the sense organs and the messages to the muscles. In every case the message consists of a series of nervous impulses of the type made familiar by investigations on the isolated nerve fibre, and the recent work in Oxford has done much to suggest how the incoming and the outgoing messages are related to one another in the central nervous system.

Although the time is scarcely ripe for the presentation of a complete survey of reflex activity, Dr. Fulton is certainly to be congratulated on the orderly and readable account he has made, both of his own researches and of the great mass of recent work on the many fields involved. Any one who is concerned with the physiology of movement, whether as an investigator, a teacher, or an examinee, will find this book a most valuable (though expensive) collection of recently acquired facts and theories. There is an interesting historical introduction which does not omit due reference to Aristotle, and the book is closed by a table of more than 1000 references. In these days it is hard to overestimate the value of a comprehensive review of this kind, and Dr. Fulton deserves high praise for writing it.

Our Bookshelf.

The Composition and Distribution of the Protozoan Fauna of the Soil. By H. Sandon. (Biological Monographs and Manuals, No. 7.) Pp. xv + 237 + 6 plates + 3 charts. (Edinburgh and London: Oliver and Boyd, 1927.) 15*s*. net.

THE study of parasitic Protozoa received an immense impetus at the beginning of the century by the increase in our knowledge of certain forms, especially Hæmosporidia and trypanosomes, which are of vast importance in relation to disease of man and animals. In a corresponding manner, the subject of soil protozoology may be said to have been re-born early in the second decade by the work of Russell and Hutchinson and their followers on Protozoa in relation to sick soils. While, however, it is not yet agreed to what extent the Protozoa are, indeed, responsible for diminution in soil-productivity, nevertheless, a new field of protozoological knowledge has been tilled and sown, and some good first-fruits are garnered in this volume.

As Prof. J. H. Ashworth points out, in a specially written foreword, the taxonomic position of the subject can be regarded as already fairly satisfactory, with a record of some two hundred and fifty described species. Two or three new generic or specific names are here created, although this practice in a book is, from the point of view of a recorder, to be deprecated. Under the different classes, the author gives helpful keys for the identification of the various forms, but, as he recognises, in one or two cases, the criteria adopted are to be used with circumspection. In connexion with the account of geographical distribution, the interesting, almost ubiquitous range of many of the species is well indicated by means of tables at the end. Our knowledge respecting the ecology is still disappointingly limited. After discussing the various factors which may influence the numbers and characters of the protozoan population of the soil, Sandon concludes that none of the climatic or soil conditions considered is capable of explaining adequately the relative abundance of Protozoa in different soils.

The book is well arranged and attractively produced, and six plates of figures of characteristic soil Protozoa are given. While, of course, no claim to finality is made for the volume, it is a distinctly needed and useful compendium for those interested in this important subject. H. M. W.

Stories in Stone: Telling of some of the Wonderlands of Western America and some of the Curious Incidents in the History of Geology. By Willis T. Lee. (Library of Modern Sciences.) Pp. xii + 226 + 49 plates. (London: Chapman and Hall, Ltd., 1927.) 15*s*. net.

THE author of this entertaining and beautifully illustrated book did not live to see its publication, but he has left behind him a record of picturesque experience and eloquent enthusiasm. Dr. Lee's work lay largely amongst the extravagant scenery of the western of the United States; while in later years he assisted in the exploration of the great Carlsbad Cavern, and began the study of landscapes from the air. The book reflects a corresponding love for the colourful and spectacular, and in an informal and non-technical way it succeeds in imparting not only the romantic spirit of geology but also a good deal of sound knowledge.

The Grand Canyon is selected as the point of departure because it introduces rocks of the earlier eras. Other pages of earth history are written round the Painted Desert and Petrified Forest of Arizona; the high plateaux and Vermilion Cliffs of Utah; the ice-scuptured Yosemite Valley; and the impressive peaks of the Rocky Mountain National Park. Many of the illustrations are reproductions of photographs taken from the air, and the book as a whole is original in both manner and matter. Teachers of geography will find in it many a telling example, and though its appeal will necessarily be mainly American, it can be cordially recommended to the layman who is looking for a brightly written interpretation of landscape and earth history.

Physiology and Biochemistry in Modern Medicine. By Prof. J. J. R. Macleod; assisted by Roy G. Pearce, A. C. Redfield, N. B. Taylor, and J. M. D. Olmsted, and by others. Fifth edition. Pp. xxxii + 1054 + 9 plates. (London: Henry Kimpton, 1926.) 42*s*. net.

WITH the advance of any science the tendency to specialisation becomes greater and its relationship to, or applications in, other branches of knowledge may be missed unless investigators and teachers can take a very wide view based on facts culled from sciences with which, perhaps, they are not immediately acquainted. Thus the application of physiology to medicine requires an acquaintance with both sciences, which is difficult to maintain when both are advancing rapidly. The aim of Prof. Macleod's book has been to supply the student of medicine with an up-to-date account of the more important facts of physiology, more especially those which have a direct bearing on the practice of medicine. In this, the fifth, edition the text has been somewhat expanded, so that the work may be used also as a text-book of physiology by the medical student: Dr. Olmsted has added a section on the special senses, and Dr. Redfield has expanded his section on the neuro-muscular system. The application of the latter subject may not at present be apparent in the investigation of disease; yet it is certain that it exists, and it can only be made when the clinician has become familiar with the very latest work. For the medical student or for the practitioner of medicine the book should prove invaluable, whilst for the research worker, further information can be found from the selected references given at the end of each part.

Supplement to an Introduction to Sedimentary Petrography: with Special Reference to loose Detrital Deposits and their Correlation by Petrographic Methods. By Henry B. Milner. Pp. 156 + plates 17-28. (London: Thomas Murby and Co.; New York: D. Van Nostrand Co., 1926.) 9*s.* 6*d.* net.

RECENT activity in the study of the mineral composition and derivation of sediments has induced the author, who has given special attention to the subject for many years, to give forth in the form of a supplement to his "Introduction to Sedimentary Petrography," a record of work done since the issue of that book in 1922. The new matter relates to methods of examination as well as to mineral descriptions, the latter including twenty minerals additional to those previously described. The two volumes cover descriptions of seventy-four minerals, fifty of which are illustrated. The illustrations are partly reproductions of wash-drawings by G. M. Part and photomicrographs by G. S. Sweeting, all of which are excellent and make a very attractive feature. The supplement contains three appendices, the first of which gives tables for the determination of detrital minerals. The second appendix gives a list of rock-forming minerals which have not yet been recorded as occurring in sediments, but may be expected to be found as the result of further investigation. The third appendix gives a short but excellent and up-to-date bibliography, which is perhaps the most useful feature of the book.

Van Nostrand's Chemical Annual: a Hand-Book of Useful Data for Analytical, Manufacturing and Investigating Chemists, Chemical Engineers, and Students. Edited by Prof. John C. Olsen; assistant editor, Dr. T. R. Le Compte. Sixth issue, 1926. Thoroughly revised and enlarged. Pp. xv + 882. (London: Chapman and Hall, Ltd., 1927.) 21*s.* net.

AMONG the many new tables that have been included in this, the sixth, issue of this quadrennial compendium of numerical information, are those of isotopes, hydrogen-ion concentrations, iso-electric points of proteins, vapour pressures of hydrated salt systems and detailed properties of lead and mercury. The general features of the volume remain unaltered; revision and correction have been effected where necessary, notably wherever the atomic weight of antimony is involved.

Comprehensive as are the lists of physical constants of compounds, one or two of the more recent commercial products have been overlooked, and certain of the organic compounds retain their German spellings. It is questionable whether the inclusion of a large number of problems, so reminiscent of very early examination days, is justified in a work of this character, although the illustrative discussions in this section ("Stoichiometry") are most useful. So far as is practicable, reference is made to original sources of information. Care must be exercised in using tables involving gallons and Beaumé scale, since the book reflects American practice.

Arrhenius is the notable man of science who figures as frontispiece for this issue. B. A. E.

Islands near the Sun: Off the Beaten Track in the Far, Fair Society Islands. By Evelyn Cheesman. Pp. 236 + 9 plates. (London: H. F. and G. Witherby, 1927.) 12*s.* 6*d.* net.

A FEW months in the Society Islands gave Miss Cheesman opportunities of seeing Tahiti, Raiatea, and Bora Bora, and her experiences and observations are recorded in this delightful volume. It differs from most books on the South Sea Islands in describing not merely the well-populated coast regions, but also the less visited high ground of the interior. Miss Cheesman's main object was to study the insect life of the islands, which was not well known before her visit, and while insects loom large in her pages, she misses nothing of interest in natural history. The book, in fact, is a record of a naturalist's wanderings, written with considerable descriptive power and much appreciation of the beauty of the islands. It is illustrated by a few photographs and sketches by the author. Among the many books on Tahiti it deserves to take a prominent place. There are appendices which give a catalogue of the fauna.

The British Hydracarina. By Chas. D. Soar and W. Williamson. Vol. 2. (Ray Society volume (No. 112) for the Year 1926.) Pp. viii + 215 + plates 21-40. (London: Dulau and Co., Ltd., 1927.)

THE authors are to be congratulated on the completion and issue of this second volume of their monograph so soon—within a couple of years—after the first. This volume is devoted to the systematic description of the water mites of the family Hygrobatidæ. The characters of the ten subfamilies, of the eighteen constituent genera and of the species are carefully defined, with the help of a liberal supply of excellent illustrations. These form plates xxi-xl of the work; the first six plates are in colour and all are well reproduced. Under each species is given a note of the localities where it has been taken in Britain, and the more general distribution of the species in other parts of the world is indicated by mentioning the countries in which it is known to occur.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Sources of Supply of Vitamins A and D.

THE problem of an adequate supply of the fat-soluble vitamins for the needs of the growing population has received prominent attention at the recent meeting of the British Association. The shortage in the supply of milk fat in particular was emphasised, and a simple calculation led to the conclusion that this shortage is not a local one in Great Britain, but of world-wide extent. Butter is irreplaceable by margarine as long as this article of diet is deficient in vitamins. Even if we do not share the gloomy view as to the effect of this shortage on the health of the nation, since milk fat is not their only source, it must be admitted that the problem of the supply of fat-soluble vitamins is of outstanding importance.

We would like to direct attention to the outcome of recent researches, only partially published as yet, in the course of which we became aware of easily accessible sources of both vitamins A and D. The solution of the problem depends now only on the industrial application of the knowledge made available by such research.

So far as vitamin A is concerned, we found that the chromogen responsible for the arsenious chloride colour reaction, discovered by one of us (O. R.), is present not only in the liver of the cod, but also in the livers of all animals examined, fishes, birds, and mammals. A study of the quantitative distribution of this chromogen and its correlation with vitamin A by means of the biological growth-test (*Lancet*, ii. 806; 1926), proved that the amount present in other liver fats in many cases far exceeds that found in cod-liver oil, the richest source of vitamin A previously known. It must be remembered that the main reason for the selection of the cod as a source of medicinal oil, leading to the development of the cod-liver oil industry, was the extraordinarily high fat content of the cod's liver and its relatively easy extraction on a commercial scale. As regards vitamin A content, however, we found that the liver oils of other fishes, such as salmon or halibut, are often more than 100 times as rich as cod-liver oil.

On account of their limited accessibility, these oils cannot be considered as a commercial source of vitamin. The same reason excludes the liver fats of birds, some of which, such as those of the grouse, goose, fulmar petrel (*Biochem. Jour.*, 111; 1927), are extremely potent. The liver fats of herbivorous mammals, on the other hand, appear to be an ideal source of vitamin A. These animals live mainly on green fodder, the original source of vitamin A, and accumulate a store of it in the liver, as do fish and birds. We found by both colorimetric and biological tests that the liver fats of sheep, calf, and ox contain on the average as much as ten times the amount of vitamin A as a good Newfoundland cod-liver oil. Taking the vitamin A content of butter—a very variable factor—as from 1/20 to 1/100 that of cod-liver oil, these fats may be said to be from 200 to 1000 times more potent in this respect than butter. A recently published letter (see *Times*, Sept. 7) shows that by an interesting coincidence our results in this respect are confirmed by the independent observations, hitherto not published in detail, of Prof. Wilson, formerly of Cairo. According to these, "the liver fats of Egyptian sheep and oxen appear to contain about 200 times the amount of vitamin A found in the best butter examined." Without entering into a calculation of the available supply of liver, we may assume that Great Britain's need is easily met at home, supplemented if necessary by Empire produce. It may be stated that the vitamin content of the fat obtained from imported New Zealand liver equalled that of the liver of home-killed animals.

As an additional advantage for the purpose suggested, we find that these fats are free from the objectional flavour of fish oils, which is apparently connected with the presence of the highly unsaturated clupanodonic acid ($C_{22}H_{34}O_2$) and the Fearon colour reaction (*Biochem. Jour.*, 1342; 1926). Owing to their low melting-point, liver fats can be easily incorporated with other fats, such as margarine. Although easily extracted by the use of fat solvents, their isolation would probably not be necessary in large scale manufacture. Vitamin A, being fat-soluble, can be directly extracted from the tissue by a neutral oil. The well-known skill of the margarine manufacturer should enable him so to incorporate the liver fats with his product as to convert a dietary article, already identical with butter in calorific value, into a cheap and palatable product of equal biological efficiency, so far as vitamin A is concerned.

The no less important vitamin D, another variable constituent of butter, remains to be considered. Contrary to the expectation that this would also be contained in the mammalian liver fat, we found that the liver fat of sheep, at any rate, is practically devoid of this vitamin. It would seem that, unlike fish, the herbivorous mammal does not store vitamin D in the liver. On the other hand, the body fats of certain fishes, although free from vitamin A, as tested both colorimetrically and biologically, were found to be a good source of vitamin D. An interesting exception to what appears to be a general rule was revealed in the examination of the body oil obtained from eels. The oil content of this fish is relatively high (about 30 per cent.), and it contains not only vitamin D, but also vitamin A in an amount nearly equal to that of some Norwegian cod-liver oils (tested colorimetrically and controlled by the animal test). This result confirms, incidentally, the high value empirically attributed to the eel as an article of diet.

There is, however, no need to search any longer for a natural source of vitamin D, since we are now able to produce this important vitamin artificially by irradiation of ergosterol (*Biochem. Jour.*, 389; 1927). Irradiated ergosterol possesses extraordinarily potent anti-rachitic activity, 1/10,000-1/20,000 mgm. per diem preventing and curing rickets in rats. Clinical experience has since shown that human rickets also is rapidly cured by daily doses of 2-4 mgm. The amount to be incorporated with margarine need, therefore, be only extremely small. By a study of the best conditions of its formation in yeast, a practically unlimited supply of ergosterol should be available for this purpose.

The margarine manufacturers have therefore at their disposal, if they care to make use of them, means which should make a perfect biological substitute for butter accessible, without unduly raising the price of margarine. Moreover, by carefully controlled methods of manufacture, it should be possible to supply a product of constant vitamin content, superior in this respect to natural butter, the vitamin content of which depends on too many uncontrollable factors of the food supply of the cow.

O. ROSENHEIM.
T. A. WEBSTER.
National Institute for Medical Research,
Hampstead, N.W.3, Sept. 13.

The Mechanism of Formation of the Latent Photographic Image.

A KNOWLEDGE of the process whereby the latent image is produced on the exposure of a photographic emulsion to light is of primary importance to those engaged in fundamental photographic research. For some years past this problem has been under investigation in the laboratories of the British Photographic Research Association, and considerable progress has recently been made in our knowledge of the primary light action.

As a first step, our method has been to try to identify the photographic mechanism with some characteristic of the silver halides which can be studied by purely physical methods, in the absence of such disturbing factors as gelatin, etc.

It has been known for a long time that the silver halides possess both photo-electric and photo-conductivity properties. By the former is meant the complete liberation of electrons from the salt under light action, and by the latter the freeing of electrons internally, resulting in a change of conductivity on illumination (sometimes called the *internal* photo-electric effect). It seemed possible to us that the mechanism responsible for one of these effects might be identified with that which produces the latent photographic image, and consequently we started more than two years ago a series of experiments to investigate thoroughly the two effects in relation to the silver halides, and especially to silver bromide.

The results of a long series of experiments which were published (*Phil. Mag.*, **3**, 482; 1927) indicated that the photographic mechanism was not photo-electric in the sense of its being a complete liberation of electrons from the crystal of silver bromide. The evidence in support of this conclusion is that photographic action takes place in an emulsion made with silver bromide at wave-lengths very much longer than the longest which will produce any photo-electric emission from that salt.

A detailed investigation of the second, *i.e.* photo-conductivity effect, has now been in progress for more than a year, and the results already obtained seem to be sufficiently striking to warrant publication in the form of a preliminary note.

A study of the literature indicated that in many ways a parallelism does exist between photo-conductivity and photographic effects. For example, the spectral regions to which emulsions are sensitive photographically are the same on the long wave-length side as those to which the corresponding pure halides show photo-conductivity effects. Take the most important case—that of silver bromide. The photographic spectral sensitivity of a slow silver bromide emulsion increases very rapidly towards the blue from practically nothing at about λ5000. The very trustworthy experiments of Coblentz (U.S. Bureau of Standards, *Scientific Paper* No. 256) on the photo-conductivity of silver bromide showed that this effect also commences in the same spectral region as the photographic effect and increases also towards the blue. To this extent, therefore, the two effects are parallel. Coblentz's results, however, showed a very serious departure from the photographic case in that as the wave-length decreased from λ5000, the photo-conductivity effect (for equal energy) after rising rapidly to a maximum, *fell practically to zero at about* λ4200. This, at first sight, seemed to indicate that the mechanisms producing the two effects are different, because it is well known that photographic action occurs at wave-lengths far shorter than λ4200.

In the case of such thickly coated plates as are commonly used in photography, there is an apparent decrease of sensitivity as we pass from the violet to the ultra-violet. This effect has, however, been shown (*Phil. Mag.*, **49**, 1104; 1925) to be due, not to a real decrease in sensitivity of the grains of silver bromide, but to secondary effects involving the thickness of the sensitive film. Experiments with thinly coated plates demonstrated (*Trans. Faraday Soc.*, **19**, 290; 1923; *Phil. Mag.*, **48**, 947; 1924) that the photographic sensitivity of silver bromide actually increases on passing from the violet to the ultra-violet. It was thought that the sharp decrease of photo-conductivity in the violet and the apparent absence of the effect in the ultra-violet reported by Coblentz might also have been due to a 'thickness' effect in the specimens used by him and was not an inherent characteristic of the silver bromide.

