Nature,
August 17, 1929

Nature

A WEEKLY

JOURNAL OF SCIENCE

VOLUME CXXIII

JANUARY, 1929, to JUNE, 1929

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

London
MACMILLAN AND CO., LIMITED
NEW YORK: MACMILLAN COMPANY

INDEX

NAME INDEX

TITLE INDEX

ASTRONOMICAL NOTES.

CORRESPONDENCE.

DEATHS.

REVIEWS AND OUR BOOKSHELF.

Agriculture, Forestry, and Horticulture:

Anthropology and Archæology:

Biology:

Chemistry:

Engineering:

Geography and Travel:

Geology and Mineralogy:

Mathematical and Physical Science:

Medical Science:

Metallurgy:

Meteorology:

Miscellaneous:

The various Supplements should be collated and bound with the numbers with which they were issued.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

*" To the solid ground
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SATURDAY, JANUARY 5, 1929.

CONTENTS.

Cancer.

A GOOD deal has been done in recent years to elucidate the laws of animal growth—the rules, that is, which determine that each individual animal grows, develops, and differentiates until its body has reached a certain size, with its various parts and organs in certain proportions and in certain relationships to one another. The deadly precision with which the 'normal' result is achieved is so commonplace that we wonder at it less than we do at the much rarer cases when the regulatory mechanism goes wrong. That is the naturalist's instinct. 'Treasure your exceptions' is, within reasonable bounds, a sound rule, and the study of unnatural forms of growth is as likely a road as any other to lead us to an understanding of normal development. Of all the varieties of abnormal growth, we know most about tumours, especially of human tumours, and more particularly of those which by their nature tend to kill the individual in which they grow and which we distinguish as 'malignant tumours' or 'cancer.'

The natural history of man is known far better than that of any other animal : an industrious worker may examine a hundred thousand individuals of some wild species ; most people would think they had done pretty well if they had closely scrutinised five hundred. But the organised activities of public health authorities now keep under pretty close observation some 200 million people, and tell us, with tolerable if improvable accuracy, the reasons why they die from year to year and from childhood to old age. We know from these data that cancer is one of the chief causes of death in civilised countries in temperate climates, and we have a great mass of information about the sex, age, occupation, and other circumstances of the people who die from it.

The whole 'cancer problem' is therefore of considerable interest from many points of view—biological, medical, and personal—and these are all represented in the report,[1] lately published, of the International Conference on Cancer, held in London last July under the auspices of the British Empire Cancer Campaign. The twenty-sixth annual report of the Imperial Cancer Research Fund also contributes once again its record of the steady, sober progress which that organisation has so consistently maintained, first under Dr. E. F. Bashford, and in recent years under Dr. J. A. Murray. Where does the problem now stand ?

A cancer grows from, and is composed of, cells of the body in which it arises. It differs from normal tissue in its gross morphology, in its minute structure, and in its functional relationships, but these differences are quantitative rather than qualitative. Anatomically and physiologically the degrees of resemblance and difference vary widely in different instances : some tumours are very like normal tissue, some are bizarrely different. All attempts to define any specifically malignant character have failed : Mr. H. G. Crabtree has lately shown that Warburg's criterion of a capacity for anaerobic glycolysis is not valid, since cellular overgrowths of an inflammatory nature show the same sort of metabolism. The most definite feature of cancers is their relative detachment and isolation in the co-operative community which is formed by the tissues and organs of the body. The normal anatomical relationships of epithelium and connective tissue, for example, are due to the mutual restraint of each tissue on the other : if a cancer starts in the epithelium, it is not held in check by the connective tissue : it defies the laws of normal growth and produces tissue which does not subserve the proper functions of epithelium towards the underlying tissues and the rest of the body.

Similarly, cancer cells are not subject to the ordinary rules of senescence. Growing old, and eventually so old that life ceases, is a function of the body as a whole, not of individual tissues. If a normal embryonic tissue is isolated from the rest of the body in artificial culture, it can be propagated by periodical transplantations for a time much longer than the natural life of the animal species from which it came, and probably indefinitely. A mouse cancer is physiologically isolated in an analogous manner : it never grows old, and by transplantation from mouse to mouse can be kept alive for many natural generations of mice, and probably for ever.

Pieces of tissue which are in this way detached from the communal activities of the body as a whole are, as might be anticipated, useless. The fat in a fatty tumour is not available as a source of energy for the body ; a tumour of stomach epithelium does not secrete gastric juice, nor is a muscular tumour of the uterus of any value in retaining or expelling a fœtus. But, which could scarcely have been predicted, they are also harmful ; it is, after all, the great practical quality of cancers that they kill. In many cases they do this by interfering in a gross way with the normal working of the stomach or intestines or brain or lungs. But they kill with equal certainty if they do not involve any vital organ and, questionless, they produce some substance which is poisonous to the rest of the body, often shown most strikingly by the production of an extreme degree of wasting. Few attempts have been made to explain this general ill effect, and we really know nothing of its intimate mechanism. Why cancer kills is a very interesting question which still needs an answer. It may be that there is a biological principle that cells which are not with the body are against it.

Far more attention has naturally been given to the origin and causes of the dissociated growth. All the evidence goes to show that it is due to a reaction between the tissues and some external stimulation. Organisms exist only in relation to their environment : normal organisms react to a normal environment in such a way that each is in perfect adaptation with the other. In cancer there is something wrong with both.

There is no substantial evidence that cancer is due to any sort of parasite. Malignant tumours produce substances which can stimulate normal cells to take on a cancerous way of growth ; in some ways they resemble the invisible viruses which are the causes of some infectious diseases ; but these carcinogenic agents have never been found apart from tumours, and it seems most likely that they arise in and are the result of cancer rather than its cause. The cumulative indications, however, that cancer is caused by various forms of stimulation which we may group together as chronic irritation, become more and more impressive, and fresh examples of the association are continually being brought forward. Irritation involves cell injury and cell destruction, and any class of agents which can injure cells may evoke cancer as a response—mechanical, thermal, chemical, parasitic, and radiant injury are all effective. But

[1] John Wright and Sons, Bristol. 1928. Pp. 588.

though a jagged tooth, swallowing food too hot, working in arsenic, being infected with the worm *Schistosomum*, and X-rays may all cause cancer, experiments on animals and observations on man agree in attaching special efficacy to soot, tar, shale oils, and other products of destructive distillation.

There are strong grounds for thinking that this is the environmental factor which connects a high cancer incidence with civilisation and town life. Man is an artificial animal, and he is evidently far from perfectly adapted to the surroundings which he makes for himself. Human and animal experience also agree in showing that cancer follows injury only after a long latent period, during which the irritation may or may not be continued. The interval in mice is of the order of one-third of their natural span of life: a corresponding period of 15 to 20 years is suggested by the human data. If man lived, like a wild animal, only for the years of his physical perfection and generally finished about 30 or 35, few people would have malignant tumours. They are not common until ages of forty and upwards are reached—a prime fact in their epidemiology which is consistent with the view that irritants are the most important stimuli of cancerous growth, especially when this mode of response is given better chances to emerge by man's unnatural habit of keeping himself alive a good deal longer than was intended.

Whether irritants produce cancer or not depends also on the tissues which are involved. Recent observations show in a variety of ways that the constitution of the irritated individual is far from immaterial. Experimentally it is easy enough to make malignant tumours with tar in mice, difficult or next to impossible in rabbits, rats, or guinea-pigs. Within the same species, races and individuals differ in the same way. Mice are so prone to develop 'spontaneous' cancers that the incidence of the disease may be observed in them as it may be in man. Some strains are more cancerous than others, and the original demonstration by the Imperial Cancer Research Fund, that a tendency to have cancer could be exaggerated by selective breeding, has been very fully confirmed by the massive observations of Miss Slye, Prof. Leo Loeb, and others. Races have been obtained in which nearly every mouse dies of cancer; other races in which cancer is almost unknown; and it is quite clear that the liability to respond to irritation by producing a cancer is a heritable constitutional quality, depending apparently on more than one Mendelian factor, and difficult to trace through man's promiscuous breeding.

We have also learned in recent years that these constitutional differences may be acquired as well as in-born. If a large number of mice are tarred to the same extent, the time at which they will develop tumours in response will vary widely: some individuals are much more refractory than others. If the cancers of the skin which first appear in the most susceptible animals are removed by operation, it proves to be exceedingly difficult or impossible to produce a second tar tumour in the same animal. Mice from which spontaneous tumours have been excised are equally refractory. The development of one cancer thus produces some alteration in the whole economy of the animal, which makes it everywhere less responsive to carcinogenic irritation.

These experimental facts are reflected in human experience. Multiple malignant tumours in one person are less common than they should be if the development of one had no relation to the development of others: cancers of the breast and of the uterus are so common that examples of the occurrence of both in the same woman should be fairly frequent instead of rare. The analysis of international statistics, in which a committee of the League of Nations has taken an important part, also suggests that relative freedom from cancer of one organ may be made up by relative abundance in another organ. Thus in England, Holland, Switzerland, and Japan the death-rate from cancer is about the same: in each case the absence of cancer of the breast and uterus in males is counterbalanced by a higher rate for cancer of the alimentary canal, so that the total incidence in the two sexes is the same. In Japan, cancer of the breast is relatively unimportant, but cancer of the uterus is so much commoner that the mortality from both is higher than in Holland or Switzerland. Through several lines of approach, therefore, we reach the conclusion that there is a cancerous diathesis affecting the body as a whole as well as a heritable liability for some particular organ to be involved.

The progress in our knowledge of cancer, its nature, causes, and cure, cannot from any point of view be regarded as unsatisfactory. The mystical ideas of thirty years ago have been replaced by a clear biological conception of stimulus and response. It cannot be long before we shall be able to define more closely the essential characters of effective stimuli on one hand and on the other the constitutional qualities which lead a tissue to give a cancerous response. The 'cancer problem' is far from solved, but it seems much more soluble as time goes on.

Eddington on the Nature of the World.

The Nature of the Physical World. By Prof. A. S. Eddington. (Gifford Lectures, 1927.) Pp. xix +361. (Cambridge: At the University Press, 1928.) 12*s*. 6*d*. net.

THE lectures endowed by Lord Gifford in 1887 for "promoting and diffusing the study of Natural Theology, in the widest sense of the term—in other words, the knowledge of God"—were delivered in 1927 in Edinburgh by Prof. Eddington. At the time they excited an interest which, even after allowing for the traditional intellectual fervour of the Scottish capital, must be regarded as altogether exceptional: and now that they are published, the interest is likely to become universal.

"I propose," Prof. Eddington says in the Introduction, "to discuss some of the results of modern study of the physical world which give most food for philosophic thought. This will include new conceptions in science and also new knowledge. In both respects we are led to think of the material universe in a way very different from that prevailing at the end of the last century." In the last four chapters he considers the position which the new scientific view should occupy in relation to religion.