Since the light absorption by silver bromide increases extremely rapidly with decreasing wave-length from the blue to the ultra-violet, the former light penetrates much farther than the latter into the silver bromide layer. Since, further, the electrical conductivity depends on the whole thickness of the layer, it was suspected that the relative photo-conductivity effects at different wave-lengths depends on this thickness, just as we have shown the photographic effect so to depend. Experiments were therefore undertaken to measure the photo-conductivity effects at the three wave-lengths λ4385 (blue), λ4060 (violet), and λ3650 (ultra-violet), and to see whether their relative values varied with the thickness of the silver bromide specimen employed.

Preliminary experiments have completely verified the predictions, and have shown that while with a fairly thick specimen (about 0·7 mm.) the relative order of effects is blue>violet>ultra-violet, yet as the thickness of the specimen is decreased, so the violet and ultra-violet increase relatively to the blue, the order given above becoming completely reversed with a sufficiently thin specimen. The thinnest yet measured is about 0·07 mm. thick, and even for this the effect of a given amount of energy is about twice as great at λ3650 as at λ4358. Thus what seems to have been the greatest difficulty in the way of demonstrating the identity of the photographic mechanism and that which produces a change in electrical conductivity on illumination, has been removed.

There is considerable experimental evidence that the mechanism of the photo-conductivity effect observed with many crystalline metallic halides involves the loosening of electrons from the *halide* ions of the lattice. The present work therefore adds considerable weight to the hypothesis that latent image formation involves the transfer of valency electrons from bromide ions to silver ions, resulting in the formation of metallic silver and free bromine.

F. C. TOY.

Physics Department,
British Photographic Research Association.
(Communication No. 66.)

The Spacing of Young Trees.

WITH reference to the article on the spacing of young trees in NATURE of July 23, practical foresters in Great Britain might be glad to know the results of any experiments in spacing carried out in high and exposed situations and loose peaty soil. While the best results cannot be hoped for under these conditions, the comparative cheapness and unproductive character of land of this class render it tempting for afforestation with sitka spruce and perhaps other trees.

It is obvious, however, that restricted root development and the production of somewhat top-heavy trees are a source of danger where woods are exposed to violent winds. May it not be preferable to space more widely in these cases and raise a crop of admittedly inferior trees, rather than follow the usual recipe and perhaps get the plantation irretrievably damaged after the first thinning? An isolated tree is often extraordinarily storm-proof as compared with trees in the interior of a well-grown wood, but of course its commercial value is small.

It would be interesting to know more of the possibilities and limitations of successful forestry on the bleak high-lying moorlands so common in many parts of Britain. Some of these moors and fells were certainly covered with large timber at one time, to judge from the evidence of place names and the actual trunks uncovered in peat cuttings, but replanting is a difficult problem now that cover is destroyed and the soil either denuded or overlaid with peat bog.

EDWARD P. FRANKLAND.
Needlehouse, Ravenstonedale,
Westmorland.

THE article in NATURE of July 23 refers to the possible effect of wide planting distances upon the quality of the timber to be produced. I can remember the time when the chief criticism to which British forestry was exposed (by those who considered Continental practice ideal for the production of commercial timber in Great Britain) was connected with this very practice of wide planting, associated with or without early thinning. The advocation of the former at the present time would suggest that sylviculture, which at one time was considered by far and away the most important branch of forestry, is to be put into the background for financial reasons. The pros and cons of wide or narrow spacing are fairly well known. In the case of species which grow quickly, or under conditions which favour quick growth during the first twenty years or so, close spacing does not always produce satisfactory results, unless early thinning is resorted to. This thinning is, however, under average conditions, unremunerative, and the argument that the expense of thinning can be avoided, and the cost of planting reduced by possibly 50 per cent. through wide spacing, is at any rate plausible enough.

The fact is often overlooked, however, that the question of importance is not altogether one of the number of trees per acre standing five years or so after planting, or which are usually regarded as established. Of far more significance is the uniform distribution of these trees over the surface, so that the competition for space and light is not eliminated in one place and excessive in another. The actual spacing may produce coarser or cleaner poles, obviate or necessitate early thinning, or reduce or increase the initial expenditure, as the case may be, but the final results are in all cases determined by complete canopy or stocking of the total planted area at an early age, and before branch development has proceeded too far for the production of reasonably clean timber.

The condition desired is not so easy to attain as many imagine. The deaths or failures which occur during the first two or three years after planting may be due to a variety of causes, but under average conditions they will occur over a larger or smaller proportion of the total area, and not with the same mathematical regularity with which planting was carried out. But these failures impose a duty on the forester which cannot be neglected if timber of the class and quality capable of commanding an open market is to be secured. This duty is to thicken up or fill in weak and gappy spots sufficiently early to enable the crop to attain the desired density. The extent to which this may be necessary does not depend upon the original planting distances, but upon other factors which apply to both thick and thin planting alike, but it obviously affects the cost of establishing plantations, and may convert originally low into ultimately high planting costs in the course of two or three years.

If the timber of northern Europe is to be partially or entirely replaced by home production, sylviculture must be considered in the same light as high farming. Costs of production must be studied from a relative rather than an absolute point of view, and cheap planting may not lead to profitable afforestation.

A. C. FORBES.
9 Upper Mount Street,
Dublin.

ONE of the points in Mr. Frankland's letter is answered by Mr. Forbes in his last paragraph, in which he enunciates a correct sylvicultural prescription that sylviculture and high farming are not dissimilar, in that the former requires at least as close a knowledge and practice; and that to curtail expense in the first years is to produce an inferior article which may prove unsaleable at a profit. Mr. Frankland's second point on the subject of the possibilities and limitations of successful forestry on the high-lying moorlands so common in Britain is not at present easily answered since practical experience is almost absent. It may, however, perhaps be stated with some confidence that the solution is unlikely to be found in wide spacing. To be successfully marketed, timber from such regions must be of as high a quality as possible. In France, where since the War exposed areas of this type are being afforested, this business is being approached from the viewpoint that close spacing is the first necessity; and that this spacing must be maintained until close canopy has been produced. Subsequent thinnings will probably be delayed owing to the slower growth to be expected; but such thinnings will be carried out as required, irrespective of whether the material is saleable or otherwise.

THE WRITER OF THE ARTICLE.

Possible Mechanism of Atomic Disintegration.

THE experiments of atomic disintegration (Rutherford, Chadwick, Kirsch, Pettersen, Kara-Michailova, Bieler, etc.) show that by bombardment of α-particles it is possible to obtain hydrogen emission. Taking the case of heavy atoms, with big nuclear charges, if the α-particle cannot reach the nucleus, then hydrogen must come from the more external part of the atom.

On the other hand, the experiments of Aston and others show the presence of hydrogen in the discharge tubes: astrophysical observations also show the extraordinary abundance of hydrogen in stellar atmospheres, where atoms are, because of the high temperature, in a state of advanced ionisation. The phenomena are ascertained and so significant that it is necessary to relate them to the atomic structure.

Rutherford and Chadwick have already supported the view that satellites may exist around the nucleus; but to give a satisfactory representation of the phenomenon, I think it may be useful to consider the difference P-$2N$ (used already by Harkins for other purposes, with the name of 'isotope weight'), where P is the atomic weight and N is the atomic number.

I have called this difference the 'excess weight,' and I have thought of it as constituted by P-$2N$

doublets or dipoles, externally to the atomic nucleus, formed by one positive and one negative electron near enough to have them forming an electrically neutral complex. We may then understand how the number of these dipoles (which must be accommodated in the intra-atomic fields) must eventually depend on the atomic structure. There are, indeed, some facts that can be related to the present hypothesis and seem to show this dependence.

Let us consider the three following magnitudes as functions of the atomic number:

(*a*) The range of 'variability of isotopes,' namely, the difference between the weights of the higher and the lower isotope of each element;

(*b*) The 'maximum excess weight,' namely, the excess weight of the higher isotope of each element, or the maximum number of doublets a given atomic configuration can accommodate;

(*c*) The excess weight calculated from the simple atomic weight.

About the range of variability we may remark:

(1) It seems that no relation exists between the range of variability and the atomic number: this fact is very well known.

(2) The range of variability is of well-defined behaviour in the various groups of homologue elements: these behaviours are generally different when we come to consider different groups of elements.

(3) Radioactive elements have a completely different behaviour from that of non-radioactive elements.

(4) Elements following the rare earths group seem to be affected by the difference of atomic structure.

These remarks seem to show that the range of variability of the isotopes depends on the particular nature of the elements, and ultimately, on their atomic structure.

Let us consider the maximum excess weight: we may examine the first twenty elements of the periodic system, possessing a relatively simple atomic structure. These elements can clearly show the existence of an eventual relationship between $P\text{-}2N$ max. and their atomic structure. Indeed, this relationship exists and $P\text{-}2N$ max. has a perfectly distinct behaviour in each period. The greatest deviations of $P\text{-}2N$ max. happen in correspondence to neon and argon in coincidence with the closing of the 8-electron ring. The following facts stand to show that this coincidence cannot be casual.

For the inactive gases and bivalent metals—zinc, cadmium, mercury—$P\text{-}2N$ max. doubles each time a given atomic structure is repeated: as a matter of fact, for neon, ending a period of 8 elements, $P\text{-}2N = 2$; for argon, ending a second period of 8 elements, $P\text{-}2N = 4$; for krypton and xenon, ending respectively a first and a second period of 18 elements, $P\text{-}2N = 14$ and $P\text{-}2N = 28$; but for radon, ending a period of 32 elements, $P\text{-}2N = 50$. For the bivalent metals, zinc, cadmium, and mercury, we get the values 10, 20, 44; we observe then an identical behaviour as for the inactive gases. The remaining elements follow different rules.

The inactive gases and the bivalent metals above mentioned, which follow the law of doubling, are characterised upon the curve of ionisation potentials (L. Rolla e G. Piccardi, *Gazz. chim. ital.*, **56,** 512; 1926) by maximum positions and correspond, following Bohr, to complete saturation of electronic orbits (external, in the case of the inactive gases, internal to a 2-electron ring, in the case of the bivalent metals). This also shows that the excess weight does not change casually, but in relation to atomic structure.

We note, therefore, that in passing from the elements of the second short period to the homologues of the first long period, $P\text{-}2N$ max. increases from 8 to 12 units, and that going from the elements of the first long period to the elements of the second long period $P\text{-}2N$ max. increases from 8 to 14 units. In the case of structures growing more complicated, as for the atoms following calcium, it is more useful to consider the excess weight calculated on the basis of simple atomic weight which, among all possible weights, represents generally the most probable one, rather than the excess weight of the maximum isotope: we may, in doing so, eliminate many gaps and uncertainties which still to-day limit our knowledge about isotopes.

The graph of $P\text{-}2N$ shows periodicity in the three long periods: these periodicities point out that the probable excess weight varies in a uniform way in every group of homologue elements.

In an interesting paper by Diaz De Barros (*Comptes rendus*, **181,** 719; 1925) no explanation was offered of the remarkable periodic properties we have pointed out, and the present hypothesis could perhaps, if worked out quantitatively, prove fruitful in developing existing conceptions of nuclear constitution.

GIORGIO PICCARDI.
R. Università: Via Gino Capponi N. 3,
Istituto di Chimica Generale,
Firenze, Italy.

Method of Manufacture of the Sligo Implements.

AN examination of the whole of the material now available makes it abundantly clear as to the general plan upon which the Sligo implements were made (see NATURE, Aug. 20, p. 260). The raw material used is limestone, and this rock is present upon the Sligo coast in the form of horizontal layers about 1 foot thick and 1½ feet wide. These layers frequently break with a fracture vertical to their longer axis, thus producing oblong masses of limestone such as is outlined in Fig. 1 (A).

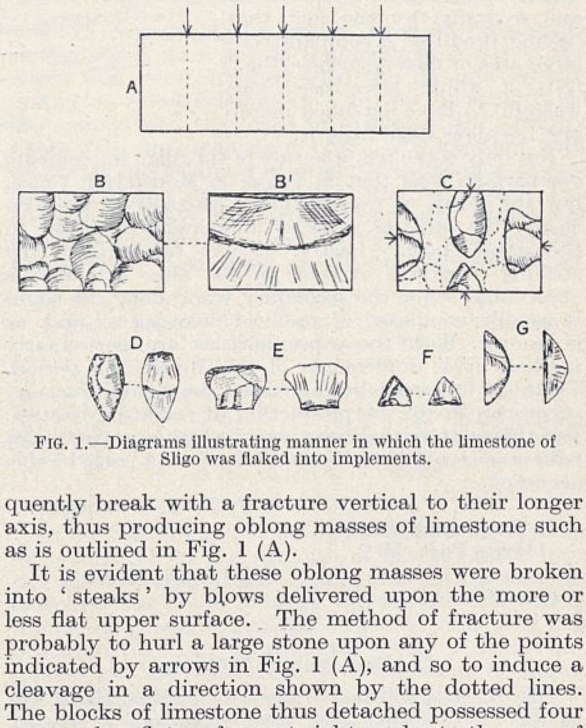


FIG. 1.—Diagrams illustrating manner in which the limestone of Sligo was flaked into implements.

It is evident that these oblong masses were broken into 'steaks' by blows delivered upon the more or less flat upper surface. The method of fracture was probably to hurl a large stone upon any of the points indicated by arrows in Fig. 1 (A), and so to induce a cleavage in a direction shown by the dotted lines. The blocks of limestone thus detached possessed four more or less flat surfaces at right angles to the area of fracture produced, and these surfaces were used as the striking platforms in the next stage of the implement-making process. This stage is shown in Fig. 1 (B), and consisted in the removal of flakes over the whole of one of the larger surfaces of the block of limestone, by blows delivered upon the four flattish sides. The other face of the block, Fig. 1 (B[1]), exhibits the fracture surface, with bulb of percussion produced in the initial detachment of the mass from the parent rock.

Having covered one surface of the block with flake scars, blows were then delivered with a hammerstone at certain selected points along the sides of this surface, and Levallois flakes of various type detached. These are indicated in Fig. 1 (C) by continuous lines, while the arrows show the direction of the flake-removing blows. The original flaking of the surface of the block remaining unaffected by the removal of the Levallois flakes is indicated in Fig. 1 (C) by dotted lines. The flakes so detached exhibit, on their upper surfaces, the truncated remains of the flake scars originally present upon the flaked block, while the under surface shows the bulb of percussion formed when the specimens were removed. After this detachment the Levallois flakes were trimmed to the desired shapes by blows delivered upon the under surface (Fig. 1 (D, E, F, and G)), and this completed the implement-making process.

It will be noticed that this process, as carried out by the palæolithic people of Sligo, bears a very close resemblance to that practised in Mousterian times in the manufacture of flint implements. In fact, the only way in which the Sligo method differs from the other is :

a. In the breaking up of the raw material into suitable blocks ; and

b. In the detachment of more than one Levallois flake from the prepared core.

These differences are, however, explained first by the differing nature of the raw material, which necessitated the adoption of a different method of preparation ; and secondly, by the fact that, having produced a comparatively large area of flaked surface (Fig. 1 (B)), it would have been very wasteful to have detached merely one Levallois flake from it.

Not only is the manufacture of the Sligo implements comparable with that in vogue in Mousterian times, but the forms of the specimens themselves are also clearly the same as those of implements referable to the latter epoch. Lastly, distinct facetting of the striking platforms of some of the Sligo artefacts is observable, while the secondary work along the edges is usually composed of resolved flake scars ; and, as is known, both these peculiarities are particularly marked upon implements of the Mousterian period. The Sligo limestone has a marked conchoidal fracture, accompanied by the production of radiating fissures, and this enables the direction in which any particular flake was removed to be ascertained with considerable accuracy.

J. P. T. BURCHELL.

30 Southwick Street,
Hyde Park, W.2.

J. REID MOIR.

One House, Ipswich.

Coming British Eclipses.

DR. HIND published some calculations about the eclipse of June 30, 1954, more than half a century ago. He first announced that it would be total in the northern part of the Shetland group, but afterwards cancelled this, stating that the track would lie a few miles north of the group. I made independent calculations of the eclipse some twenty years ago, but a numerical error in the final steps escaped notice ; this error caused the track to miss the Shetlands, thus confirming Hind. I have recently repeated the whole calculation quite independently, using Hansen's tables with Newcomb's corrections for the moon, and Newcomb's for the sun ; estimated corrections were applied as follows : $+8''\cdot5$, $-0''\cdot8$ to the moon's longitude and latitude, $+2''\cdot3$ to the sun's longitude. The error in my former work was brought to light, the two calculations agreeing perfectly in every other respect. The surprising result emerges that Hind's first announcement was correct ; the eclipse is total throughout the island of Unst, and in the northern part of Yell and Fetlar. The point taken for calculation, on the north coast of Unst, is $0°\ 45'\cdot7$ W., $60°\ 49'\cdot4$ N. Totality here lasts 117 seconds, the duration on central line being 156 seconds. The sun's altitude is $52°\ 12'$.

The conditions are thus extremely favourable, and it is rather strange that Hind's error has not been detected sooner. The eclipse is also observable in south Iceland, Faroe Islands, south Norway (Bergen), south Sweden (Oland I.), Memel, Tilsit, Sea of Azov. It is a repetition after three Saroses of the 1900 eclipse (Spain and Algiers); the series gives another European eclipse (Finland and Lapland) in 1990, besides the Constantinople eclipse of 1936.

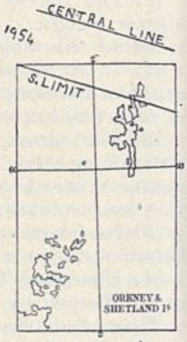


FIG. 1.—Tracks of total solar eclipses of 1954 and 1999.

Some doubts having been expressed (notably by Herr C. Schoch, who is an authority on ancient eclipses) as to whether the 1999 eclipse would be total in England, I have recently investigated it, using Brown's Tables for the moon, with corrections of $+18''$, $+1''\cdot7$ in longitude and latitude, and Newcomb's Tables for the sun, with correction $+3''$ in longitude. The result vindicates the almost perfect accuracy of Hind's track published in NATURE of Dec. 30, 1875; my track is $5\frac{1}{2}'$ south of his, and passes $11\frac{1}{2}'$ north of the Lizard. The Rev. J. Maurus Moorat, O.S.B., has kindly made an independent calculation for check, using Hansen's tables of the moon ; his track does not differ greatly from mine, but lies a few miles farther north,[1] thus placing beyond doubt the fact that totality reaches England. In fact, three quarters of Cornwall, the southern quarter of Devon, and a small portion of Dorset about Portland Bill will enjoy totality, as will also a large tract in north-east France. The duration of totality is 2 minutes ; the sun's altitude, 47°.