Descriptions of the phenomena of atomic physics as given in popular text-books have an extraordinary vividness. We see nuclei surrounded by circulating electrons, which from time to time are tossed into higher orbits by X-rays or torn away altogether, and after hairbreadth escapes are again caught and fall back again. The success of this model in co-ordinating the facts of spectroscopy shows that it bears some analogy to the actual atom; but (as is made clear by wave mechanics) there is no real resemblance. The fall of an electron from one orbit to another is merely a conventional way of representing a particular change of state of the atom which cannot properly be represented by movements in space as macroscopically conceived. *Something unknown is doing we do not know what*—that is what the theory amounts to. The reason why it is fruitful is that our descriptions are not limited to unknown agents executing unknown activities, but include *numbers* scattered freely in the description. To contemplate electrons circulating in the atom carries us no further; but by contemplating eight circulating electrons in one atom and seven circulating electrons in another, we begin to realise the difference between oxygen and nitrogen. Out of the numbers proceeds that harmony of natural law which it is the aim of science to disclose.

So far, Eddington is just a Pythagorean. "The leading principle of Pythagoreanism," as Walter Pater said, "was the universality, the ultimate truth, of numerical law, analogous to the numerical laws of harmony in music: the finite (τὸ πέρας) or definable, with all the unity-in-variety of concerted music, ever controlling the infinite (τὸ ἄπειρον), the indefinite, formless brute matter of our experience of the world," and the plan of the whole book reminds us forcibly of what Proclus says of Pythagoras, that he "examined the principles of natural knowledge to the bottom, and investigated its theories in an immaterial and intellectual manner" (ἀΰλως καὶ νοερῶς). Let us see, then, how Eddington illustrates his view about the nature of exact science by analysing, in an immaterial and intellectual manner, an examination question.

"If we search the examination papers in physics and natural philosophy for the more intelligible questions, we may come across one beginning something like this: 'An elephant slides down a grassy hillside. . . .' The experienced candidate knows that he need not pay much attention to this: it is only put in to give an impression of realism. He reads on: 'The mass of the elephant is two tons.' Now we are getting to business: the elephant fades out of the problem and a mass of two tons takes its place. What exactly is this two tons, the real subject matter of the problem? It refers to some property or condition which we vaguely describe as 'ponderosity' occurring in a particular region of the external world. But we shall not get much further that way: the nature of the external world is inscrutable, and we shall only plunge into a quagmire of indescribables. Never mind what two tons *refers* to: what *is* it? How has it actually entered in so definite a way into our experience? Two tons *is* the reading of the pointer when the elephant was placed on a weighing-machine."

Similarly for the other data of the problem. Thus by the time the serious application of exact science begins, we are left only with pointer-readings. *Science is simply the linkage of pointer-readings with pointer-readings.*

The Victorian physicist felt that he knew just what he was talking about when he used such items as *matter* and *atoms*. Atoms were tiny billiard balls, a crisp statement that was supposed to tell you all about their nature in a way that could never be achieved for transcendental things like consciousness, beauty, or humour. But now we realise that science has nothing to say as to the intrinsic nature of the atom. The physical atom is, like everything else in physics, a schedule of pointer-readings. The schedule is, we agree, attached to some unknown background, but what it is we do not know. Only in one case—namely, the pointer-readings of our own brains—have we an insight that is not limited to the pointer-readings: and that insight shows that they are attached to a background of consciousness.

Why not, then, suppose that the unknown background of all pointer-readings is something continuous with our mental nature, something of the nature of consciousness? Why should not the stuff of the world be mind-stuff? What knowledge have we of the nature of atoms that renders it all incongruous that the assemblage of atoms constituting a brain should be of itself a thinking object?

The doctrine that ultimate reality is of the nature of mind, or thought-content, is as old as Plato; but Eddington's approach to it is original and bears not much resemblance to that of the idealist metaphysicians. His lectures, coming from a physicist of the front rank, will penetrate where philosophers have never found a hearing; and how much need there is for teaching such as Eddington's may be realised when we compare him with (for example) Bishop Barnes, who, in his objections to the Catholic doctrine of the Sacraments, still seems to be dominated by the nineteenth-century physicist's conception of matter as something necessarily and entirely unspiritual.

Having swept away one of the two principal causes of tension between science and religion—namely, the association of science with materialistic philosophy—Eddington now turns to the other, namely, the deterministic character which has hitherto been attributed to physics, and the difficulty of reconciling scientific determinism with doctrines of human free will and responsibility. Here the solution is one that could not have been dreamt of twenty years ago—it is nothing more or less than a total denial of determinism in physics itself. "On the scientific side," he says, "a new situation has arisen. It is a consequence of the advent of the quantum theory that *physics is no longer pledged to a scheme of deterministic law.* Determinism has dropped out altogether in the latest formulations of theoretical physics and it is at least open to doubt whether it will ever be brought back. . . . The future is a combination of the causal influences of the past, together with unpredictable elements—unpredictable not merely because it is impracticable to obtain the data of prediction, but because no data connected causally with our experience exist."

The position is that the laws governing the microscopic elements of the physical world—individual atoms, electrons, quanta—do not make definite predictions as to what the individual will do next. These laws indicate several possibilities in the future and state the odds on each. In general the odds are moderately balanced and are not tempting to an aspiring prophet. But short odds on the behaviour of individuals combine into very long odds on statistics of a large number of individuals; and all the successful predictions hitherto attributed to causality are traceable to this.

The questions which have been referred to in this review are only a small proportion of those dealt with in what must be regarded as an epoch-making book. Considerable discussion may be expected, for example, over the doctrine propounded in Chapter xi., that Einstein's gravitational field-equations and Maxwell's electromagnetic field-equations are not controlling laws of physics, but mere truisms, the violation of which is unthinkable, like the law that $3+1=2+2$. I must confess myself unable to follow the argument here, especially as Eddington indicates (p. 237) that in his opinion the law of ponderomotive force of the electric field is *not* to be regarded as one of these truisms; for it is known (as is proved, *e.g.*, in *Proc. Roy. Soc.*, **113**, pp. 509-511; 1927) that the equations of ponderomotive force are merely mathematical consequences of Einstein's gravitational field-equations and Maxwell's electromagnetic equations.

In conclusion, we may express our satisfaction that Eddington has avoided two pits into which many other travellers in these regions have fallen. The first is indicated in his own words:

"A besetting temptation of the scientific apologist for religion is to take some of its current expressions, and after clearing away crudities of thought (which must necessarily be associated with anything adapted to the everyday needs of humanity) to water down the meaning until little is left that could possibly be in opposition to science, or to anything else."

If the Christian religion had meant no more than some of its modern expositions, need the early Christians have suffered martyrdom?

And the other, also in his own words:

"The religious reader may well be content that I have not offered him a God revealed by the quantum theory, and therefore liable to be swept away in the next scientific revolution."

E. T. WHITTAKER.

Science and Life.

Point Counter Point. By Aldous Huxley. Pp. v + 601. (London: Chatto and Windus, 1928.) 10*s.* 6*d.* net.

SCIENCE, by flinging into the lap of an unprepared world an over-rich and embarrassing assortment of food for thought, must be held responsible for the mental indigestion from which the world is suffering. It is not surprising, considering the bewildering array of new knowledge and the number of new theories spread before us, that the only beliefs are unbeliefs, that traditions are anachronisms, and precedents ephemeral things. This is not an age of reason but of unreason. We are attempting to explain everything in terms of psycho-physiologico-physico concepts, but have so far succeeded only in making life more complicated for the majority. No great synthesis of our new knowledge has yet been attempted upon which to base a guiding philosophy for puzzled mankind. Mr. H. G. Wells may yet accomplish this task for us, but that it has still to be done is the opinion held by many, an opinion which will find reinforcement in this latest volume by Mr. Aldous Huxley, in which nearly every character is shown either floundering or detached.

"Point Counter Point" will not satisfy those who want novels based on the Richardson model, "a story wrought round the passion of love to a tragic or joyous conclusion," or that of Scott, who combined excellence of characterisation with the harmonious development of his plots. Mr. Huxley flouts such conventions. He conveys the impression that the principal character of the book is outside it. Interestingly and provokingly drawn as they are, we have not to read far to become less interested in his characters than in himself, less interested in their outlook on life than speculative about his. He introduces character after character into his pages, psycho-analyses them, and then lays them aside once they have served the purpose either of explaining their reactions to environmental stimuli in terms of old or new theories of behaviourism, or as vehicles for the expression of his varied and conflicting thoughts on different types. His analyses are brutally realistic, although it is probable that, by restricting his field of choice to exaggerated types obsessed by sex, he loses some of his effect. At the end he leaves us wondering whether he intends to point a moral or merely to record his observations concerning the disastrous effects on some people of the breakdown of tribal authority and the waning influence of taboos resulting from the impact of science on society. But he makes it clear that he despises most of the devices by which most writers maintain interest in their characters, while at the same time showing more than once that he could, if he would, write a thrilling 'best-seller' conforming to pattern.

However, we need not be concerned here with Mr. Huxley's merits or demerits as a novelist. They have been dealt with elsewhere by others whose business it is to tell the members of the general public what they should think about the books written for them. What should interest us is his attitude towards science and scientific workers, and his assumption that the creative scientific research worker is something essentially different and less human than the creative artist. It is for his explanations of, and his onslaughts on, science, rather than for his studies in psycho-pathology, that this volume should be read by all who consider themselves specialists in any branch of science. Having been for years held up to the wonder and admiration of the world by Mr. H. G. Wells, scientific workers may need the corrective to their self-esteem which Mr. Huxley supplies. Rampion, his artist, remarks:

> "The lizards died of having too much body and too little head, so at least the scientists are never tired of telling us. Physical size is a handicap after a certain point. But what about mental size? These fools seem to forget that they're just as top-heavy and clumsy and disproportioned as any diplodocus. Sacrificing physical and effective life to mental life. What do they imagine's going to happen? . . . They're just marching towards extinction; . . . they're marching the rest of the world along with them."

Rampion and his wife, incidentally, are the only really attractive characters Mr. Huxley introduces into his six hundred pages, though it must be confessed that Rampion's fulminations against physical research—the search for "non-human-truth" as he calls it—becomes somewhat tiresome, partly through repetition, but mostly because all the explanation given of the other kind of truth, "human truth," is that it is something you discover by living—"living completely, with the whole man"—to which any interpretation can be given.

Apparently the assumption is made that persons like scientific specialists, absorbed in an intellectual occupation for a great deal of their time, are necessarily consistently "mental, conscious, and voluntary," and never "physical, intuitive, instinctive, and emotional," in their reactions. The fact is that most modern scientific specialists are ruled by their prejudices and emotions in everything except their own small branches of study. They are neither rational nor realistic in most affairs of life, merely normal, which is a real misfortune to the world and the civilisation which is due to their discoveries. Science has lost the art of leadership, if it ever possessed it. The scientist is afraid to be different, timidly afraid to accept the implications of the results of his own work and acquired knowledge, afraid to suggest that his own outlook of inquiry and patient observation, fearlessness to discard outworn or useless hypotheses, all of which be brings to bear on his own research, could with advantage be applied to our political, social, and economic institutions. Perhaps, however, indifference and not fear is the cause of it.