Comparison may be made of the above results with those of Mähler, which are based on Oppolzer's Canon of Eclipses. Mähler indicates totality in Unst in 1954, his central line being 11 miles north of mine ; in 1999 Mähler's central line is about 14 miles south of mine, running through the Lizard. It will be remembered that all Mähler's tracks are decidedly too wide, since he uses Hansen's value of the moon's semidiameter, which is $2\frac{1}{2}''$ too great for eclipse

[1] A revision of his work makes it practically coincident with mine.

purposes. Since the lunar tables used by Oppolzer omit many small terms, Mähler's tracks are uncertain by fully 25 miles, so the discordances found are not unduly large.

The central lines and limits of totality in these two eclipses are indicated on the accompanying map (Fig. 1). The occurrence of these two favourable British totalities within 45 years of each other is some compensation for the unusually long barren period which has just ended.

A. C. D. CROMMELIN.

The Production of Sound by Heat.

PROF. KNIPP, in his letter to NATURE of Sept. 10, seeks for reasons why the 'singing tube' was not discovered long ago by research workers doing their own glass-blowing. In point of fact, it was so discovered. I observed it when making for my father some vacuum tubes for examining the spectrum of argon, about 1896. But I found that it had been long familiar to him. He discussed it in a lecture at the Royal Institution (*Proc. R.I.*, **8**, p. 536; 1878. NATURE, **18**, p. 319; 1878. Collected "Scientific Papers," vol. 1, p. 350) giving a mechanical explanation similar to that of Prof. Knipp. He had learned the facts from a paper by Sondhauss, which might no doubt be easily located from the Royal Society's catalogue of scientific papers. I am, for the moment, away from easy access to a scientific library.

RAYLEIGH.

Beaufront Castle,
Hexham,
Sept. 12.

IN an interesting letter on a 'singing tube' which emits a sound when heated at the sealed end near a constriction, Prof. C. T. Knipp gives reasons "why it was not discovered long before by research workers doing their own glass-blowing." However, Sondhauss had a paper in the *Annalen der Physik* on the subject in 1850 (Vol. 79, page 1). He says at the commencement (I translate): "Many physicists must have observed that bulbs blown on glass tubes of 2 mm. to 3 mm. diameter often give out a tone, so long as they are strongly heated; observations on these have been made public only by Pinaud (*Pogg. Ann.*, **42**, 610; 1837) and C. Marx (*Erdmanns Journal für praktische Chimie*, **22**, 129; 1841). I had observed the same before Pinaud's publication . . . and was led to take up a more particular study of the phenomenon." Sondhauss rightly considered the source of sound to be the vibrations of the air in the 'singing tube' and gave an empirical formula for the frequency of the tone emitted by a tube having a spherical bulb blown on one end.

I should like to add, from my own observation, that a plain cylindrical tube can be made to 'sing', by means of a hot gauze, even if the latter is placed at a *loop*, *i.e.* at the open end of the tube, provided a supply of coal-gas be admitted to the tube and lit just above the gauze. This is known as 'Lissajous' whistling flame,' although I have never been able to trace the reference. By using a lighted Méker burner for the gauze with gas lit above, I was able to produce ear-splitting howls when the burner was placed just beneath the open end of a long brass tube.

E. G. RICHARDSON.

University College,
Gower Street, London, W.C.1,
Sept. 10.

Climatic Changes: Their Causes and Influences.

THE evidence for climatic changes in Great Britain about the thirteenth century is not so inconsistent as Prof. Gregory makes out in his reply to Mr. Meyer in NATURE of Sept. 10. Literary records tend to be comparative (as I have previously explained), so that one would expect most records of droughts to occur at a time when the climate was becoming drier rather than during a time of stable dry climate. Thus, both literary records and the east Kent watermills discussed by Mr. Meyer point to a rapidly decreasing rainfall in England in the latter part of the thirteenth century. There is probably plenty more evidence of a similar nature buried in old documents, county histories, etc., and only waiting for the spade of the antiquarian.

I cannot claim any direct acquaintance with the sagas, but O. Pettersson appears to have studied them in sufficient detail, and his arguments about the comparative freedom of the Greenland waters from ice in the tenth century have been thoroughly confirmed by the recent excavations at the Eastern Settlement. Absolute freedom from ice is only suggested as a possibility, and not argued as a probability, but I should not care to deny it from arguments about the climate of Britain at that time, for two reasons; first, we do not yet know how or to what extent changes in the ice area off Greenland affect British weather, and secondly, we know practically nothing of the climate of Britain in the tenth century.

C. E. P. BROOKS.

34 Glenhurst Avenue, N.W.5,
Sept. 10.

Black Sea Earthquakes of Sept. 11 and 12, 1927.

GOOD records of the above series of earthquake shocks which were felt on the northern coasts of the Black Sea were obtained with the Galitzin seismographs at Kew Observatory. In the following table are summarised the times of arrival of the primary phase (P), and secondary phase (S), together with estimates of the times of origin (O), distance of epicentre (Δ) and co-ordinates of the epicentre. The co-ordinates have been worked out using Strasbourg and Kew observations, and the figures given are provisional only. All times are Greenwich Mean Time.

	Day.	Hour.	*P.*		*S.*		*O.*		Δ	Epicentre.
			m.	s.	m.	s.	m.	s.	km.	
	Sept.									
I.	11	22	21	2	25	18	15	41	2640	45° N., 34° E.
II.	11	23	49	50	54	18	44	13	2800	45°·5 N., 37° E.
III.	12	3	25	22	29	46	19	50	2750	45°·5 N., 36°·5 E.
IV.	12	6	38	43	43	6	33	12	2730	43°·5 N., 35° E.
V.	12	14	29	12	33	28	23	51	2640	45° N., 34° E.
VI.	12	19	36	(22)	40	(42)	30	(55)	(2690)	..

In the case of the first shock, it was possible to make an estimation of the azimuth of the epicentre from the Kew records alone. Using this estimation, the epicentre was found to be 43° N., 34° E. The shocks numbered I. and V. give the largest records, and it is probable that the co-ordinates given of these two quakes are the most correct for the series of shocks. An earthquake occurred in the same region on June 26 of this year, and the epicentre worked out at Strasbourg was given as 45° N., 34° E.

R. E. WATSON.

Kew Observatory,
Old Deer Park,
Richmond, Surrey,
Sept. 19.

Telekinesis and Materialisation.

By Dr. E. E. FOURNIER D'ALBE.

THERE are certain classes of phenomena, both physical and biological, which for two generations have been persistently pressing for recognition by official science, and have been as persistently refused such recognition. With the present world-wide organisation of scientific research, such a situation is, to say the least, unusual. It is not as if new observations were habitually neglected. Quite the contrary. The announcement of a new discovery instantly sends a flutter through the universities and research laboratories, and within a week hundreds of competent men are eagerly testing, repeating, and criticising the alleged discovery. After a short period of doubt and perhaps controversy, the innovation is either confirmed or discredited, and the attitude of science towards it is settled.

This sifting process is particularly rapid in physical and chemical phenomena, where spurious discoveries are given short shrift. We need only recall the recent 'death-ray' scare to realise the rapidity and finality of the process.

When a biological or psychological factor is involved the decision is often delayed. It took nearly three years to demolish Blondlot's 'N-rays,' and even then the Académie des Sciences awarded him a prize of 20,000 francs for his (more or less futile) researches in a field of unusual difficulty.

In medicine the issue may be in doubt even longer, as in the case of Koch's tuberculin, though the rapid recognition of insulin as a cure for diabetes is an example to the contrary.

It would be difficult to find cases where facts and their interpretations have been in doubt for more than fifty years. Yet that has happened in the case of the alleged phenomena of 'telekinesis' and 'materialisation.' They belong to the class of phenomena formerly termed 'occult,' but as this term is too suggestive of the Middle Ages, more up-to-date names such as 'supra-normal,' 'hyper-physical,' or 'metapsychic' have been invented. Currently they are called 'mediumistic,' on account of their association with spiritualism.

The word 'telekinesis' was coined by Alexander Aksakow, the first man to attempt to erect occultism into a science. It denotes the movement of objects at a distance without normal means. 'Materialisation' means the formation of organic or inorganic structures from material borrowed from the body of the person in whose presence the phenomena take place, and who is essential to their production. This person is barbarously called the 'medium,' though the word 'psychic' is often preferred.

'Materialisation' was first heard of in 1870, when Mrs. Andrews, of Moravia, N.Y., produced 'spirit forms.' These were originally supposed to be efforts of disembodied spirits to take on ordinary substance for the purpose of making themselves visible to mortals. No importance was attached to these and similar phenomena by scientific men until 1871, when Prof. (later Sir William) Crookes announced his intention to make a series of test experiments. The experiments were spread over three years, and led to the most amazing results, which, if corroborated, would have revolutionised both physics and biology.

Unfortunately, they were conducted without those extensive precautions without which, as experience has shown, it is impossible to arrive at a clear-cut decision in these matters. Crookes himself seems to have felt that he was losing his way. He abruptly stopped his investigations, and for the rest of his life confined himself to an unprogressive attitude of general assent to the spiritualist position. But his action gave a tremendous impetus to occultism generally, and a succession of famous mediums did their best to reach the pinnacle of D. D. Home and Florence Cook. Eusapia Paladino in Italy, Marthe Béraud ('Eva C.') in France, Kathleen Goligher in Belfast, Willy Schneider in Austria, and 'Margery' (Mrs. Crandon) in America, are the only ones who have been subjected to scientific tests.

Of these, Eusapia stands out as the most remarkable personality. She was born at Minervino-Murge in the Abruzzi in 1854. Orphaned at an early age, she went into service at Naples, and soon got caught in the epidemic of table-turning which prevailed in the 'seventies. At twenty-two she was 'discovered' by the Florentine spiritualist Damiani, who had been strongly influenced by the work of Crookes. We accordingly find that Eusapia's chief 'control' thereafter was a spirit called 'John King,' who claimed to be a brother of 'Katie King,' the amiable spirit maiden whom Crookes had embraced at one of his most remarkable séances. At thirty-two she had married a small shopkeeper, but soon she was lifted out of her lowly sphere by the generosity of Cavaliere Chiaia, who educated her and afterwards introduced her by open letter to Lombroso, the famous criminologist.

"Bound upon a chair," he said, "or held tightly by the hands of the curious, she attracts the furniture round her, raises it up, keeps it suspended in mid-air like Mahomet's coffin, and makes it descend in a wavy motion, as if obedient to a strange will. She increases or diminishes her weight at will. She raps and hammers on the walls, the ceiling, or the floor as requested. . . . When her arms are fastened, a third arm appears, nobody knows whence, and plays amusing pranks. It removes hats, watches, and money, rings and pins, and skilfully returns them. . . . A large, horny hand, which makes you feel cold down your back, may be grasped, pressed, and inspected, and finally rises and hangs in the air, as if severed at the wrist, resembling the wooden hands hung outside their shops as signs by glove-makers."

This introduction led to the complete conversion of Lombroso, who was eventually persuaded that he had embraced the spirit of his dead mother, materialised through Eusapia's mediumship.

Eusapia soon became famous. She travelled all over Europe. But she was not always equally fortunate. The Society for Psychical Research found she had a trick of freeing one hand by joining the hands of the persons controlling her. But such exposures do little harm to established mediums.

Practically all the well-known mediums have been detected in fraud at one time or other. But for every such exposure there is a ready excuse. The medium is in a state of trance or semi-consciousness, and the controlling spirits are of all kinds, even tricksters. When Florence Cook was, in 1880, caught impersonating the spirit 'Mary'; in other words, when she was convicted of fraud, the explanation advanced was that it was a 'transfiguration.' The supernatural element is introduced at every stage. Even when not deliberately mentioned, it is made to influence the investigator in the form of a demand for 'sympathetic' conditions. In a word, the application of the scientific method is rendered impossible by making the success dependent upon the whim of a supernatural entity.

During the study of mediumistic phenomena for more than twenty years, I have met most of the famous mediums and have had occasion to defend some of them against what I believed to be hasty and ill-considered judgments. I had great hopes of Eva C. and Miss Goligher, thinking they would furnish the groundwork of a new science. But at every step the investigator is baffled by the 'unseen operators'—be they embodied or disembodied—who will not come to a clear-cut issue.

The reviewer in NATURE of Geley's "Clairvoyance and Materialisation" says, in the issue of Aug. 27, p. 296: "It seems to me the duty of science either to show that, in the nature of things, there is no inherent possibility for the existence of ectoplasmic matter, or to attempt a tentative explanation of the phenomena." I regard the former alternative as impracticable. Who can set a limit to the possibilities of the organic world? Every individual born is a new experiment, and none can say what strange beings may yet be produced, or with what wonderful faculties they may be endowed.

If we must have a tentative explanation, there is one ready to hand. *The alleged phenomena of telekinesis and ectoplasm are all spurious, and are due to faulty observations or faulty conditions.* How difficult the conditions of the average séance are can only be realised by practical experience. The illumination is of the order of 0·001 foot-candle, and is usually considerably over-stated. The observer is wearied by hours of strained attention without anything happening. Often the sitting is entirely barren, and before the next sitting he will naturally examine his conscience to see whether an undue insistence on evidential conditions may have inhibited the phenomena. So he relaxes them. Then he gets phenomena. But they are no longer evidential.

Out of the large array of mediums who have shown the phenomena of 'teleplasm' or 'ectoplasm,' only three have been investigated under scientific conditions. Dr. Baron von Schrenck-Notzing spent several years in studying Eva C. He gives the following description of ectoplasm:

"The Ectoplasm on further condensation becomes white and transforms itself into amorphous coagulated masses or packets, or assumes the structure of the finest web-like filmy veils. Sometimes the veil-like forms are doubled over at the margin, so that the first impression is that of a stitched hem. THE VEILS NEVER SHOW THE CHARACTERISTIC SQUARE THREAD-WORK OF REAL VEILS. . . .

"The pieces look like torn shreds of fabrics, or like ribbons, strings, or long fibres, or again like low organisms. . . . The mass seems to pass freely through the lighter materials of the dress, penetrating them, perhaps in a vaporous form, and subsequently condensing in the form of grey flakes.

"The experiences with Eva C. show many correspondences with the phenomena of Eusapia Paladino. The symptoms of mediumistic labour and its muscular accompaniments were found in both persons. The same utterances of pain, the same moaning and pressing, the same effort of will."

On two occasions Dr. von Schrenck-Notzing was able to obtain samples of the substance, and subject it to analysis. The first sample was indistinguishable from human skin such as might be peeled off a human heel. The second sample closely resembled saliva in its microscopical character.

In March 1922, Eva C. was investigated by a committee appointed by the Psychological Institute of the Sorbonne. This committee reported that what phenomena there were could be produced by regurgitation. The same result had been arrived at by the London Society for Psychical Research in 1920.

The case of Kathleen Goligher resembled that of Eva C. in many particulars, but her phenomena were unaccompanied by the signs of physical distress exhibited by the other mediums. Dr. Crawford published numerous photographs, which strongly suggest the textile nature of the substance. This was established by me in 1921, when I succeeded in taking the only contact photographs of ectoplasm ever obtained. They were taken by putting the photographic plates on the floor under the table and requesting the 'operators' to place some ectoplasm upon them. When all was ready, a small electric lamp fixed on the under side of the table was switched on for a few seconds. The results showed the unmistakable structure of chiffon or a similar material.

Quite recently another case of materialisation, in connexion with 'Margery' (Mrs. Crandon), was investigated by Mr. E. J. Dingwall. He found the materialisations resembling animal tissue. "The appearance," he says, "suggests something analogous to lung tissue, and the smell of the substance which, according to Dr. Worcester, resembled the smell of the entrails of a freshly killed animal, pointed in the same direction."

There is nothing in all this to make out a plausible case for the assumption of a new substance called 'teleplasm' or 'ectoplasm.' It is impossible to extract from the literature on the subject any consistent description of its supposed properties. In the days of Katie King, the apparition was able to cut off portions of her dress and distribute them to her audience, who found that they resembled ordinary calico. Nowadays the substance is supposed to be very fugitive and sensitive to light. The hypothesis which seems to cover all the facts is that a succession of mediums, under pressure from sitters anxious to see marvels, have produced these 'spirit forms' by trickery. This trickery has become increasingly difficult and has practically disappeared whenever test conditions are applied. It is, therefore, impossible to admit the existence of any new facts, and even a tentative explanation of them is uncalled-for. Science might just as well concern itself with the anatomy and physiology of fairies.

There is another matter which must not be overlooked. The forces behind occultism and supernaturalism are very powerful. They are based upon the very human craving for the marvellous. All religions contain this element, and promote it in various ways. There is a tendency in modern times, especially in America, to link religion with science, so as to utilise the growing prestige of the latter. The funds available for the enterprise of winning the approval of science for the modern miracle are very considerable. A wealthy French spiritualist recently established and endowed an International Metapsychic Institute in Paris, and appointed as its director a local practitioner of spiritualistic sympathies, Dr. Gustave Geley. The publication of his conclusions and speculations in an imposing and expensive volume formed a very telling piece of propaganda.

Such institutions form a kind of spearhead forged by occultism for piercing the armour of science, and it would not be surprising to see the foundation in England of an Imperial Academy of Natural and Supernatural Science, generously endowed from British and American sources. Its prospectus would be liberally sprinkled with the names of Crookes, Lombroso, Richet, Flammarion, Geley, Crawford, and von Schrenck-Notzing, and everybody would know that science had at last become 'spiritualised' and centred in other worlds than ours; and sacerdotalism, having been expelled by the door, would come back through the window.

Base Exchange and the Formation of Coal.

By Dr. E. McKENZIE TAYLOR.

DURING a soil survey of the northern portion of the Nile Delta for reclamation purposes, a deposit of vegetable debris was discovered at a depth of two metres below the soil surface. As this deposit was found to contain peat, fusain, and partially fusainised material, an association that does not appear to have been recorded previously, it appeared that an investigation of the conditions under which the deposit existed might afford evidence of the mode of formation of coal. It is accepted that coal has been formed from vegetable material, and it has been generally assumed that the vegetable material accumulated as peat. The connexion between peat and coal has, however, not been established.

An examination of the soil overlying the vegetable layer in Egypt showed that it was alkaline and that the principle replaceable base present was sodium. The soil had originally been formed by the deposition of Nile silt in which the main replaceable base is calcium. The conditions under which the soil was situated showed that the conversion of the calcium-clay in the Nile silt into sodium-clay had taken place as the result of base exchange with sodium chloride solutions, and that the alkalinity had been produced by the subsequent hydrolysis of the sodium-clay in fresh water. Investigations in the laboratory have shown that it is possible to maintain the alkalinity of a medium for a considerable length of time by the hydrolysis of sodium-clay. It has also been shown that a roof containing hydrolysing sodium-clay is impermeable to gases and water, that the conditions under such a roof are anaerobic, and that the alkaline medium produced under such a roof is suitable for the continuous bacterial decomposition of organic matter.

A study has been made of the bacterial decomposition of organic materials under the alkaline anaerobic conditions furnished by a roof containing sodium-clay. Sugars, starch, and cellulose decomposed under these conditions yield gaseous products only, the gas produced accumulating beneath the roof. An examination of this gas showed that it was principally methane, the carbon dioxide produced during the decomposition having been absorbed by the sodium hydrate resulting from the hydrolysis of the sodium-clay. Mature leaves were submitted to bacterial decomposition under a sodium-clay roof. The residual solid product was black and possessed the typical fusain structure. Analyses of the leaves at intervals showed that elimination of oxygen was taking place and that the process of decomposition was continuous. The bacterial decomposition of peat under a roof containing sodium-clay was also investigated. It was found that peat could be decomposed under the alkaline anaerobic conditions, that the alkali-soluble 'humus' in the peat was removed in solution from the seat of the bacterial action, and that the gas accumulating under the alkaline roof was methane. The investigation of the bacterial decomposition of organic materials under a roof containing sodium-clay has shown that bacterial activity in the continuously alkaline medium is not inhibited by the accumulation of toxic products of the decomposition and that the solid residue is a reduction product. It has also shown that peat can be decomposed under alkaline anaerobic conditions.

As peat can be decomposed by bacteria under an alkaline roof, and as vegetable material decomposed in such a situation yields a solid reduction residue with a fusain structure, the occurrence of a peat deposit containing fusain under an alkaline soil points to the conclusion that fusain is a decomposition product of peat under the alkaline anaerobic conditions imposed by a roof containing hydrolysing sodium-clay.

Since fusain is a constituent of bituminous coal, it seemed probable that bituminous coal might have resulted from the bacterial decomposition of vegetable material under alkaline roof conditions. A considerable number of specimens of the roofs of coal seams in Great Britain were examined, and it was found that the great majority were alkaline and that sodium was the main replaceable base present. The exceptions to these rules were of two main types: (*a*) coarse-textured shales or black sandstones, and (*b*) white sandstones and conglomerates. The final result of the hydrolysis of sodium-clay is the production of an unsaturated clay with an acid reaction. If the amount of reactive clay present in the roof was originally small, complete hydrolysis is likely to have taken place under fresh-water conditions with the formation of an unsaturated residue with an acid reaction. The coarse-textured shales and black sandstones would contain comparatively little reactive clay material, and hence the sodium compound would be liable to complete hydrolysis. The first exception is apparently due to the complete hydrolysis of the sodium-clay originally present. The second type of exception is of local occurrence only and is usually in the nature of a wash-out, indicating that the sandstone or conglomerate is not the original roof of the seam. Frequently the sandstone is underlain by a thin shale layer. From a consideration of the results, it appears that the original roofs of bituminous coal seams have undergone base exchange with sodium chloride solutions, and that afterwards the sodium-clay has undergone hydrolysis in fresh water.

An examination of the roofs of the anthracite coal seams of South Wales has shown that they are also alkaline and contain sodium-clay, indicating that the anthracite in the South Wales coalfield has been formed under similar final conditions to bituminous coal.

The results of these investigations point to the conclusion that bituminous coal has been formed as the result of the bacterial decomposition of vegetable residues under the alkaline anaerobic conditions imposed by a roof which has undergone base exchange with sodium chloride solution and subsequent hydrolysis of the sodium-clay in fresh water.

An examination of the roofs of a number of lignite seams has also been made. It appears that the main replaceable base present in the roofs of lignite seams is calcium, indicating that the roofs of these seams have not undergone base exchange with solutions of sodium chloride. Lignite is therefore not necessarily an intermediate product between vegetable matter and bituminous coal, but is rather a decomposition product of vegetable matter under a roof containing calcium-clay.

As bituminous coals and anthracite occur in different parts of the same seam and under the same roof conditions, it is suggested that the difference in the final decomposition products—bituminous coal and anthracite—is due to differences in the material submitted to bacterial decomposition under the final alkaline anaerobic conditions. It is not necessary to assume differences in the original plant materials to account for this. Differences in the decomposition products during the 'peat stage' may have arisen due to variations in the conditions of the first decomposition. This would result in a variety of products being submitted to the final decomposition under alkaline anaerobic conditions giving rise to the variety of final products composing the bituminous coal-anthracite series.

Base exchange between sedimentary deposits and solutions of sodium chloride can take place under three conditions in Nature: (*a*) by deposition of the silt in sea water, (*b*) by submergence in sea water of a deposit already formed, and (*c*) by the reaction of the clay with capillary solutions of sodium chloride raised from a water-table containing that salt. Geological evidence of base exchange under conditions (*a*) and (*b*) will be positive. Under condition (*c*) there will be no geological evidence of base exchange, determinations of the *p*H value and the nature of the replaceable bases being the only evidence on which to base a conclusion. From the examination of the roofs of the coal seams in Great Britain, it appears that the majority of the roofs have undergone base exchange with capillary solutions of sodium chloride.

The presence of the alkaline roof satisfactorily accounts for the observation that coal seam gases mainly consist of methane. Oxygen elimination from the vegetable material must have taken place during coal formation, but no appreciable quantity of carbon dioxide has been recorded in coal seam gases. The carbon dioxide produced by the oxygen elimination would be absorbed in the sodium hydrate solution resulting from the hydrolysis of the sodium-clay leaving a methane residue.

Three main conclusions concerning the formation of coal may be drawn as a result of this investigation:

(1) The vegetable material accumulated as peat.

(2) The roofs of bituminous and anthracite coal seams have undergone base exchange with sodium chloride solutions, the sodium-clay being afterwards hydrolysed in fresh water. This would provide an alkaline medium under anaerobic conditions for the bacterial decomposition of peat.

(3) The decomposition of peat under a roof containing calcium-clay results in lignite formation.

The roofs of bituminous coal seams other than those of the Carboniferous System are being investigated. The results so far obtained indicate that base exchange between the roof and sodium chloride solutions is common to all bituminous coal seams and forms the connecting link between the coal seams of the various geological formations.

The Ancient History of Sponges and Animals.[1]

By Dr. G. P. BIDDER.

IT is not fitting for one who is not a geologist to do more than touch very lightly on the problems of the pre-Cambrian. But connected with them is an interesting consideration to which I would direct the attention of fellow biologists. If we follow the American geologists in attributing organic origin to the graphites of the Grenville series at the base of the Laurentian—which are stated by Dawson to contain as much carbon as the whole American coal-measures, and with which we may class the graphite schists described by Geikie under the Scottish Lewisian, and the seven feet of so-called ' anthracite ' found in Finland by Sederholm in the Jatulian, at least two miles under the Cambrian—I do not see how we can avoid the conclusion that there was vegetation growing in or about quiet landlocked waters, for many thousands of years, as long before the Cambrian as the Cambrian was before us. Among palæontologists the view prevails that it is in such still landlocked waters that rapid evolution has always taken place. It seems impossible not to believe that a terrestrial flora, and a terrestrial fauna, must have been evolved in those favourable times and the long ages which followed, to be swept to destruction in the deluge that denuded the Torridonian. If so, we see in the succession of Cambrian and Ordovician fossils—the ' marine period ' of the Palæozoic, as Marr designates it—the development for a second time of a littoral from a deep-sea fauna, which fits closely with Walcott's conclusions on the Cambrian ; and in the Silurian and Devonian we see the evolution of a terrestrial flora and fauna for the second time.

If all the pre-Cambrian lands were swept by fierce and terrible torrents, marine organisms might nevertheless survive in the deep abysses of the sea, to recolonise later the still-vexed Cambrian shores. It is also conceivable that exceptional organisms might survive in the tranquil abysses of the high air, or on the occasional mountain-tops ; and the fancy has struck me that such isolated survivors from the ancient sub-aerial population may conceivably be recognised in the progenitor of the Ordovician winged insects, and also in the ancestor to Hugh Miller's conifer of the Old Red Sandstone.

Leaving the geologists and botanists to settle for us the truth or error of the premisses, the argument does not seem without philosophic interest : —that if the 7-foot graphite bed in Finland be of organic origin, 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.

The Laurentian coal, if coal it be, must mark the climax of a long evolution in the seas of the still earlier pre-Laurentian, and in that part of our history must come the primary advance which Church has rightly taught us to regard as the greatest step in evolution, the evolution of the flagellates. Church claims that, since protoplasm appeared, we may fairly estimate half the time elapsed as being required for the evolution of the flagellate. If Dr. Church measures his time in years, the geological record seems difficult to fit ; for the chætopods, molluscs, crustaceans, and echinoderms of the Cambrian are clearly very old phyla. But the single step in evolution is not a year but a generation, and there may well have been as many generations of our ancestors before they became flagellates as there have been since we have been multicellular. If we have been ' higher animals,' averaging ten generations a year, for 1000 million years, then some 10,000 million generations may have brought us from jelly-fish to men. But 1000 generations a year would be a very moderate number for flagellates and pre-flagellates, so that 10 or 20 million years would give them as many steps in evolution, to make a flagellate from nothing, as it has taken us to build up a flagellate into man.

We are still lacking a satisfactory account of the early ocean in which those fateful 20 million or 200 million years were passed, and in which life began. I suggest as a working hypothesis for biologists that, since the pre-Cambrian, there have been no variations in the mean salinity of the ocean so great as the difference between the salinity in the Mediterranean and in the North Sea. The first ocean was more or less saline : it was also soaked with carbon dioxide. In the air there was no oxygen, but nitrogen, much water-vapour, and carbon dioxide in large quantities. Life is the history of high carbon compounds, in which every atom of carbon has been in a molecule of carbonic-acid gas. Volcanoes and springs have always been pouring into the air carbon dioxide from the bowels of the earth, coal-plants and calcareous animals have buried in solid form the carbon from many thousand times the quantity of carbon dioxide which we have now in the atmosphere ; it is therefore probable that the alkalinity of the sea, and the dissolved calcium, have varied considerably from epoch to epoch. If all the surface of the globe were one continuous meadow, evenly producing a ton of hay an acre annually, I make out that in twenty-five years it would have fixed as much carbon dioxide as there is in the atmosphere, and in 15,000 years it would produce as much free oxygen as we have in the world to-day.

We see, therefore, that the advent of photosynthetic protein in the ocean must itself have changed the physiology of the world very considerably, and that the change in conditions, after a million years' duration of the lowest form of life, rendered the world capable of supporting organisms which would have been impossible at the beginning of that age, and conceivably rendered it incapable of supporting ever again the first forms of life.

Of the possible genesis of the first form of life we

[1] From the presidential address to Section D (Zoology) of the British Association, delivered at Leeds on Sept. 1.

heard from Dr. Allen at Hull. To-day let us take up the tale, in the warm pre-Laurentian sea, with little fragments of protein lying in the sunlit waters. Each fragment is continuously receiving energy—whether from the sun, according to Prof. Baly's theory of activation, or from some other electromagnetic source—and with that energy is building up the molecules of the surrounding solution into molecules of protein, so that the fragment grows.

The supply of energy is continuous, and the supply of solution is continuous, yet growth of the fragment of protein cannot be continuous, because *number* is discontinuous. A growing fragment contains 100 molecules of protein, presently it will contain 101, then 102. It may be a thousandth of a second, it may be an hour between the moment of attaining 100 and the moment of attaining 101 molecules, but with a constant supply of energy it will be closely the same interval after acquiring the 101st molecule and before the 102nd is added. Let us suppose that the interval had been 10 seconds. What will be happening during the next 10 seconds before the molecules number 103 ?

The continuous supply of energy must in some form be stored in the 102 molecules until its total is adequate to compel the combination of the water, carbon, nitrogen, sulphur, and the rest of it into the new 103rd molecule of protein. This stored energy is then spent in forming the combination, and for another 10 seconds the 103 molecules accumulate gradually a sufficient supply to force the combination of a 104th molecule. We cannot suppose that the molecules can store energy except by a change of atomic or electronic arrangement, or that such change fails to affect their molecular volume. Expansion of molecular volume means storage of energy which is released on contraction; we may feel sure that even if the main storage of energy be in some other form, it will at least be accompanied by expansion in volume and surface. When energy is given up to form the new molecule, all the old ones will return to their original volume, and if their expansion was by more than one-hundredth of their volume, the whole fragment will contract.

A slow expansion while energy is being accumulated, a rapid but smaller contraction when the new molecule is formed, so these fragments of protein pulsate steadily through the day. So they continue through the ages, while protein enters into new combinations, and the aggregate of protein molecules is replaced by a unit of protoplasm, still keeping the rhythm of saving up energy and making-a-molecule, saving up energy and making-a-molecule.

Now protoplasm in most organisms which we can study becomes altered at the surface which is in contact with water, by a change which is conveniently called 'gelation,' the protoplasm at the surface losing most of its fluidity and changing in other properties. In certain circumstances, such as increased salinity of the water, the internal fluid protoplasm will burst out through this gelated surface in fine threads, which either gelate in their turn or change into strings of drops.

I venture to suggest that the great evolution of the flagellate, which Church pointed out to us, accomplished in some ten thousand or hundred thousand million generations, was the formation of a permanent filament of protoplasm of which one side was more gelated than the other side, so that one longitudinal strip of the cylindrical outer surface is more elastic and therefore less easily extensible than the opposite strip. Let us suppose the gradual accumulation of energy causing, as before, a gradual increase in volume of the protoplasm ; then the more easily extensible surface will swell, and therefore lengthen, and the filament will gradually bend. When the quantum of energy is reached which suffices for formation of a new molecule, every old molecule will suddenly lose its surplus energy and return to its old molecular volume, the distended surface will return to its old dimensions and the filament will straighten.

I have spent an appreciable part of my life watching the flagella on the living collar-cells of Calcareous sponges—Grantia, Sycon, Leucandra, and Clathrina. Their movement is nearly confined to one plane and is asymmetrical, being almost always with a faster beat to one side than to the other. There is a pause, a stroke, and a counterstroke. Mr. James Gray pointed out to me that if the counterstroke be elastic, as I supposed, it should always take the same time, as compared with the varying time of the active contraction. This I found to be the case. At about 2½ double vibrations to the second, the stroke and counterstroke are of equal duration ; at higher frequencies the stroke is the shorter, as in a schoolmaster's cane ; at lower frequencies the stroke is the longer, as in a fisherman's trout rod. The broad features of the phenomena are therefore consistent with the hypothesis that the counterstroke is an elastic rebound.

The apparent improbability of a lowly-organised cylindrical cell, with an axial straight flagellum, having one longitudinal strip of the surface of that flagellum different from all the rest of that surface, disappears when we recognise that one longitudinal strip has a different history from all the rest of the surface. A collar-cell in a sponge is usually surrounded on all sides by six other collar-cells, of which one is its twin sister. Like all flagellates, including metazoan spermatozoa, collar-cells divide longitudinally. The details of this division were worked out very beautifully by Miss Robertson and the late Prof. Minchin ; and they showed that the little bead at the base of the flagellum, known as the blepharoplast, is the first thing in the cell to divide, and forms two daughter blepharoplasts which take the part of centrosomes and induce the division of the nucleus into two daughter-nuclei, followed by the division of the cell into two daughter-cells. In each of these daughter-cells the new blepharoplast grows a new flagellum. It will be seen that the part of the blepharoplast which was last in contact with its sister is, as it were, a healed wound, and the strip of flagellum which grows from this has therefore a different parentage from that which grows from the opposite surface of the blepharoplast, which is an intact part of the parent surface.

There is no nervous system in sponges, and no sign of nervous control of the flagella, either from the individual cell or from the community. The direction and timing of their beat is wholly uncorrelated, and though the frequency of two neighbouring cells generally approximates to equality, it is not exactly the same. The frequency varies when the temperature and soluble contents of the water vary. Except in certain cases where a wandering ovum (Grantia) or pore-cell (Clathrina) is laid over a collar-cell, I have never seen a flagellum motionless in a cell which was not moribund. I believe the motion to be ceaseless, unconscious, and uncontrolled, a direct function of the chemical and physical environment.

What has this to do with the history of animals? Our ancestors were flagellates, or lower than flagellates, for as many generations as they have been anything else, for perhaps five or fifty times as many generations as they have been vertebrates, at least two hundred times as many generations as they have been mammals, and our ancestors were flagellates for at least five thousand times as many generations as they have been men. All those flagellate ancestors of ours passed their whole active lives in this continual rhythm of accumulating energy and building, accumulating energy and building, twenty or more to the second through the whole of their short lives. Is it likely that we have forgotten that rhythm? I believe that all through our growth, from infancy to prime, we added our molecules to every unit of protoplasm, rhythmically, as our flagellate ancestors did. When we have passed our prime, our units keep their rhythmic reconstruction; only now, because we are land-animals and must not grow any bigger for fear that our limbs should snap, the rhythm or the chemical change is readjusted, so as only each beat to add as many molecules as we use up between the beats. But the adjustment is not perfect, so that when we have done growing our protein units do not keep absolutely constant—they lose a little each beat on the balance of gain and expenditure. So that as we grow older our muscles shrink, and our nerves shrink, and our cartilages shrink, and our brain shrinks, and we become what other people call 'senile'; and at length we die—a thing which none of our twelve thousand million flagellate ancestors ever did.

Incidentally, I believe that to that same metabolic rhythm, inherited from the flagellates, we owe our sense of time; so that our appreciation of dancing, poetry, and music shows that we are still flagellates at heart.

Obituary.

Mr. E. W. Ferguson.

SCIENTIFIC circles in Australia have suffered a great loss in the death at Wahroonga, New South Wales, on July 18 last, of Dr. Eustace Ferguson. Eustace William Ferguson was born at Invercargill, New Zealand, in 1884, the son of the distinguished divine, Rev. John Ferguson of St. Stephen's, Sydney, and when an undergraduate of the University of Sydney showed a passion for natural history. He was encouraged to collect coleoptera by Mr. George Masters, Curator of the Macleay Museum, in whose room I first made his acquaintance. Graduating in 1908 with honours in medicine, he showed an unusual knowledge of that side of his work which dealt with zoology and microbiology. He joined the Linnean Society of New South Wales in 1909 and contributed his first entomological paper on the Phalidurinæ, or ground weevils of Australia, in which group he became the authority; in all he published fourteen papers on the group, papers that were distinguished by their lucidity and judgment.