Mr. Huxley may be justified in stating that "the real charm of the intellectual life—the life devoted to erudition, to scientific research, to philosophy, to æsthetics, to criticism—is its easiness." . . . Easiness breeds indifference. It is this indifference which makes for misunderstanding, for the oft-expressed irritation of the non-specialist with the specialist, and for the suggestion that the research worker—the really creative research worker—is less of an artist than other specialists—sculptors, painters, poets, and the like. Mr. Huxley gives me the impression that he has weighed science in his scales of human values and found it wanting. But is science responsible for that ?

A. G. Church.

Archæological Investigation in Guernsey.

The Archæology of the Channel Islands. By T. D. Kendrick. Vol. 1 : *The Bailiwick of Guernsey.* Pp. xxiv + 273 + 20 plates. (London : Methuen and Co., Ltd., 1928.) 25*s.* net.

TO anthropologist and historian alike the Channel Islands are rich in interest. The last vestige of the Duchy of Normandy—there the King is still officially the Duke—they possess a constitution of their own, and they have their own language, not a patois, but a lineal descendant of old Norman French, of which it retains the pronunciation and vocabulary, to the confusion of French-speaking visitors. The racial affinities of the inhabitants are by no means clear, though this is perhaps due to the fact that their physical characters have not been adequately studied. A series of measurements taken in Jersey more than thirty years ago would not now be regarded as entirely satisfactory in technique, and the conclusions then drawn require reconsideration in the light of later theory. It is, however, patent that at least two racial strains are present, a fair and a dark breed. Cultural affinities with Brittany are present ; and attempts have been made to show that the place-names embody a Celtic element. This latter contention is more than doubtful, and there is little convincing evidence for anything which cannot be derived from Norse or early Norman French. For the affinities of the fair strain it is probable that we should look to the Norse type, and especially, in view of historical relations, through the Contentin, while connexion with Brittany may reasonably be correlated with the short, dark, long-headed man who forms the substratum of the population on the north-western fringe of Europe. The fair type, to the eye at least, appears quite distinct from the fairer Breton, who possibly may derive from a constituent in the later immigration of Celtic-speaking peoples from Britain.

The first volume of Mr. Kendrick's "Archæology of the Channel Islands" deals only with the Bailiwick of Guernsey, that is, the Islands of Guernsey, Alderney, Sark, Herm, and attendant islets. Jersey here obtains incidental reference only, and will receive attention in a second volume to be published later.

The history of archæological discovery in the islands is exceptionally important in its bearing upon the nature of the evidence. So many of the monuments and early finds have now disappeared that for our knowledge we are dependent upon the work of early explorers, and especially of F. C. Lukis, to whom Mr. Kendrick's tribute and constant references do no more than justice. The greater part of his record remains still in manuscript, but it has been used freely by the author, and it will always be the basis and starting-point of any work on the archæology of the islands. Lukis began his archæological investigations in the first decade of the nineteenth century, when he assisted in the excavation of the great passage grave of La Varde by Jean Gosselin, whose paper in *Archæologia* in 1811 is the first published reference to the prehistoric remains of Guernsey.

Archæologically, the Channel Islands are profoundly interesting. Though Guernsey and its attendant islands show no evidence of palæolithic man, in Jersey a human tooth discovered in a cave at St. Brelade's Bay bears witness to the extension of Neanderthal man to the islands. Considering the area of the islands, megalithic remains were very numerous ; they present certain resemblances to those of south-west Britain. A large and important bronze hoard found in Alderney shows relation with the British Bronze Age, and a gold torque found in Jersey is similar to those of Ireland. It is probable, therefore, that the islands served as a gathering place and entrepôt along the lines of prehistoric trade. This may explain the discrepancy between the numbers and distribution of stone axes and of megalithic monuments in the islands, the latter being most frequent in Alderney and Herm, while the largest number of stone axes, as might be expected, is found in Guernsey. Mr. Kendrick thinks that the islands of Alderney and Herm may have been regarded as specially sacred. But Alderney at least, notwithstanding its dangerous sea passage, is on the obvious line of communication from the Continent to Britain, and it may be remembered that generally monuments, especially funerary monuments, tend to cluster around trade centres and along trade routes.

The difficulties enumerated by Mr. Kendrick of interpreting archæological evidence in any insular area are well illustrated in the Channel Islands. The most reasonable inference is that they were, on the whole, intensely conservative over a long period, but along certain lines admitted local development. Presumably this is the explanation of certain details in which the Channel Island finds are unique, such as the curious form of long-nosed stone pick and a certain type of pottery. Yet they were not entirely free from outside influence. This is more marked in Jersey than in Guernsey, no doubt owing to the fact that within the period of human occupation an elevation of the land has twice joined Jersey to the Continent. This would account for palæolithic culture being present in Jersey alone. If influx took place at the time of the second elevation, as is suggested by the evidence, a knowledge of seafaring would then have enabled man to pass to Guernsey and the adjoining islands. For there the history of man, so far as we know, begins with the megalithic period and the culture is predominantly megalithic throughout.

The Guernsey group shows transition from the early Bronze, through the full Bronze, to the late Bronze and Iron Ages. Yet progress throughout is along a line of development from the great communal burial places in the passage graves with which the cultural history begins. It is influenced by outside relations rather than modified by the intrusion of a new civilisation. Thus, though cremation appears in these islands, they have nothing to show like the round barrow and the Hallstadt cemetery of Jersey until the time of a La Tène settlement from Gaul in the century preceding our era. On the other hand, the evidences of outside influence are many. The absence of flint *in situ* and its occurrence in the form of beach pebbles only mark out the finer implements of this material, such as the Pressigny types, as imported. One flint axe is of Scandinavian character. The remarkable hoard of two hundred objects of bronze found at Longy in Alderney, already mentioned, includes many British in type. But more marked are the relations with Brittany, to which constant reference has to be made throughout Mr. Kendrick's text, justifying the conclusion to which he leans that the Channel Islands predominantly represent an outpost of the megalithic culture of that area.