Joining the Department of Health of New South Wales as pathologist, Ferguson succeeded Prof. Cleland as chief microbiologist; and in logical sequence his later entomological work took a medicinary turn. He was soon keenly engaged in the study of mosquitoes, biting flies (Tabanidæ), fleas, and ticks. Here, as in the field, he showed a remarkable power of close observation, which, combined with a retentive memory, enabled him to recognise at once any form, however minute, that he had once examined. As the companion of many a delightful collecting trip, I have never met his equal for keenness of sight and notice of detail in natural objects.

Ferguson possessed a wide knowledge of Australian birds—whether on land or sea. From 1915 until 1918 he served in the Medical Corps of the A.I.F. in France, Egypt, and Palestine, using his opportunities to visit the Natural History Museum to study types of Australian insects; while in the East he was greatly interested in the history and archæology of those lands. He contributed some half dozen papers on the Diptera—chiefly on the Tabanidæ and Syrphidæ—to the Linnean Society of New South Wales, and used his influence with other specialists to communicate some sixteen valuable papers by them to the same society between 1922 and 1927—papers largely founded on material supplied by himself.

Ferguson was a member of the council of the Linnean Society of New South Wales from 1921, and its president in 1926—during the November of which year he was attacked by his fatal illness, actually writing an able presidential address, "A Review of Medical and Veterinary Entomology in Australia," on his sick-bed. He was also a member of council and president in 1922 of the Zoological Society of New South Wales, his address containing a strong plea for a biological survey of Australia. In his Department he organised "Tests for the Susceptibility to Diphtheria," and wrote a valuable Report on Dengue Fever. He leaves a widow and six children, five sons and a daughter.

H. J. Carter.

MR. S. R. WILSON.

THE news of the accidental death, at the early age of forty-five years, of Sidney Rawson Wilson while carrying out an experiment with nitrous oxide has given a painful shock to his many scientific and medical friends.

Wilson was the son of Arthur Cobden Jordan Wilson, of Penistone. He had a brilliant career as a student at Manchester, during which he obtained the Junior and Senior Platt Physiological Exhibitions and the M.Sc. (Vict.) in physiology. Thus early he showed an interest in physiology which remained unabated throughout his life. He afterwards took the M.B. degree, both at London and at Manchester, in both cases with honours, and the F.R.C.S. Edin.

Professionally, Wilson was one of the first to make anæsthetics his speciality, and he always endeavoured to combine scientific investigation along with its practical applications. He developed the use of the combined administration of oxygen and nitrous oxide for prolonged anæsthesia and introduced improvements in the method of ether administration. The use of carbon dioxide as a respiratory stimulant, the importance of which has been emphasised by Yandell Henderson in America, was another of Wilson's contributions to practical anæsthetics. This year he published a paper on 'ether' convulsions, the first scientific contribution to the elucidation of this new and dangerous phenomenon.

Although previously noted in workers in paraffin refineries, Wilson collected evidence so early as 1906 of the occurrence of cancer of the scrotum in mule spinners. His work on this disease won the Tom Jones Surgical Scholarship in 1907. In 1922 he published a joint paper with Mr. A. M. Southam on this condition, and in 1926 the report of the Home Office Committee on mule spinners' cancer gave him credit for this pioneer work.

On the inauguration of a new course in human physiology in the Manchester School, Wilson gave, although in the midst of many professional demands, unstinted help in the development of this teaching and in the carrying out of both human and animal experiments. These led him to try out fearlessly their results on his own person. He had early this year inaugurated research on the problem of how far nitrous oxide possesses specific anæsthetic properties apart from its action as an oxygen diluent in producing anoxæmia. Indeed, it was this work that led him to undertake the experiments which resulted in the fatal accident and deprived the Manchester School of an untiring and intrepid worker.

Wilson took a deep interest in the special senses and in the physiological interpretation of hypnosis. Recently he had initiated work on the retinal sensitivity to the red end of the spectrum, in the course of which he discovered some remarkable phenomena and was engaged in their elucidation during the early part of this year. Recognition of his work by American colleagues gave him great pleasure, and he did much to open up co-operation between the workers in the two countries. Besides contributing to the medical journals he took a large part in the foundation of the *British Journal of Anæsthesia*. He leaves a widow, son, and daughter to mourn his loss. F. W. L.

WE regret to announce the following deaths:

Dr. Bruce Fink, since 1906 professor of botany in Miami University, an authority on lichens, on July 10, aged sixty-five years.

Sir William Glyn-Jones, from 1919 until 1926 secretary of the Pharmaceutical Society of Great Britain, on Sept. 9, aged fifty-eight years.

Prof. R. A. Lehfeldt, professor of economics in the University of the Witwatersrand, Johannesburg, since 1917, and formerly professor of physics in East London College and also in the South African School of Mines and Technology, aged fifty-nine years.

News and Views.

THE notice of Dr. Gustave Geley's book on "Clairvoyance and Materialisation," in NATURE of July 23, seems to have been understood by some readers as signifying acceptance of the demonstrable existence of what is known as 'ectoplasm.' Mr. Campbell Swinton expressed the general scientific attitude upon this subject in a letter to NATURE of Aug. 27, and the reviewer, "W. W. L.," then explained that what were described as "facts of experience" in the notice are not necessarily scientific facts capable of being repeated and demonstrated at will. Whether statements about psychical manifestations related by uncritical observers, or similar evidence of 'ectoplasmic' structures, are accepted as 'facts' at all, depends largely upon the tendency of the listener or reader to believe or to doubt. The distinction is aptly drawn by Cowper in his poem "Conversation" in the words:

> "Can this be true?" an arch observer cries:
> "Yes" (rather moved), "I saw it with these eyes."
> "Sir! I believe it on that ground alone;
> I could not had I seen it with mine own."

ASSERTIONS as to the real nature and physical properties of 'ectoplasm' are received by most natural philosophers in the sceptical frame of mind expressed in these lines. So much attention has, however, been given to the subject in recent years that we invited Dr. Fournier d'Albe, who translated Schrenck-Notzing's "Phenomena of Materialisation" (see NATURE, Nov. 18, 1920, p. 367), to contribute an article upon the actual evidence for the existence of what has been alleged to be an incipient type of matter; and his contribution appears elsewhere in this issue. It will be seen from this article that Dr. d'Albe regards all the alleged phenomena of ectoplasm as spurious. This conclusion of a physicist who has devoted many years to psychical research and spiritualism must carry more weight in a court of natural science than that of many witnesses not possessing his experience in careful observation and cautious conclusion.

IN Heft 4, Bd. II. (1927) of the *Zeitschrift für kritischen Okkultismus*, Dr. d'Albe has supplemented his unfavourable report of the alleged mediumistic phenomena occurring with the Irish Goligher Circle which he published in 1922 (see NATURE, Feb. 3, 1923, p. 139). In the present note he comments on the inadmissible character of Dr. Crawford's interpretation of certain of the photographs obtained by the latter. In one case the supposed 'teleplastic' structure, which Dr. d'Albe suggests was probably made of chiffon, is shown in the act of partially levitating a small table. Crawford supposed that this structure emerging from the medium was pushing the table away from her; whereas Dr. d'Albe shows that the table's centre of gravity is such that the top of the three-cornered piece of chiffon is merely attached to the lower portion of the table top, and is preventing the table from toppling over instead of supporting it.

THE weather during August in Great Britain and Ireland was noteworthy on account of the excessive rainfall in all districts excepting northern Scotland, especially in the Orkneys and Shetlands, where Lerwick had less than half the normal total for August. There were two fine periods—one near the beginning of the month and the other at the end. Rain, however, occurred on most days, and thunderstorms were numerous and widespread. At many places rain fell on more than 20 days; London had 7 days free from rain and Dublin only 4. Exceptional rainfalls were recorded in many districts, particularly from Aug. 5 to Aug. 12, 3·47 in. being recorded at Glen Lyon (Invermearan) on Aug. 5, and 2·21 in. at Marchmont on Aug. 8. In Perthshire and the Lothians the rainstorms were of unusual intensity on Aug. 8 and 9. In Edinburgh the month was the wettest August since 1770, with the exception perhaps of the years 1829 and 1877. In parts of northern and north-western England and Wales, monthly rainfall totals exceeded more than twice the normal. Harrogate with 7·5 in., and Ilkley with 8·2 in., had nearly three times the normal. The week ending Aug. 20 was the wettest in most districts, and the total general rainfall in the Midland counties of England was nearly four times the normal during this period. In some parts of Northern Ireland there was a deficiency of rainfall, but at Mallarany 2·14 in. fell on Aug. 6 and 2·73 on Aug. 14. Expressed as a percentage of the normal August rainfall for the period 1881–1915, the monthly total this year for England and Wales was 155 per cent., while that for the year 1917 was 210 per cent., and for 1912, 216 per cent. It will be seen, therefore, that in the years 1912 and 1917 August was even wetter than it was this year.

ENGLAND, or that part of it lying to the south of a line joining the Bristol Channel to the Wash, experienced a period of recurring rains from Sept. 13-15. The rains were caused by two depressions, one moving south-eastwards from Ireland on Sept. 13 and the other eastwards up the English Channel a day later. The largest daily total of rain occurred between the mornings of Sept. 14 and 15. During this period Brighton had 2·52 in.; Southsea, 2·41 in.; Norwich, 2·26 in.; Winchester, 2·21 in.; Southampton, 2·01 in.; Littlehampton, 1·97 in.; Marlborough, 1·90 in.; Bognor, 1·89 in.; Yarmouth, 1·82 in.; Leafield and South Farnborough, 1·73 in.; Ventnor, 1·69 in.; Hellingly, 1·66 in.; Worthing and Bath, 1·65 in.; Bournemouth and Weymouth, 1·61 in. In the area considered, with the exception of a small narrow strip near the south-east coast, the day totals were well above an inch in most places. The intensity of the rainfall during the three rain days, Sept. 13, 14, 15, becomes more apparent when the totals for the three days are taken (the normal for the whole month of September for the period 1881–1915 is given in brackets after each station mentioned); Norwich, 3·84 in. (2·14 in.); Yarmouth, 3·73 in. (1·96 in.); Marlborough, 3·15 in. (2·10 in.); Brighton, 3·08 in. (2·05 in.); Southsea, 2·65 in. (2·17 in.); Bognor, 2·60 in. (2·07 in.); Lowestoft, 2·55 in. (1·96 in.). Many other places had 1·5 in.-2·5 in. during the period.

THE recent fatal accident at Newport, where a boy was killed when trying to listen to the broadcasting, has created a certain amount of uneasiness among users of radio apparatus. The cause of the accident, however, as shown at the inquest, is fairly obvious. An old piece of badly worn flexible cord was in use for connecting a table lamp to a lampholder by means of an adaptor. The flexible cord was wound round the knobs of two of the bedposts, and both the bedstead and the metal of the portable lamp were 'alive.' A bad shock, therefore, would be obtained by touching the metal of the bedstead and anything connected with the earth, for example, a damp wall, a metal beam, or a gas fitting. The boy had put one of the wires connected with his crystal radio set into his mouth under the impression that this would make him hear better. This wire was, as usual, connected with the earth; consequently, if he touched either the metal bedstead or the lamp he would receive a tremendous shock, which would almost certainly be fatal. Apparently the electric lighting had been installed in an unsatisfactory way, but this had little to do with the accident, which was due to the defective flexible cord. The accident has very little connexion with broadcasting receiving sets. It proves, however, the necessity of care being exercised when a receiving set is connected with the lighting mains. To get a shock it is necessary for the lighting circuit to be defectively installed and for the individual to be making good contact with the earth, standing, for example, with damp boots on a damp floor. Flexible cord for a reading lamp is often in contact with a metal bedstead. If the cord be defective the metal may become alive and serious shocks will be obtained if any one touches it and anything connected with earth; the less the resistance to earth the greater the shock. Such a state of affairs should always be remedied at once.

USING an antenna only 25 feet long which emitted waves having a frequency of 9140 kilocycles (32·8 metres), an experimental radio station in America has been heard all over the world. It has been picked up and rebroadcast in Australia. These high frequency waves have the peculiarity that they seem to skip over long distances and then for greater distances become clearly audible again. We learn from a *Daily News Bulletin* issued by Science Service, of Washington, that the engineers of the General Electric Co. at Schenectady, when experimenting with waves having a frequency of 60,000 kilocycles (5 metres), have discovered new and interesting phenomena. The preliminary tests made showed that these signals produced a shadow effect very similar to that produced by light. A small hill, for example, prevented reception in the valley beyond, although the transmitting set was fifty feet above the level of the ground. Using a power of only 60 watts, which is the power taken by an ordinary electric lamp, it was possible to pick up the signals 32 miles away. All the tests were made in the day time, but further tests with higher powers at night time are being carried out. A receiving set for these waves is being placed on the top of the Woolworth Building in New York City, which is 135 miles away. This building was selected because there is an uninterrupted line of 'vision' between it and the Schenectady sending set. The region of the spectrum between these rays and the invisible heat and infra red rays has still to be explored.

THE success of broadcasting has led many to speculate on the possibilities of other applications of Hertzian waves. Broadcasting appears to be the culmination of the development of the non-directional property of these waves. Developing the possibilities of directional transmission is attracting a great deal of attention at the present time. Dr. Dellinger, in an address printed in the *Journal of the Franklin Institute* for August of this year, makes some interesting suggestions. A fair amount of success has been attained in concentrating a beam of radio waves in one direction. With short waves, beams have been transmitted thousands of miles. These waves exhibit the phenomenon known as 'skip-distance,' that is, beyond a short distance round the transmitting station, there may be a zone of several hundred miles where the signal cannot be received. Beyond this there is a zone of a definite width where the signals can be heard quite clearly. If it were possible, therefore, to confine such waves sharply along a given line from the transmitting station, there would only be a limited area on which the signals from the transmitting station could be received. By controlling the frequency and the direction it would thus be possible theoretically to communicate exclusively with one definite locality on the earth's surface. At present this is impossible, as the beam is not sufficiently concentrated. Dr. Dellinger thinks that the idea of transmitting substantial amounts of power by radio is quite Utopian. Engineers doubtless could build a radio station which could transmit enough power to light and heat a house several miles away, but the commercial efficiency would be hopelessly low. Directive radio has proved of great value in aviation and in navigation. It appears to have a great future for these purposes. It has not been very successful so far for individual communication, and it probably will never be successful for power transmission.

AT the annual conference of the National Veterinary Medical Association, held at Torquay last week, tuberculosis was the subject of an important discussion. Major B. de Vine, of the Birmingham Veterinary Department, pointed out that large sums are being expended annually upon sanatoria, hospitals, and clinics for the treatment of human tuberculosis. These costly measures might soon become unnecessary if legislation provided powers to deal with the disease in cattle during its early stages. Prof. Hobday, Principal of the Royal Veterinary College, said that although human pulmonary tuberculosis is becoming less and less prevalent, much abdominal tuberculosis, particularly in children, remains, and is always derived from tuberculous infected milk. If, therefore, cattle could be freed from the disease, the lives of 10,000 children who die yearly of the infection might be saved. He alluded to the work of Calmette and Guerin in France, who have prepared an attenuated living culture of the tubercle bacillus as a preventive vaccine against the disease, which has been used experimentally on calves with wonderful success, and to the work of Dr. Nathan Raw in Great Britain, who is carrying out a similar method with a dead vaccine. If these measures were equally successful when applied to man, human tuberculosis might well become a thing of the past. Both Prof. Hobday and Prof. Wooldridge emphasised the importance of medical men and veterinary surgeons working in collaboration for the general good.

THE third annual Norman Lockyer lecture of the British Science Guild will be given by the Very Rev. Dean Inge on Monday afternoon, Nov. 21, in the Goldsmiths' Hall, London.

THE seventy-second annual exhibition of the Royal Photographic Society of Great Britain was opened on Sept. 12, at 35 Russell Square, W.C.1, and will continue open until Oct. 8. Admission is free. The exhibition includes this year, in addition to more than one thousand selected photographs of various subjects, many of them of great beauty and interest, a number of pieces of historic and modern scientific apparatus and photographic accessories. Different sections of the exhibition are devoted to natural history, photomicrography, radiography, astronomical and aerial photography, and technical applications, including meteorological, geological, and metallurgical photography and useful photographic devices. A special number of the *Photographic Journal* (price 1*s*. 9*d*., post free) contains authoritative articles on different sections of the exhibition and many reproductions of pictures, including twenty from the natural history section.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A demonstrator in mathematics in the Royal College of Science —The Secretary, Imperial College of Science and Technology, South Kensington, S.W.7 (Sept. 27). An open research fellowship in the department of Coal Gas and Fuel Industries of Leeds University—The Clerk to the Senate, The University, Leeds (Sept. 30). A lecturer in dental anatomy (including comparative anatomy), physiology, and histology at the Dental School, Cairo—The Director of the Dental School, Cairo (Sept. 30). A second demonstrator (medically qualified) for the department of physiology—The School Secretary, Middlesex Hospital Medical School, Mortimer Street, W.1 (Oct. 8). An assistant master to teach biology—The Secretary, City of London School, Victoria Embankment, E.C.4 (Oct. 10). A biologist at the Dove Marine Laboratory, Cullercoats—The Registrar, Armstrong College, Newcastle-upon-Tyne (Oct. 13). A district lecturer in agriculture and an assistant lecturer in dairy husbandry in the University of Leeds —The Registrar, The University, Leeds (Oct. 15).

Our Astronomical Column.

RECENT SUNSPOTS.—The large sunspot, to which attention was directed in NATURE of Aug. 27, p. 311, was seen again as it crossed the disc on Sept. 3-16. Although accompanied by a considerable area of bright faculæ, the spot itself had diminished to about one-fifth of the area it presented during its first appearance. It may be noted that the magnetograph traces were somewhat disturbed between Sept. 7 and 15, more particularly on Sept. 9 and 10. On Sept. 10, at $21\frac{1}{2}$ hr., a wave was recorded by the horizontal force magnetograph at Abinger, Surrey, which represented a change in H.F. of 250 γ within 20 minutes. The sunspot already referred to was on the central meridian on Sept. 10·1.

In brief intervals of sunshine on Sept. 14, a naked-eye group was detected near the central meridian. A telescopic view showed a large stream (two large spots with smaller companions between them) which had grown from a few tiny spots photographed near the sun's east limb on Sept. 9. North of this group, another of about half the size was also developing on Sept. 14 and was still increasing when observed again on Sept. 17. These two groups may be looked for at their return to the sun's east limb on Oct. 4 at position angles 135° and 127° respectively from the north point of the image. The larger of these two groups is added to the list of naked-eye spots as follows :

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area on Sept. 14.
9	Sept. 9-20	Sept. 14·3	19° S.	1/800 of hemisphere.

THE DAYLIGHT FIREBALL OF SEPT. 7.—Mr. W. F. Denning writes : "This object appears to have attracted a great number of spectators. Some excellent descriptions have been received of its path, direction, and aspect. Observers agree in stating that it pursued a long, horizontal flight from east to west, and that it exhibited a bright bluish-green colour. Reports have come from the south of England, France, and Jersey. The following results have been obtained from a comparison of the observational data :

Mean height	53 miles.
Length of path . . .	295 „
Velocity per second . . .	25 „
Radiant point	347° + 1°

Appeared over Alençon, France.
Disappeared over Ushant I., west of Brest.

The radiant point was rising on the eastern horizon and the meteor traversed its extensive course with little change in its height except perhaps near the end of its trajectory, when it apparently exhibited an inclination earthwards."

A SPECTROSCOPIC DETERMINATION OF THE ABERRATION CONSTANT.—In a paper on this subject in *Mon. Not. R.A.S.* for May last, Dr. H. Spencer Jones recalls that Sir David Gill's first thought when Mr. Frank McClean offered the Victoria telescope to the Cape Observatory was that it would give a determination of the solar parallax by the annual changes in the radial velocities of the stars. Such a determination was completed in 1908 and gave $8''{\cdot}800 \pm 0''{\cdot}006$ for the parallax. A new determination has been made from subsequent plates taken between 1908 and 1926. Slightly different values are obtained according to the manner of treating stars with variable radial velocity, but the extreme range is only $0''{\cdot}003$. The adopted result is $8''{\cdot}800 \pm 0''{\cdot}004$ using the same terrestrial radius and velocity of light as in 1908, but on substituting Hayford's spheroid and Michelson's new value of the velocity of light, it becomes $8''{\cdot}803$. The corresponding value of the constant of aberration is $20''{\cdot}475 \pm 0''{\cdot}010$. The agreement of the two independent determinations is very satisfactory.

METEOR CRATER, ARIZONA.—This remarkable formation, recalling a lunar crater, was formerly known as Coon Butte, and lively discussion took place on its origin ; the meteoritic origin was disputed by many experts, including the late Sir Archibald Geikie. Evidence in its favour has, however, accumulated, and it is now so widely accepted in America that the name has been altered to Meteor Crater. The *Scientific American* for September contains an interesting article on it by D. Moreau Barringer, junr. Some of his principal conclusions are as follows ; the amount of rock crushed and displaced was 350,000,000 tons. It is estimated that this would give a mass of 10,000,000 tons to the falling meteor ; if in one piece, this would mean a diameter of 400 feet, but reasons are given for believing it to have come as a swarm of smaller masses. It was at first assumed that the fall was vertical, since the crater is round ; it is now thought to have been oblique, and in fact a drill hole on one side of the crater revealed numerous meteoric masses ; this search is being continued. The date of the fall is put between 700 and 5000 years ago. A tree growing on the rim of the crater, with some 700 rings, gave the lower limit ; the other was fixed by the amount of erosion. The meteors must have been much more concentrated than in the ordinary meteor shower ; we may conjecture that it was the actual head of a comet that struck the earth. The small stellar nucleus of Pons Winnecke's comet, seen at its recent approach, suggested considerable concentration, though not so much as in this case.

Meteor Crater has done a good deal to revive the meteoritic theory of the lunar craters ; their resemblance is so close that a similar origin in each case is strongly suggested.

Research Items.

THE LIFE-HISTORY OF THE NORTH SEA PLAICE.—The Ministry of Agriculture and Fisheries has recently issued *Fisheries Notice*, No. 12, which sets out in non-technical language our present knowledge concerning the life-history of the plaice in the North Sea, and of the effect of fishing upon the stock of plaice. Within the compass of an eight-page pamphlet, the author has succeeded in presenting an admirable summary, not only of the known facts, but also of the methods by which the facts have been established. Section 4 deals with the all-important question of the extent to which man takes toll of the quantities of plaice in the North Sea. The results of marking experiments have shown that out of 1000 living plaice marked and released, 250-300 are recaptured inside a year from the time of marking. It has been estimated, on the basis of all the English marking experiments carried out before the War, that if we start with 1000 male plaice and 1000 female plaice, about 6-7½ inches long and 2-3 years old, their numbers will decrease in succeeding years as follows:

At the end of the first year,	788 males and	844 females.
" " second	" 444 "	" 573 "
" " third	" 236 "	" 329 "
" " fourth	" 125 "	" 189 "

Thus, at the end of four years, only about one plaice in seven is left. The careful study of market statistics of commercial landings of plaice in the years before and after the War provides an object-lesson on a big scale of how fishing affects the stock of fish. If too many fish are left on the ground owing to there not being enough fishing, the ground gets crowded and the fish do not grow so fast—this actually happened during the War. So, too, when a new ground is fished for the first time, the fish caught are generally large and thin and old; but as this old accumulated stock is reduced by fishing, the survivors begin to thrive and grow faster, so that fishing improves the growth-rate of the individual fish. But if the fishery is continued on too big a scale, the fish, fast-growing though they may be, do not grow up in sufficient numbers, with the result that the medium and large fish becomes very scarce.

FRESHWATER EELS IN THE PACIFIC AREA.—In order to complete his well-known work on the distribution and biology of the freshwater eels, Dr. Johs. Schmidt last year undertook a voyage to the Pacific to study the tropical species in their native habitat. In an article entitled " Les Anguilles de Tahiti " (*La Nature*, No. 2765, July 15) he gives a résumé of his investigations, and the new methods he has employed in the identification of species, illustrated by excellent diagrams and photographs. Tahiti was chosen as a centre largely because Darwin's account of the island in his " Journal of a Naturalist during a Voyage round the World in H.M.S. *Beagle*," showed its suitability for the purpose, and also because the three species of eels which occur there in great abundance are widely distributed in the tropical Pacific. The species are found in very different conditions, their colour harmonising with their surroundings. *Anguilla obscura*, dark and unspotted, lives in the mud and stagnant waters of shallow ponds; the spotted *A. megastoma* and *A. mauritiana*, both of which attain a great size, are found on the pebble and gravel beds of the rivers, the first in the rapid streams of the mountain districts and the other in the rivers nearer the sea. Dr. Schmidt refers to the numerous native legends connected with the eel, and especially to the story of a giant race of eared eels peculiar to Lake Vaihiria, to which his attention was first directed by Sir John Murray. This legend has proved easy of explanation. The so-called 'ears' have nothing to do with the auditory organs, but are simply the two pectoral fins just behind the head, one on each side, small and not easily seen in the young animal, but deeply coloured and very noticeable in the adult. The two specimens collected in Lake Vaihiria by the *Challenger* Expedition, and now in the British Museum, were examined, and proved to be nothing more than very large examples of *A. megastoma* and *A. mauritiana*. With regard to the migrations of the Pacific eels, Dr. Schmidt states that it is not possible to determine their breeding-places with any exactitude unless a research vessel equipped for the purpose is employed. He was able, however, to make a series of observations on one of the species, *A. mauritiana*, from which he concludes that this species at least differs very greatly from the European eel in its breeding habits, and that it forms two distinct races, each with a different centre of reproduction.

DAMAGE BY MARINE CRUSTACEANS.—A fresh example of serious damage done to submarine timbers by crustaceans has been described by Dr. James Ritchie (*Scottish Naturalist*, 1927, p. 37). Dock-gates of yellow pine and greenheart were placed in Methil Docks, on the Firth of Forth, in 1897, and by the autumn of 1925 they had become so dilapidated that they were removed and replaced by dock-gates of steel. The damage was entirely due to the boring of *Limnoria lignorum* and *Chelura terebrans*, small isopod and amphipod crustaceans. Of these, Chelura was the most numerous and most serious pest, and in typical portions of the damaged timbers it had caused the removal of as much as 13 inches of wood, the rate of damage averaging more than one-third of an inch a year. Chelura has not hitherto been found in the Forth estuary, although in association with Limnoria it has a world-wide distribution, and the suggestion is made that its presence at Methil may be due to a relatively recent importation in timber from another port, and that there is a possibility of a colonisation of the Firth of Forth from the Methil centre by this destructive pest.

NORTHERN CTENOPHORA.—Dr. Thilo Krumbach, in describing the Ctenophora of the North Sea and Baltic ("Die Tierwelt der Nord- und Ostsee," Lieferung 7, Teil 3, f 1. Leipzig: Academische Verlagsgesellschaft m.b.H., 1927), gives a very able account of the group, emphasising the general biology although in no wise neglecting the morphology. Ctenophores have now a peculiar significance as they are known to be such carnivorous feeders that they must be regarded as serious enemies to young fishes, both directly by eating them and indirectly by swallowing in huge quantities the food which the fishes themselves might have eaten. They are thus not only interesting in themselves, but also must be taken into account by all fisheries workers. Beroë alone may be regarded as a friend as it devours other ctenophores. The author only allows three species in the area covered:—*Pleurobrachia pileus*, *Bolinopsis infundibulum*, and *Beroë cucumis*, all well known; occasional so-called closely related species recorded by other zoologists being included in these. As visitors he records *Mertensia ovum* from the Arctic regions and *Cestum veneris* from the warmer seas. This arrangement is satisfactory and simple, for it seems right to bring together such evidently closely related forms which, for example, are described as separate species from the Mediterranean and the present area. *Bolinopsis infundibulum* and *B. hydatina* are thus regarded as synonymous, an arrangement with which we heartily agree, as the chief difference is in the windings of the lobe canals, which certainly in the British form can vary to a large extent according to age.

MARINE PLANKTON IN RELATION TO PHYSICAL AND CHEMICAL FACTORS.—Miss S. M. Marshall and Mr. A. P. Orr, working from the Marine Station, Millport, have made a careful and elaborate study of plankton production in the Clyde area, and particularly in Loch Striven, which was visited weekly for the greater part of 1926. The results are given in *Jour. Marine Biol. Assoc.*, **14**, 4, May 1927, pp. 837-868. Simultaneous observations were made on the quantity and character of the plankton, dissolved oxygen saturation, phosphates, salinity, *p*H, nitrates, and nitrites ; meteorological conditions were also taken into account. A close relation was found to exist, at least for the surface layers, between the quantity of diatoms and the changes in *p*H, dissolved oxygen and phosphates. The usual spring maximum of diatoms occurs, but there are others later in the year, more numerous than in the open sea, due apparently to the more frequent mixing of the water in the Loch. The conditions leading up to the spring maximum are discussed, and the conclusion reached that neither amount of sunlight nor rise of temperature is the decisive factor. The paper contains much valuable data, and is well illustrated by some twenty graphs ; it is important particularly in relation to the work of Atkins in England and Gran in Norway.

TEST FOR INCIPIENT PUTREFACTION OF MEAT.—Fresh meat is such an important article of diet that some rapid test that would indicate whether butcher's meat is strictly fresh or otherwise is very desirable, and many investigations have been made in order to devise one. Mr. Ralph H. Weaver has recently published the results of investigations into this question (*Technical Bull.*, No. 79, Agricultural Experiment Station, Michigan State College). Fresh Hamburger steak was employed, and Mr. Weaver finds that neither the number nor the characters of the micro-organisms present prove a sure guide. Finally, a test was devised which has given promising results. One gram of the meat is placed in a test-tube with 10 c.c. of a standard meat broth. A strip of lead acetate paper is suspended in the tube, which is then incubated in a partial vacuum at 37° C. and the time of appearance of blackening of the acetate paper, indicating the presence of hydrogen sulphide, is noted. Good meat gave a positive result in 7-10 hours, stale meat in 2-5 hours.

CRETACEOUS MOLLUSCA FROM JAPAN.—A narrow belt of Cretaceous beds, known as the Sanchû Graben, occurs faulted down between Palæzoic rocks in the main island of Japan to the north-west of Tokyo. These beds, representing several stages of the Lower Cretaceous, have been subdivided into five groups, and a recent paper by H. Yabe, T. Nagao, and S. Shimizu deals with the fossil Mollusca of the upper three (*Science Repts.*, *Tôhoku Imp. Univ.*, Sendai, Ser. 2, vol. 9, No. 2). Eleven species of Ammonites, six of Gastropoda, and twenty-eight species with two varieties of Pelecypoda are described, a large number as new, and well illustrated.

THE GEOLOGY OF ST. HELENA.—The full report of Prof. R. A. Daly's recent investigation of St. Helena has now been published in the *Proc. Amer. Acad. Arts and Sci.*, vol. 62 (2), 1927, and is a geological document of great importance and interest, adding as it does to our still meagre knowledge of the deep-sea islands. The emerged part of the island is a composite volcanic structure made up of two domes, each of which has been built up by lavas from a network of fissures. The larger dome has been punctured by a dozen pipes of phonolite and alkali-trachyte. Basalt is otherwise by far the commonest rock. Unlike Ascension, St. Helena provides no evidence of a continental type of foundation. From the point of view of isostasy the island is remarkable, for despite the fact that it appears to be largely uncompensated and therefore represents a heavy load carried by the earth's crust, it shows no sign of having subsided during a period of the order of a million years. Stability in recent times is proved by the presence of the five-metre wave-cut bench which here, and in many other parts of the world, indicates a eustatic fall of sea-level that probably took place some three thousand years ago. No new facts bearing on the age of the island have been discovered, but the geological history is in accordance with Wallace's deduction from the fauna and flora that the island dates back to at least the Miocene.

THE ORIGIN OF ANORTHOSITE.—A noteworthy contribution to the evidence bearing on the still unsolved problem of the origin of anorthosites is made by J. B. Mawdsley in his report on the St. Urbain area of Quebec (*Mem. Geol. Survey Canada*, 152, 1927). The mass described has a smoothly ovoid form against a series of granites and diorites. The latter overlie the anorthosite complex and in places hold blocks of basic anorthosite. Within the anorthosite body itself more albitic phases cut and enclose blocks of an earlier and more anorthitic phase. All the rocks contain fragments of large andesine crystals, suggesting that the granite-diorite series and the anorthosites are closely related. Foliation in both series, in a narrow zone following the main contact, further suggests relative movement between them while each was still in a condition in which flowage was possible. Mr. Mawdsley suggests that this puzzling association implies that at least the later andesine-anorthosite advanced into its present position as a liquid. This conclusion is at variance with the well-known hypothesis due to Bowen, according to which anorthosites have been formed *in situ* by the collection of felspar crystals from a gabbroid magma, and not from a magma of their own composition. If sound in principle, as it appears to be, Bowen's views must be modified to allow for subsequent flowage of the crystal aggregate on a scale, and with an ease of movement, not previously thought to be necessary.

THE EVAPORATION OF WATER.—Volume 4 of the *Japanese Journal of Astronomy and Geophysics* contains a contribution on this subject by Mr. T. Hirata of the Forestry Experimental Station. His evaporimeter was a polished copper pot 20 cm. in diameter and 10 cm. deep filled with water to a depth of 2 cm. and placed on a sodded mound 20 cm. high. The height of the water was observed each day at 10 A.M. (This appears to be the usual instrument of the Japanese meteorological service.) The observations are consistent with the relation:—depth of water evaporated $= a(V - v)\sqrt{W}$ where a is a constant, V the saturation vapour pressure at the temperature of the surface water, v the actual vapour pressure in the air above, and W is the velocity of the wind over the surface. The value of a depends on the amount of sunshine and the heat conducted to the pot by its surroundings. It is reduced by an increase in the size of the pot. The effect of sunshine diminishes with altitude of the surface above sea-level up to 700 metres and then becomes nearly independent of altitude.

LIGHTING IN FACTORIES.—In the *Journal of the National Institute of Industrial Psychology* (vol. 3, No. 7) is an article on lighting in the factory by Mr. A. M. Hudson. He maintains that although improvements in lighting have been made in recent years, yet many factories still fail to make the best use of daylight, and that artificial lighting is generally below the standards that modern research has shown to be physiologically desirable. He discusses the effect of dirty windows—unfortunately far too common—the relation of under illumination and eye-strain, the effects of inadequate artificial light in reducing output and increasing strain. He points out the importance of a study of glare, concerning which there is much work to be done. He pleads for a much greater use of photometers in factories, particularly in fine-process and inspection departments. The subject is one of extreme importance, and it seems clear that while there is room for much more scientific work on the problems of lighting, there is also room for a wider application of what is already known.

ACTIVE NITROGEN.—The August number of the *Physical Review* contains several papers on active nitrogen. In one, P. A. Constantinides has described experiments performed by him under the direction of Prof. Dempster, from which he concludes that it is not ionised, and suggests that its essential constituent is an excited diatomic nitrogen molecule, with an energy of activation equivalent to about ten volts. In a second communication, E. O. Hulburt and W. H. Crew state, *inter alia*, that active nitrogen can be formed under conditions in which it is unlikely that there is any considerable dissociation into atoms, whilst in two further papers, Prof. Mulliken and some collaborators have given a detailed analysis of the β bands of nitric oxide. These were produced in the nitrogen afterglow, and photographed in the second order of a 21-ft. Rowland concave grating. The mass of information which they have obtained is important both for the light which it throws on the structure of nitric oxide, and also for the test which it affords of theoretical predictions about the nature and probability of the various quantum transitions which occur in diatomic molecules.

CHROMIUM-PLATING.—The *Chemiker-Zeitung* of Aug. 10 contains an account of recent developments in the art of chromium-plating, which has hitherto been attended with serious difficulties. Not only has it been possible, by the use of suitable electrolytes, to reduce both the quantity and the density of the current to reasonable dimensions, but also the disturbing effect of the hydrogen evolved at the cathode has been recently eliminated, without the application of heat, by a new process patented by Dr. von Bosse. It has been ascertained that the amount of hydrogen occluded by the chromium increases very considerably with increasing current-density and frequently cracking and scaling of the deposit takes place. The chromium-hydrogen alloy thus produced can, however, be broken down by the application of a high-tension alternating current in a highly evacuated chamber, when light is emitted and in the course of a few minutes the hydrogen is completely eliminated as gas. The end of the process can be recognised by observing the change which takes place in the character of the light emitted. The necessary apparatus is supplied by the firm Langbein-Pfanhauser of Leipzig and Vienna.

ADSORPTION ON CHARCOAL.—Interesting experiments on the adsorption of acids from solution by ash-free charcoal are described by E. J. Miller and S. L. Bandemer in the July number of the *Journal of the American Chemical Society*. The results show that acids adsorbed on charcoal are incapable of inverting sucrose in solution. It is suggested that the adsorbed acids are in an undissociated state, that (contrary to existing ideas) the adsorption of acids does not imply a high concentration of hydrogen ions around the adsorbent, and that some theories of adsorption and catalysis are seriously affected by the results.