Among the more remarkable of the archæological remains described here are the statue menhirs carved in the representation of a human female form—a type of the mother goddess. A carving on the underside of a stone roofing a megalithic monument from its position—part of the carving overlies the upright on which it rests—is obviously older than the structure of which the stone forms part. These statue menhirs are sometimes called ‘neolithic,’ but, after a comparison with similar monuments elsewhere, notwithstanding their archaic appearance, the author is inclined to consider their age as uncertain.

Mr. Kendrick has marshalled his facts with consummate ability, and makes them tell a consistent story so far as they carry him within the limits he has set to the subject matter of this volume. For his discussion of their broader relations we must await his second volume.

Nitroglycerine Explosives.

Nitroglycerine and Nitroglycerine Explosives. By Dr. Phokion Naoum. Authorised English Translation, with Notes and Additions by E. M. Symmes. (The World Wide Chemical Translation Series, No. 1.) Pp. xi + 469. (London: Baillière, Tindall and Cox, 1928.) 31*s.* 6*d.* net.

THE translator of Dr. Naoum's well-known work has rendered useful service in making it available to a wider circle of readers, containing as it does a fuller collection of information on its subject than any other work in the English language. Originally published in Germany in 1924, it gives an account of the great industry built on the foundations laid in 1847 by Sobrero, the discoverer of ‘nitroglycerine,’ and by Nobel, who in 1862 first commenced its manufacture on a technical scale. Not only is this substance of great value to humanity for peaceful purposes, but it is also of vital importance in the manufacture of propellants as munitions of war, to an extent probably not foreseen by Nobel, the founder of the Nobel peace prize, who died in 1896.

The claim of the author of this book to include "all matter worth while on the subject" is not fully justified, in view of the omission of information on developments in this branch of explosives technology which became available in the years preceding and immediately following the War. To a slight extent this has been remedied by the translator by the insertion of numerous footnotes, but these are extremely brief, and for the most part refer to differences between German and American practice. The origin of the book is evident from the occasional presence of such phrases as "the never-to-be wholly avoided blown-out shots," but with very few exceptions the translation is excellent.

Following a short historical summary of the development of the nitroglycerine and dynamite industry, the book is divided into three parts, the first of which deals with the manufacture, uses, and properties of nitroglycerine. On page 11 we read the surprising statement that "nitroglycerine explosives as munitions achieved little importance," but on the next page we find that "In the World War nitroglycerine was the most indispensible [*sic*] component of munitions."

The manufacture of nitroglycerine as carried out in Germany at the works of the Dynamit-A.G. vorm. Alfred Nobel, of whose central laboratories in Hamburg Dr. Naoum is director, is fully described, but only very brief footnote references are made to the very different practice followed in the U.S.A. The Nathan, Thomson, and Rintoul nitrator-separator process used in Great Britain and elsewhere is described with the aid of a diagram from which the reference letters mentioned in the text are omitted. In the chapter referring to the denitration of spent acids, the references are all to early pre-War plant, and make no mention of the developments made during the War, records of which were available in 1920. The same criticism applies to the chapter on the physical and chemical properties of nitroglycerine as an explosive, no reference being made to modern methods of measuring explosion pressures by the application of the Hopkinson pressure-bar, and the piezo-electric gauge.

Part 2 contains a description of the preparation and properties of homologous and related nitric esters, many of which possess valuable properties from the thermo-chemical point of view, but have failed to find a permanent place in the explosives industry owing to their high cost of production, or defective properties of volatility, hygroscopicity, etc. Of special interest are those esters used in the production of 'non-freezing' explosives; of these, 'nitroglycol' has only recently become an economic possibility, owing to the development of methods for the manufacture of ethylene-glycol from the ethylene in natural gas.

Part 3 details the manufacture and properties of the numerous series of explosives containing nitroglycerine which are used for blasting purposes, but does not include the non-brisant mixtures used as propellants. The mis-translation of 'brisanz-granaten' on p. 281, as 'brisant grenades,' gives rather a restricted impression of the importance of trinitrotoluene–ammonium nitrate mixtures as shell fillings during the War. The development of gelatinised explosives following on Nobel's discovery of the gelatinisation of nitrocellulose by nitroglycerine marked a great improvement on the dynamite type of explosive, and finally led to the introduction of smokeless propellants containing nitroglycerine. A brief description of the manufacture of nitrocellulose or collodion cotton for this purpose omits all mention of the Nathan and Thomson displacement pan method, which was introduced more than twenty years ago, and has since been widely used.

The description of ammonium nitrate as an endothermic explosive compound, and of tetryl as tetra-nitromethylaniline, should be corrected in future editions.

A large number of tables are given showing the composition and properties of nitroglycerine explosives, but these have not all been brought up-to-date; for example, out of eleven British Permitted explosives quoted, only three are now on the Permitted list.

The book is well printed, and contains few printers' errors. With the reservations mentioned above, it can be recommended to all who are interested in the development and products of the nitroglycerine and nitroglycerine explosives industry.

R. C. G.

The Mechanism of the Nervous System.

The Basis of Sensation: the Action of the Sense Organs. By Dr. E. D. Adrian. Pp. 122. (London: Christophers, 1928.) 7*s*. 6*d*. net.

IT is not always easy to induce the worker who is making great discoveries to put them into a book: and the thanks of the scientific world are due to the University of London for persuading Dr. Adrian to give last year the short course of lectures which formed the starting-point of this little monograph.