THE ATOMIC WEIGHT OF SCANDIUM.—N. H. Smith describes experiments in the July number of the *Journal of the American Chemical Society* on the atomic weight of scandium. Anhydrous scandium chloride ($ScCl_3$) was prepared by the action of pure carbon tetrachloride on the oxide at 750°-800°. The material used was pure, and the corrections necessary in Hönigschmid's previous determinations, made in 1919 with scandium bromide contaminated with small quantities of scandium oxide formed by the action of the bromide on quartz apparatus, were avoided. A solution of the chloride was almost exactly precipitated with silver nitrate solution from a weighed amount of pure silver, and the slight excess of halogen or silver determined by the nephelometer. The atomic weights of chlorine and silver were assumed as 35·457 and 107·880, and the average of nine analyses gave Sc = 45·160, in fair agreement with Hönigschmid's value 45·099 (earlier values ranged from 43·90 to 45·23). The origin of the material used by Smith is not stated.

THE CONSTITUTION OF THE PROTEINS.—The behaviour of protoplasm seems very closely bound up with the physical and chemical properties of the proteins, of which protoplasm is largely composed; and some elucidation of the chemical structure of the protein molecule will go far towards clearing up some of the problems underlying the metabolic activities of living cells. The mechanism of heredity depending, so far as we can judge, on the specificity of living matter, may possibly also be in some measure explained by structural variations displayed by the proteins. The polypeptide theory of the constitution of the proteins, propounded by Emil Fischer, has long held the field. He conceived proteins as gigantic molecules consisting essentially of several amino acids joined together by means of the peptide linkage —CO—NH—, thus forming a considerably long chain. In *Acta Phytochimica* (vol. 2, No. 4, Dec. 1926) Prof. Keita Shibata, of the Imperial University of Tokyo, supports the view that the molecules of amino acid anhydrides, which are mostly derivatives of diketopiperazines, are bound together by a force other than ordinary valency, giving rise to a colloidmicell of definite magnitude, the protein molecule. Apparently this new idea suggested itself to investigators through analogy to the now prevalent and well-founded conception of the constitution of the polysaccharides, such as starch, cellulose, glycogen, inulin, which may be regarded as association or polymerisation products of the ground bodies, *i.e.* anhydrides of simple sugars. The theory of the anhydridic structure of protein is now receiving support from various sides. Some of the outstanding evidence from recent experimental work include: (*a*) Its characteristic colour reaction towards soda-alkaline solution of picric acid (Abderhalden); (*b*) its oxidation and reduction products (Abderhalden); (*c*) its röntgenographic properties and the determinations of its molecular weight (Herzog, Troensegaard); (*d*) the action of hypobromite on it (Goldschmidt); and (*e*) its racemisation in alkaline media (Levene).

The Morphology of the Insect Thorax.

By Dr. A. D. IMMS, Rothamsted Experimental Station.

MUCH has been written relative to the morphology of the insect thorax and its appendages, but few of the contributions of recent years have led to any modification of the present-day conceptions of that subject. The whole problem, however, has been re-investigated in a comprehensive memoir by Dr. R. E. Snodgrass,[1] whose work is characterised by clarity of deduction and an honest attempt to place the subject on a better foundation. In discussing the general problem of segmentation, he takes us back to the primitive soft-bodied ancestors of the arthropods and points out that in such animals the grooves limiting the body-segments coincided with the lines of attachments of the longitudinal muscles. This same condition is still met with in many insect larvæ. Adult arthropods, on the other hand, with their hard exoskeletal body-plates, have acquired a secondary segmentation. This has been achieved by the development of a membranous unchitinised zone just in front of each muscle-bearing intersegmental groove. The function of this flexible area is to admit of freedom of movement and telescoping of the hardened resistent segments. Such membranous areas are commonly regarded as truly intersegmental in position, but, as Janet was the first to demonstrate, the term intersegmental membrane, although justified from its function, is morphologically inexact. Flexibility could not well be at the original intersegmental grooves because the muscles are here attached and demand firm support. The dorsal and ventral regions of these grooves have become converted into internal ridges, which have become fused with the skeletal plates immediately behind them as is shown in the accompanying illustration (Fig. 1).

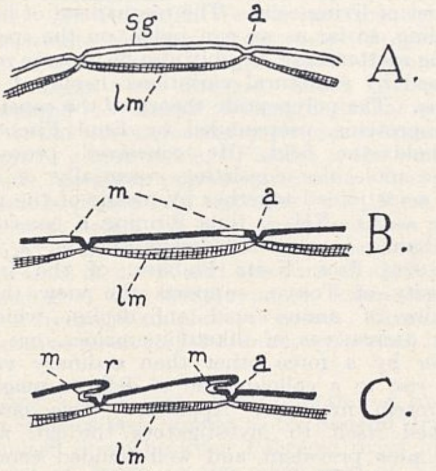


FIG. 1.—Diagram of lengthwise section of portion of a segmented animal (adapted from Snodgrass).

A. Primary segmentation of soft-bodied animal with segments marked by intersegmental grooves.
B. Secondary segmentation of an insect with chitinised body-wall and membrane developed in front of the primitive intersegmental grooves.
C. Secondary segmentation accompanied by telescoping of the segments, each segmental plate ending in a posterior reduplication.
a, primitive intersegmental groove; *lm*, longitudinal segmental muscle; *m*, membrane; *r*, reduplication; *sg*, segment.

In discussing the morphology of the primitive arthropod limb, Dr. Snodgrass takes as his starting-point the hypothetical generalised appendage, which includes a basal region or protopodite and two distal rami—the exopodite and the endopodite. Of the three segments into which the protopodite is divided, the first (pleuropodite or subcoxa), he maintains, has lost its power of movement in insects. As the evolving limb came to demand more rigid support, the subcoxa became flattened out and embedded in the wall of its segment as the forerunner of the pleuron. The coxa (coxopodite) was thus forced to replace the subcoxa as the functional base of the limb in all insects. The hypothetical biramous appendage does not, unquestionably, appear to have been retained in any insect. The only fact that can be construed as evidence of this feature, is the presence of styli on the coxæ of the middle and hind legs of Machilis and related genera. It is claimed by many morphologists that these styli are exopodites, whereas a true exopodite is borne on the basipodite—a segment either lacking in most insects or included in the trochanter. Dr. Snodgrass maintains that it still remains to be demonstrated that these organs are other than merely secondary structures. His discussion of the hypothetical evolution of the pleuron is too lengthy to be detailed here, but, in a few words, it may be said that according to the view upheld in his memoir, the original subcoxa became reduced to a basal eupleuron, from which the epimeron and episternum were later derived, and a distal trochantin in immediate contact with the coxa.

With regard to the leg-segments, reference is made to the double trochanter so frequent in the parasitic Hymenoptera. The proximal segment of this region, Dr. Snodgrass believes, is the true trochanter, and he bases this conclusion on a study of the reductor femoris muscle. The second trochanter is merely a basal area of the femur, separated off from the main portion of that segment by means of a secondary suture and ridge. In the nymphs and adults of the Odonata the structural relations of the double trochanter appear to be quite different, and Dr. Snodgrass brings forward evidence for concluding that, in this order of insects, the two trochanters represent two primary leg segments, as has already been maintained by Verhoeff. In most insects the two trochanteral segments have fused into a single piece.

With regard to the tarsus, this region consists of a single segment in holometabolous larvæ as it does in adult Protura, which segment is to be regarded as the propodite of the generalised arthropod limb. In most insects the tarsi are divided usually into five subsegments, and these latter appear to be subdivisions of the single primitive shaft. They have no articular hinges with each other and are never provided with their own special muscles—facts which evidence that these divisions are not true segments. The tarsus is moved, as a whole, by muscles inserted into its base, or by tension of the claw muscles on the tendon which traverses it. The region at the extremity of the tarsus—the 'foot' in usual terminology—consists of a group of organs which were designated the prætarsus by de Meijere. In its simplest form it consists of a median claw-like segment: in this form it occurs in the Protura, in certain Collembola, in caterpillars, sawfly larvæ, and in most beetle larvæ.

Dr. Snodgrass follows de Meijere and regards the prætarsus not as an outgrowth of the last tarsal 'segment,' but as a development of the dactylopodite

[1] *Smithsonian Miscellaneous Collections*, vol. 80, No. 1: Morphology and Mechanism of the Insect Thorax. By R. E. Snodgrass. (Publication 2915.) Pp. 108. (Washington, D.C.: Smithsonian Institution.)

of the generalised arthropod limb. In the Lepismidæ each prætarsus bears three claws and it appears probable that the smaller median claw is the homologue of the original dactylopodite and that the lateral claws of these, and most other adult insects, are subsequent developments. According to de Meijere, the paired claws are outgrowths from the base of the original dactylopodite. One or other of these, on the other hand, may be secondarily suppressed, as in many of the Anoplura (*sensu lat.*).

In addition to those features already alluded to, this memoir discusses the tergal and sternal sclerites, the origin of wings, the flight muscles, position of the spiracles, etc. These and sundry other problems must be left to the reader who desires to consult this suggestive work first hand.

Forestry Research in South Africa.

THE research work which is being carried out by Dr. John Phillips at the Forest Research Station, Deepwalls, Knysna, in South Africa, is of considerable interest to practical foresters, whilst at the same time being of botanical value. Dr. Phillips graduated B.Sc. in forestry in 1922, and his work in South Africa has recently received the recognition of the degree of D.Sc. from the University of Edinburgh. Two recent papers published in the *South African Journal of Science* for December last, indicate the lines upon which Dr. Phillips is working.

The first deals with the ecology and sylviculture of the monotypic genus Virgilia Lamk, an important tree of seral forest at the Knysna. The tree is said to be of use in sylviculture, affording excellent cover to the seedlings of other forest species. It is readily raised from seed and transplants easily. The Virgilia is one of the fastest-growing native trees at the Knysna, natural stands often requiring thinning. In spite of these important faculties its distribution is restricted, as is that of others of the curious indigenous species of these South African forests. The species is light-demanding, developing best on soils of medium hollard, being susceptible to frost, but capable of resisting high surface-soil temperatures in its seedling stages, a characteristic of considerable importance.

After dealing with the botanical characters of Virgilia, the author discusses the subject of its restricted range. Schonland considered it to be a relict; to this the author agrees, "if 'relict' implies that the species is an old but not an effete one." The study of the species has shown that it is a virile one, but owing to its poor means of dispersal, must have taken a considerable time to extend its limits. Dr. Phillips expresses the view that the species, being evolved within the south-western region, and dependent upon a medium hollard and the absence of frost, has been unable to invade areas surrounding that region. Poor means of dispersal, need of the seed to be stimulated before it will germinate, and dependence upon a particular strain of *Pseudomonus radicicola* are other factors to which he ascribes the restricted range.

Elsewhere in the same journal Dr. Phillips deals with the propagation of 'stinkwood' (*Ocotea bullata* E. Meyer) by vegetative means. So early as the seventies of last century Captain C. Harison, first Conservator of Forests of the Knysna-Humansdorp Forests, endeavoured to propagate this species by cuttings. The attempt was unsuccessful. In 1882 the Comte de Vasselo de Regne, Superintendent of Woods and Forests, considered that the stinkwood could reproduce itself like the poplar by cuttings, and recommended that experiments should be undertaken on the lines he recommended. These efforts were also unsuccessful, as were those of D. E. Hutchins, Conservator of Forests from 1888 until 1892. Other attempts carried out by forest officers from that date to 1922 proved abortive.

The experiments detailed in the present paper were commenced in the latter year, and so far as the work has gone to the present date, Dr. Phillips is forced to the conclusion that the propagation of the Ocotea by vegetative means is not possible on a practical scale; but he invites criticism and suggestions from fellow-workers in this field of research. The continued experimentation under controlled conditions has shown that *Ocotea bullata* can be made to form callus and roots from cuttings, leaves, eyes, root-cuttings, and layers, but that the percentage of success obtained is insignificant. Furthermore, it is clear that establishment of the callussed and rooted portions is a matter of great difficulty. The principle reasons for the poor response of the plant are to be found in the delicate nature of the shoots and in the occurrence of the strongly lignified stereome and the U-shaped stone cells in the pericycle.

The practical value of the research work here undertaken will be obvious to the forest officer; for the effort to propagate the species has been until lately the subject of more or less rough experiments carried out for more than half a century.

In a third paper published in the same journal, Dr. Phillips gives a summary of preliminary studies on the general biology of the flowers, fruits, and young regeneration of sixty-three of the more important trees and shrubs occurring in the Knysna forest. This little handbook should prove of the greatest value to forest officers both from the botanical point of view and that of the sylvicultural. In support of the latter the following may be quoted:

"A point of the very greatest interest, but not at all easy to explain, is the truly excellent manner in which the yellow-wood (*Podocarpus Thumbergii* Hook) regenerates. . . . It might be suggested that the Knysna forests were in the past ages pure *Podocarpus* communities, and that these Gymnosperms are being slowly ousted by Phanerogamic trees; this supposition, however, is certainly not supported by the present efficient manner in which *P. Thunbergii* (and in places *P. elongata* L'Herit. as well) regenerates. Perhaps the regeneration process, though still so excellent, has, with the centuries, gradually decreased in efficiency, and possibly the incoming hordes of flowering trees and shrubs are slowly but surely gaining the upper hand."

The author deals with the botanical characteristics of the sixty-three species on the usual lines. He then summarises the dispersal of the fruits and seeds under the headings of wind, water, birds, mammals, man, and 'various,' and discusses generally the question of dispersal—an important matter from the forestry point of view. In one of his tables Dr. Phillips summarises information relating to viability, chief agents of mortality, and average period required for germination of seeds. The author's results were based on "phenological studies of definitely marked trees over a period of about three and a half years," study of the structure of fruits and flowers, pollination experiments under natural and under controlled conditions, observations and experiments connected with the dispersal of fruits and seeds, and nursery and quadrate germination experiments.

These papers place Dr. Phillips in the forefront amongst the younger generation of workers in this type of research work.

University and Educational Intelligence.

BRISTOL.—The new Henry Herbert Wills Physics Laboratory, now practically completed, will be opened by Sir Ernest Rutherford on Oct. 21. At the conclusion of the ceremony and inspection of the Laboratory, a Degree Congregation will be held at which the degree of Doctor of Science *honoris causa* will be conferred upon the following: Prof. Max Born (Göttingen), Sir William Bragg (Royal Institution, London), Prof. A. S. Eddington (Cambridge), Prof. Alfred Fowler (Imperial College of Science and Technology, London), Prof. P. Langevin (Paris), and Sir Ernest Rutherford (Cambridge).

DURHAM.—Mr. R. B. Green, lecturer in anatomy at the College of Medicine, Newcastle-on-Tyne, for the past five years, and author of a "Manual of Human Anatomy for Dental Students," has been elected professor of anatomy in succession to Prof. R. Howden.

THE Department of the Interior, Bureau of Education, U.S.A., has issued a report (*Bull.*, 1927, No. 14) on "Physical Education in American Colleges and Universities," by Marie M. Ready. The information has been collected from 182 institutions. Of these, 129 require a medical examination at entrance, 65 include physical efficiency tests as a part of it, and 79 keep continuous records of the students' physical condition during their entire college course. Corrective gymnastics are prescribed and required of those needing them by 70 per cent. of the institutions. Ability to pass certain tests in swimming is required by 48 institutions for graduation. A large number of institutions require a certain amount of physical education as a part of every undergraduate course leading to graduation; courses on hygiene are also required by many. Vaccination for small pox is made a definite requirement by 58, and for typhoid fever by 13 institutions.

THE Pan-Pacific Conference of Education, Rehabilitation, Reclamation, and Recreation, held at Honolulu last April, has a certain significance as a new grouping for purposes of international intellectual co-operation. The conference was called by the President of the United States and presided over by the U.S. Secretary of the Interior. The other countries represented were: Great Britain, Australia, Fiji Islands and British Western Pacific, New Zealand, France, Japan, Chile, Peru, Mexico, Colombia, and Nicaragua. The more important of the discussions were those on education, and these led up to a series of important resolutions, among which were the following: It is desirable to promote interchange of educational ideas and the establishment of educational centres of information through such means as visits of eminent professors, creation of university information bureaux, uniformity in educational terminology, and, as a step to that end, publication by the Bureau of Education, Washington, of a glossary of current educational terms, appointment of educational attachés to embassies and legations, and of a government Pan-Pacific committee on museum co-operation; vocational education of less than college grade should be included in the public school programme for the benefit of those who do not go to college; the extension of parental education by means of health centres, visiting nurses, correspondence courses, etc., should be encouraged, systematic co-ordination of the home with the school programme should be effected, and courses in maternal and child hygiene should be introduced so far as possible into the curriculum of secondary schools. A summary report of the proceedings appears in *School Life* (Bureau of Education, Washington) for June 1927.

Calendar of Discovery and Invention.

September 25, 1845.—The first successful electric clock to be used in England was patented by Alexander Bain on Sept. 25, 1845. The principle of this early clock is still used in electric clocks of the present time. The pendulum carried an electro-magnet which swung between two permanent magnets arranged with their N poles facing one another. The pendulum itself controlled the current which magnetised and demagnetised the electro-magnet in such a way that it was alternately attracted and repelled by the permanent magnets.

September 26, 1721.—One of the earliest English patents for a pump was granted to John Orlebar on Sept. 26, 1721. The inventor claimed "an entire new method of raising water by a much deeper, extensive and more expeditious way of sucking and forcing it than was ever yet or could be effected by the leaver and crank." The method, however, does not appear to have been sufficiently expeditious to have been much used.

September 27, 1825.—The commencement of the railway era may be said to date from the opening of the Stockton and Darlington Railway, which was the first public railway in the world on which steam locomotives were used. George Stevenson was the engineer. The line, with branches, was 36 miles long. It was a single track with passing places every quarter mile. The capital expenditure on the line was nearly £170,000. It was opened on Sept. 27, 1825.

September 28, 1852.—Henri Moissan, born on this date, was one of France's most illustrious scientists. A long series of researches on compounds of fluorine, began in 1884, led to the isolation, for the first time, of fluorine itself. Investigation of gaseous fluorides of carbon with the view of liberating the carbon in the form of diamond by removal of fluorine from the compounds failed. This failure led to the successful attempts to make artificial diamonds by the sudden cooling of molten iron containing carbon in solution. In order to obtain the necessary high temperatures, Moissan devised the electric furnace.

September 29, 1892.—On this date Lord Rayleigh addressed a letter to NATURE directing attention to his discovery that nitrogen prepared from air had a density greater by 1 part in 1000 than that prepared from ammonia. Investigation by Rayleigh and Ramsay of the cause of the disagreement led to the discovery and isolation of the inert gas, argon. This was followed soon after by Ramsay's isolation of helium from the mineral clèveite.

September 30, 1880.—The first astronomical photographs were made in 1840 by J. W. Draper, using daguerreotype plates. Draper's last great photographic achievement was a record of the great nebula in Orion, made on Sept. 30, 1880. Attempts at improving on this first effort were cut short by Draper's death. On Jan. 30, 1883, however, Dr. A. Ainslie Common secured a picture far superior to any which had previously been taken.

October 1, 1840.—William Henry Fox Talbot is best known as one of the founders of photography. He discovered 'photogenic drawing,' produced by the action of light through leaves, etc., in contact with silver chloride paper, fixation of the photographic image by potassium iodide or by washing in salt water; and evolved the method of printing positive images from transparent negatives on paper. He applied his genius in other spheres, and on Oct. 1, 1840, was granted a patent for an engine "for obtaining motive power" by electrical means. W. C.

Societies and Academies.

PARIS.

Academy of Sciences, Aug. 29.—The president announced the death of Emile Haug, *membre titulaire* of the Section of Mineralogy.—Paul **Appell**: The small oscillations of a system round a position of stable equilibrium.—Paul **Marchal**: Contribution to the genotypic and phenotypic study of the Trichograms.—N. **Podtiaguine**: The order of regularity of growth [of functions].—Serge **Bernstein**: A problem relating to absolutely monotone functions.—Y. **Rocard**: Modification of the Einstein theory of diffusion of light.—Frantz **Cathelin**: Formulæ of the curves of magnetism in electrical machines and of the induction curves in the core plates.—P. **Lejay**: The applications of a particular type of amplifier.—Mlle. **Choucroun**: The selective permeability of membranes. The influence of the size of their interstices.—D. **Ivanoff**: The constitution of the Grignard organo-magnesium compounds. An attempt to decide between the formulæ RMgX (Grignard) and R_2Mg, MgX_2 (Jolibois) by extracting the product with anhydrous ether, in which the magnesium halide is more soluble. The product of the action of carbon dioxide upon ethyl magnesium bromide showed that magnesium bromide was extracted, and this is taken as proving the presence of the symmetrical compound (Jolibois).—V. **Grignard**: Remarks on the preceding paper. The results of M. D. Ivanoff are not quite conclusive, and the author still thinks that the form RMgX predominates, although there may be a small proportion of the other form in equilibrium.—Pierre **Viennot**: The tectonic of the neighbourhood of Sarrancolin (Hautes-Pyrénées).—N. P. **Péntcheff**: Researches on the rare gases of some Bulgarian thermal springs. The total rare gases and the proportions of helium and argon are given for the springs at Soulou-Dervent, Kaménitza, and Hissar. The radioactivity of these springs has also been studied.—F. **d'Hérelle** and E. **Peyre**: Contribution to the study of spontaneous tumours.

ROME.

Royal Academy of the Lincei, May 15.—Giorgio **Abetti**: Relations between solar eruptions and terrestrial magnetic storms. Evidence is adduced in support of the view that the disturbed regions of the sun emit atoms which, when their direction is such as to meet the earth, result in perturbation of terrestrial magnetism.—Q. **Majorana**: A new method of optical telephony by means of ordinary or ultraviolet light.—A. **Angeli**: The azides. Various physical and chemical observations, made by different investigators, are in direct contradiction to Hantzsch's opinion that the nitrogen atoms of hydrazoic acid are arranged in ring formation.—L. **Cambi** and L. **Szegö**: Spectrographic studies on complex iron cyanides. (ii.) The reaction between nitroprusside and alkali. The results of spectrographic measurements demonstrate the existence of the equilibrium

$$[Fe(CN)_5NO]'' + 2OH' \rightleftarrows [Fe(CN)_5NO_2]'''' + H_2O.$$

—E. **Bortolotti**: Cebiceff's nets and conjugated systems in Riemannian V_n.—M. **Bossolasco**: Systems of Tchebycheff's functions which are orthogonal.—G. B. **Pacella**: Investigations on the form of light waves from an examination of shadow fringes.—B. **Colombo**: The transformations (m, n) which change $m+n+2$ integrals of an equation with partial derivatives of the second order in two independent variables into integrals of an analogous equation.—L. **Berwald**: Co-variant second differentials.—N. **Mouskhelichvili**: Periodic orbits and closed geodetic lines.—A. **Weil**: Functional linear calculus.—G. **Thomsen**: Relativistic mechanics of holonomous systems.—M. **Crudeli**: A new category of stationary motions of (heavy) viscous liquids between vertical (round) cylindrical tubes.—U. **Barbieri**: Geodetic connexion of the vertex of Andrate with the State network of the first order.—E. **Fermi**: The mechanism of emission in wave mechanics.—G. **Malquori**: The system $Fe(NO_3)_3 : Al(NO_3)_3 : H_2O$ at 25°. Feric and aluminium nitrates form neither additive compounds nor mixed crystals at 25°. The solid phases in equilibrium with the saturated solutions are $Al(NO_3)_3, 9H_2O$ and $Fe(NO_3)_3, 9H_2O$ respectively for the two branches of the solubility isotherm.—G. **Natta** and E. **Casazza**: Crystalline and atomic structure of ferrous hydroxide. The results of examination by the powder method and of the study of the photometric intensity show that ferrous hydroxide crystallises in the holohedral class of the rhombohedral system with a structure analogous to that of brucite. The elementary cell, containing one molecule, has the dimensions $a=3{\cdot}24$, $c=4{\cdot}47$, $c:a=1{\cdot}38$. The calculated density is 3·40 and the structure appears to be ionic.—M. **Comel**: Action of *p*H on muscular pulp in the presence of phosphate ions.

SYDNEY.

Royal Society of New South Wales, Aug. 3.—Sir George **Knibbs**: Rigorous analysis of the phenomena of multiple births. The number of cases of maternity and of the resulting numbers of twins, triplets, and quadruplets, are given for each year from 1890 to 1925. The frequency of twins changes very slowly with time, but increases linearly with age up to age 37 years, and then decreases linearly with age from 37 to 49 years. The probability of giving birth to twins through the division of an ovum after fertilisation, is sensibly a constant quantity throughout the productive period of female life; that is, it bears a constant ratio to the number of cases of maternity. The relative frequency of the production of twins from two ova, however, varies systematically with the age of the mother. The number of cases of triplets was not sufficiently large to admit of an exhaustive analysis, but the distribution shows that it is a function of the mother's age, the maximum frequency being at about age 35 years.—W. L. **Waterhouse**: Studies in the inheritance of resistance to leaf rust, *Puccinia anomala* Rostr., in crosses of barley (1). More than a hundred varieties of barley obtained from various countries and belonging to six species were tested to determine their reaction to an Australian physiological form of *Puccinia anomala* Rostr. The majority of the varieties were quite susceptible, but all the resistant varieties had some characters which were agronomically undesirable. Cross-breeding work involving these resistant sorts and the commercially valuable susceptible types was undertaken. The F_1 plants showed complete dominance of resistance. In the F_2 there was segregation in the ratio of 3 resistant plants to 1 susceptible. The F_3 results confirm the hypothesis that a single dominant genetic factor underlies resistance. Evidence of linkage between rust resistance and morphological characters was lacking in the cases examined. There is an indication of correlation between resistance to *Helminthosporium sativum* and *Puccinia anomala* in certain of the varieties.—M. B. **Welch**: The wood structure of some species of Kauri. Macroscopical and microscopical details, together with the principal uses and physical properties, are given of six species of Kauri which find their way as commercial timbers to the Sydney market. The variation in individual species renders identification difficult. The plugs of phlobaphene material in the tracheids are described and the occurrence of wood parenchyma, usually regarded as being absent in the normal secondary wood of the Araucarineæ, is noted.

Official Publications Received.

BRITISH.

Royal Society of Arts. Report on the Competition of Industrial Designs, 1927. Pp. 30. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society. August. Pp. xii+iv+1759-2022. (London: Gurney and Jackson.)

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1926; with Report of the Geological Survey Board and Report of the Director. Pp. vii+202+6 plates. (London: H.M. Stationery Office.) 4*s.* 6*d.* net.

Battersea Polytechnic, Battersea Park Road, London, S.W.11. Calendar of Evening and Afternoon Courses for Session 1927-1928. Pp. 24+10 plates. Free. Technical College for Day Students and Day School of Arts and Crafts, Calendar, Session 1927-1928. Pp. 47+11 plates. 3*d.* Department of Hygiene and Public Health, Session 1927-28. Pp. 28+3 plates. 3*d.* Domestic Science Department and Training College, Full Time Day Instruction, Afternoon and Evening Classes, Session 1927-1928. Pp. 33+8 plates. 3*d.* (London.)

Transactions of the Optical Society. Vol. 28, 1926-27, No. 3. Pp. ii+117-172. 10*s.* Vol. 28, 1926-27, No. 4. Pp. ii+173-224. 10*s.* (London.)

Professional Schools, Post-Graduation Courses and Specialist Studies in the Universities and University Colleges of Great Britain and Ireland. Session 1927-8. Pp. 40. (London: Universities Bureau of the British Empire.)

Journal and Proceedings of the Asiatic Society of Bengal. New Series, Vol. 22, 1926, No. 1. Pp. 91+3 plates. (Calcutta.) 3.6 rupees.

Journal of the Royal Society of Western Australia. Vol. 12, 1925-1926. Pp. xx+239. (Perth.) 35*s.*

The East London College (University of London). Calendar, Session 1927-1928. Pp. 184. (London.) 1*s.*

Aeronautical Research Committee: Reports and Memoranda. No. 1087 (Ae. 266): Wind Tunnel Tests on Aerofoil R.A.F. 34 at Negative Incidences. By A. S. Hartshorn. (A.3.a. Aerofoils-General, 175.—T. 2417.) Pp. 4+2 plates. 4*d.* net. No. 1090 (Ae. 269): Further Wind Tunnel Tests of a Slot and Aileron Control on a Wing of R.A.F. 31 Section. By A. S. Hartshorn. (A.2.a. Stability Calculations and Model Experiments, 124.—T. 2426.) Pp. 9+9 plates. 9*d.* net. (London: H.M. Stationery Office.)

London University Guide and University Correspondence College. Calendar, 1927-1928. Pp. 216. (Cambridge and London: University Correspondence College.) 2*s.* 6*d.*

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 2, No. 14: On the Quantitative Relation of Comb Size and Gonadic Activity in the Fowl. By A. W. Greenwood and F. A. E. Crew. Pp. 190-197. 9*d.* Vol. 47, Part 2, No. 15: The Life and Work of Nicolas Théodore de Saussure. By Dr. R. J. Harvey Gibson. Pp. 198-201. 6*d.* Vol. 47, Part 2, No. 16: The Stability of Suspensions. ii. The Rate of Sedimentation of Kaolin Suspensions containing Colloidal Silicic Acid. By Dr. William Ogilvy Kermack and Dr. William Turner Horace Williamson. Pp. 202-221. 2*s.* Vol. 47, Part 2, No. 17: A Case of partial Sex-Transformation in Cattle. By A. Calder. Pp. 222-229+2 plates. 1*s.* 3*d.* (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

University of Manchester: Faculty of Technology. Prospectus of University Courses in the Municipal College of Technology, Session 1927-28. Pp. 310. (Manchester.)

The Physical Society. Proceedings, Vol. 39, Part 5, August 15. Pp. xix+375-472. (London: Fleetway Press, Ltd.) 6*s.* net.

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 32: A Survey of the Tanning Materials of Australia. By D. Coghill. Pp. 136. (Melbourne: H. J. Green.)

Commonwealth of Australia. Journal of the Council for Scientific and Industrial Research. Vol. 1, No. 1, August. Pp. 63. (Melbourne: H. J. Green.) 1*s.* 6*d.*

The East Anglian Institute of Agriculture (Essex Agricultural Committee). Calendar, 1927-1928. Pp. 84+xxviii. (Chelmsford.)

Journal of the Royal Microscopical Society. Series 3, Vol. 47, Part 3, September. Pp. xiv+209-318. (London.) 10*s.* net.

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 6: Work of the Bureau of Education for the Natives of Alaska. By William Hamilton. Pp. 5. 5 cents. Bulletin, 1926, No. 23: Biennial Survey of Education, 1922-1924. Pp. iii+886. 1.75 dollars. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Department Circular 419: Grouping of Soils on the Basis of Mechanical Analysis. By R. O. E. Davis and H. H. Bennett. Pp. 14. 5 cents. Technical Bulletin No. 4: Lygus Elisus, a Pest of the Cotton Regions in Arizona and California. By E. A. McGregor. Pp. 15. 5 cents. (Washington, D.C.: Government Printing Office.)

Statens Meteorologisk-Hydrografiska Anstalt. Nr. 256: Organisation: météorologique Internationale, Commission de Météorologie agricole. Procès-verbaux de la 2ième Réunion, Zürich, 1926. Pp. 87. 2 kr. Nr. 260: Description des stations météorologiques Suédoises, pouvant figuer aux Météo-radiogrammes Internationaux, publiée conformément à la résolution 41 de la Conférence des directeurs à Utrecht, 1923. Pp. 19. 1 kr. Årsbok, 6, 1924. iv: Meteorologiska iakttagelser i Sverige. Pp. x+183. 7 kr. (Stockholm.)

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 4, No. 1: Vegetationens utvecklingsgång i Norrland. Av Knut Arnell. Pp. 28. 2 kr. Band 4, No. 2: Studier över nederbördens fördelning vid olika vindar i Svea- och Götaland (Distribution des pluies suivant les vents dans les Provinces de Svealand et de Götaland). Av C. J. Ostman. Pp. 30. 2 kr. (Stockholm.)

Bulletin géodésique: Organe de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Année 1926, No. 12, Octobre, novembre, décembre, 1926. Pp. 187-265. Année 1927, No. 13, Janvier, février, mars, 1927. Pp. 64. (Toulouse: Édouard Privat; Paris: J. Hermann.)

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 5. Pp. iv+130. (Paris: Les Presses universitaires de France.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 83: Burials of the Algonquian, Siouan and Caddoan Tribes West of the Mississippi. By David I. Bushnell, Jr. Pp. x+103+37 plates. (Washington, D.C.: Government Printing Office.) 50 cents.

Smithsonian Institution: United States National Museum. Bulletin 136: Handbook of the Collection of Musical Instruments in the United States National Museum. By Frances Densmore. Pp. iii+164+49 plates. (Washington, D.C.: Government Printing Office.) 45 cents.

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No. 5, Supplement. Pp. 103+8 plates. (Philadelphia, Pa.)

School of Mines and Metallurgy, University of Missouri. Technical Series Bulletin, Vol. 9, No. 4: Descriptive Bibliography on Oil and Fluid Flow and Heat Transfer in Pipes. By Prof. Joe B. Butler. Pp. 62. (Rolla, Mo.)

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 50: Revision of the American Lemming Mice (Genus Synaptomys). By A. Brazier Howell. Pp. ii+38+2 plates. (Washington, D.C.: Government Printing Office.) 10 cents.

Publications of the Allegheny Observatory of the University of Pittsburgh. Vol. 6, No. 8: Standard Solar Wave Lengths (5805-7142A). By Keivin Burns and C. C. Kiess. Pp. 125-139. Vol. 7, No. 1: Photographic Photometry with the Thirty-inch Thaw Refractor. The Light Curves of Twenty-nine Cepheid Variables. By Frank C. Jordan. Pp. 124. (Pittsburgh, Pa.)

Publications du Laboratoire d'Astronomie et de Géodésie de l'Université de Louvain. Vol. 3 (Nos. 27 à 43), 1926. Pp. 290. (Louvain.)

R. Osservatorio Astrofisico de Catania. Catalogo Astrofotografico Internazionale, 1900-0. Zona di Catania fra le declinazioni +46° e +55°. Vol. 1, Parte 1ª: Declinaz. da +46° a +48°, ascens. retta da 0h a 3h. (Fascicolo N.1.) Pp. v+8+99. Vol. 3, Parte 2ª: Declinaz. da +48° a +50°, ascens. retta da 3h a 6h. (Fascicolo N.18.) Pp. viii+43. (Catania.)

CATALOGUES.

X-Ray News and Clinical Photography. No. 2, August. Pp. 13-24. (London: Kodak, Ltd.)

Magnum Radio Products. Publication No. 010927: Catalogue of complete Wireless Receiving Sets, Accessories and Components, Kits of Parts for Home Constructors. Pp. 36. (London: Burne-Jones and Co., Ltd.)

Diary of Societies.

SATURDAY, SEPTEMBER 24.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at Herne Bay), at 11 A.M.

WEDNESDAY, SEPTEMBER 28.

FARADAY SOCIETY (at Chemical Society), at 8.—Prof. T. M. Lowry: The Electronic Theory of Valency. Part VI. The Molecular Structure of Strong and Weak Electrolytes. (*b*) Reversible Ionisation.—E. B. R. Prideaux: The Effect of Temperature on Diffusion Potentials.—C. Morton: The Ionisation of Polyhydrion Acids.—K. J. Pedersen: The Velocity of the Decomposition of Nitroacetic Acid in Aqueous Solution.

CONGRESSES.

SEPTEMBER 23-26.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Trinity College, Cambridge).—Subjects for discussion: Report of the Public Libraries Committee of the Board of Education (A. E. Twentyman and Lieut.-Col. L. Newcombe); Recent Developments in connexion with the Science Library, South Kensington (Sir Henry Lyons); Information, Organisation, and Statistics in Industry (Major L. Urwick, S. J. Nightingale, H. Quigley, W. Wallace, A. E. Overton, F. W. Tattersall); Patent Classification (A. R. Wright, A. Gomme); Problems of the Information Bureau (A. F. Ridley, P. K. Turner, Dr. J. C. Withers); Photographic Reproduction of Printed and MS. Material (N. Parley, Sir William Schooling, R. H. New); Standards of Book Selection in Science and Technology (Sir Richard Gregory).

SEPTEMBER 26 AND 27.

CERAMIC SOCIETY (Refractory Materials Section Meeting) (at Town Hall, Bournemouth), at 10 A.M.—A. T. Green: A Consideration of Steel Works Refractories.—W. J. Rees and W. Hugill: Note on Silica Bricks made without Added Bond.—R. S. Troop: Some Experiments in the Drying of Clays.—W. C. Hancock: Crushing Strength of Unfired Fire-clay Bodies.—A. E. J. Vickers: Determination of Iron Silicates.—Prof. D. A. Moulton: Refractory Material used as Mortar for Laying up Refractories.—Dr. A. F. Joseph: Characterisation of Clay.—A. J. Dale: Effects of Temperature on the Mechanical Properties of Silica Products.