Of all the work recorded in the field of physiology in recent times, none is more beautiful in itself, more striking in its historical derivation, more pregnant with possibilities of future development, than that which Dr. Adrian with such engaging modesty and humour describes herein. To have heard the roar in Dr. Adrian's loud-speaker of the amplified afferent impulses flowing up from the heart in the depressor nerve, to have seen the sensory waves in a single nerve fibre from the frog's skin chasing each other like little imps across the screen of Matthews' oscillograph, is to have one's imagination stirred by the progress which has been achieved in the last few years in knowledge of how the nervous system works, and by the picture of the complex scurrying activity on which sensation and consciousness are built. The scientific basis of this achievement is described very shortly but very clearly and with great charm in this book.

It has long been realised that a state of continuous activity cannot be produced in a nerve by artificial means. The only form of message known to occur in a nerve was that of which the fundamental unit is the single nerve impulse, a short wave propagating itself at high speed by what are presumably electro-chemical processes. The activity of a nerve was no more continuous than that of a machine gun: the frequency with which its messages could be carried was similarly limited; after a single impulse, a 'refractory' period occurred during which no other impulse could pass. No proof, however, was at first forthcoming that natural activity in the living body did not invoke another kind of process, one of a continuous nature not involving a stream of discrete waves in the transmitting medium. It is still not certain that such continuous states of activity do not occur: it *is* certain, however, that a large part of the normal functioning of the nervous system depends upon a succession of separate impulses in the nerve fibres exactly similar in nature to those evoked by the physiologist in his studies of isolated nerve. For some years this conclusion has been obvious for the case of motor impulses to the skeletal muscle: Dr. Adrian has made it equally certain for the afferent impulses from the sensory end organs, and in recent work (not referred to in this monograph) has discovered how contractions are graded by the frequency of the impulses which reach the muscles along their motor nerves.

In 1914, Keith Lucas delivered a course of seven lectures at University College, London, and these, after his death at Upavon in 1916, were embodied in a book, "The Conduction of the Nervous Impulse," in a foreword to which Dr. Adrian speaks of himself as "one whose pride it is to regard himself as a pupil of Keith Lucas." Dr. Alexander Forbes, of Harvard, would with equal pride regard himself as a pupil both of Lucas and of Sherrington, and he was among the first to show objectively the discontinuous nature of the afferent messages of the proprioceptive system. The justice of this pious regard for Lucas's memory will be seen in Dr. Adrian's own book, where, suitably modified in the sensory organs, those properties of the nerve fibre which Lucas discovered are shown to be "the basis of sensation." In its skill and subtlety, in the judgment and ingenuity displayed in experiment, no less than in the fineness of its exposition, the work of Adrian is a worthy memorial to Lucas.

The achievement of recording a single wave of action potential in a single nerve fibre, which is the ultimate basis of this work, was made possible by modern developments in valve amplification. In Dr. Adrian's words: "It is now possible to work with a 5000 fold amplification on an input change of a few microvolts without danger of interference from unsteadiness in the amplifier." He pays an amusing tribute to the importance of the amplifier in his work: "When the academic scientist is forced to justify his existence to the man in the street he is inclined to do so by pointing out the essential part played by academic research in the development of our modern comfort. It is only fair, therefore, to point out that in this case the boot is on the other leg and the academic research has depended on the very modern comfort of broadcasting."

Dr. Adrian's work, however, will not be allowed long to remain without its own applications. It is interesting to find how this, the most academic branch of scientific physiology, pursued for purely scientific ends, has suddenly in Dr. Adrian's hands broken out into a region where neurology and medicine cannot fail, in a few years, to gain much by contact with it. Within a short space of time it may well prove as fundamental as the work of Sherrington and Magnus. To a mere physiologist it would seem that psychology also might have much to learn from it. How do our sensations differ in intensity? By the frequency of the impulses started in the end organs. How do we 'get used' to external changes? By the 'adaptation' of the end organs, which is seen in its extreme form in the nerve fibre itself. In Chapter vi., Dr. Adrian deals gently with behaviourists on one hand and idealists on the other: he is much too clever to take sides with the one or the other, and after poking fun at the statement that "the brain secretes thought as the liver secretes bile," he concludes that "it does not matter very much whether we regard the relation of matter to mind as inexplicable or as needing no explanation." "There is a relation of some kind between nervous impulses and sensation, and we can discuss this without attempting to decide how, or whether, the one can 'cause' the other." After which he returns, in the manner of physiologists, to a consideration of the facts of his experiments. A. V. Hill.

Our Bookshelf.

(1) *How you Began: a Child's Introduction to Biology.* By Amabel Williams-Ellis. Pp. 96. (London: Gerald Howe, Ltd., 1928.) 2*s*. 6*d*. net.
(2) *A First Biology.* By Prof. S. Mangham and Prof. W. Rae Sherriffs. Pp. viii + 184. (London: Sidgwick and Jackson, Ltd., 1928.) 2*s*. 6*d*.
(3) *Fundamentals of Biology.* By Prof. Arthur W. Haupt. (McGraw-Hill Publications in the Zoological Sciences.) Pp. xii + 358. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 15*s*. net.

These three volumes may all be said to be books intended to introduce biology to pupils in schools. Mrs. Williams-Ellis's book is intended for young children of about seven or eight years of age. The volume by Mangham and Sherriffs is supposed to be for older boys and girls before they enter a university; whilst Dr. Haupt's "Fundamentals of Biology" is a reprint of lectures given to freshmen in New York, but the intellectual level attained by American freshmen is lower than that attained in the upper forms of the science side in schools in England.

Mrs. Williams-Ellis's book is preceded by a flattering introduction by Mr. J. B. S. Haldane. The book is beautifully written, and is an attempt to describe to young children the general course of human development interpreted in the light of the recapitulation theory, and the view that the essence of life is striving or desire. The child is told that he played at being a fish before he decided to become a man, and so on. Mr. Haldane considers that Mrs. Williams-Ellis's account of evolution is more nearly correct than those recently published by two scientific men. We do not know to what accounts Mr. Haldane refers, but Mrs. Williams-Ellis's account resolves itself into 'chance variations.' The late Dr. Bateson said "there are only two possible explanations of variation—chance, or the reaction of the animal to the environment." We prefer the latter, and believe that Mr. Haldane will also in the course of time.

The other two volumes give a mixture of chapters on animals and plants, and we suppose that the authors imagine that this is the easiest method of initiating young people into the study of biology. Many school teachers are, as a matter of fact, obsessed with this idea. Nevertheless, we hold that it is a profound mistake. That animals and plants are ultimately derived from the same stock, no biologist would deny: there is a level—that of the Flagellata, where they grade into one another. From this starting-point, however, evolution has pursued totally different courses in the two kingdoms, and it is most confusing to place side by side, as Mangham and Sherriffs do, reproduction in the higher plants with its concealed alternation of generations and that of animals. Haupt is not so blameworthy, for he gives a rapid sketch of plants just before proceeding to animals. The only proper way to study either animals or plants, in our opinion, is the way introduced by Huxley, namely, the examination of a series of types, and as we are animals and not plants, it is easier to begin with animals and then proceed to plants. Haupt, as might be expected from New York, devotes a disproportionate amount of space to Morgan and *Drosophila*. We hope that after Miller's exposition of the pathogenic character of the *Drosophila* mutations, this nightmare will gradually vanish from elementary text-books as an illustration of the "fundamental laws of heredity." E. W. M.

Truck Crop Plants. By Dr. H. A. Jones and Dr. J. T. Rosa. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Pp. xiv + 538. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 25*s*. net.

Vegetable growing on a large scale at some distance from a market has assumed such proportions in the United States that certain universities have established divisions of 'truck-farming,' to guide the development of the system along the most economical and profitable lines both as regards cultivation and marketing. The economics of the manuring of truck crops is still in the experimental stage, but the growers are fully alive to the importance of controlling insect and plant pests.

Owing to the distance from market, the appropriate selection of crops is all-important, in order to obtain the essential correlation between the adaptation of the crops to soil and climate and the expected time of marketing. The development of truck farming has largely run parallel with improvement in transport systems, and the installation of refrigerating cars has done much to open up still more distant markets. As the crops are perishable, there is danger of loss from over-supply, and the possibility of competition between truck crops and the local supply in any district needs careful consideration. It seems probable that future advance in truck farming lies in production at lower costs rather than in higher selling prices, entailing concentration on intensive cultivation on land already cleared.

The variety of crops suitable for the purpose is somewhat limited, the most important genus being *Brassica*, which alone provides many species of great economic importance. The general methods of treatment of each crop, from seed to harvest, vary considerably, and are outlined in this volume, sufficient illustrations and tables being provided to emphasise the salient points in crop development, manuring and marketing, and to provide a useful guide to the reader.

(1) *Rovers and Stay-at-Homes*. By Maribel Edwin. Pp. v + 181. (London and Toronto: J. M. Dent and Sons, Ltd.; New York: E. P. Dutton and Co., 1927.) 5*s*. net.

(2) *African Jungle Life*. By Major A. Radclyffe Dugmore. Pp. viii + 246 + 8 plates. (London: Macmillan and Co., Ltd., 1928.) 15*s*. net.

(1) In these short tales, Mrs. Edwin has succeeded in capturing again the fine feeling of her earlier book. The stories are written for young children, and are marked by delightful simplicity of word and narrative. Each story gives a charming and accurate impression of the ordinary life-story of a common British creature—seal, sparrow, rat, sea-gull, eagle, and red-deer are typical samples. Lively pen sketches by M. M. Howard decorate almost every page, but the artist has an exaggerated notion of the amount of leg which a Scottish kilt may properly expose.

(2) Major Dugmore has chosen a series of silhouettes of African jungle life, and round them has written and illustrated a book which, while not specifically addressed to the young, will entrance both them and their elders. His personal touch with the jungle gives vividness, freshness, and accuracy to his stories of the adventures of the selected creatures—elephant, lion, buffalo, rhinoceros, and giraffe—and it is gratifying to read of the success which restrictive game laws, animal reserves, and, not least, enlightened public opinion, have had in preserving the wild fauna and increasing the numbers of innocuous creatures like the giraffe.

Major Dugmore is less happy in his arguments against the advocates of protective coloration, though his actual experiences must be given due weight; when, for example, he suggests that the winter change of the Arctic hare is not protective, because the hare retains its black eye, he forgets that a black eye is surely less conspicuous in snow than a complete brown hare, and that the pigmentation of the retina is an essential to the best vision.

The Earth and its Rhythms. By Prof. Charles Schuchert and Clare M. Le Vene. Pp. xvi + 410. (New York and London: D. Appleton and Co., 1927.) 15*s*. net.

Of the many recent attempts to present popularised geology to the general reader, most of which have come from the United States, this is undoubtedly by far the most successful. The book is attractive in style and make-up; beautifully adorned with illustrations; well proportioned in its matter; and authoritative in its facts. The authors are fully aware of the difficulties that stand in the way of interpreting the processes of geology and the principles of evolution and earth-history to the non-scientific mind. They point out that the book is not intended for the geological purist, and that if there are any generalities that may offend him, he can best spend his spare time in explaining the exceptions that outcrop in the field of generalisations.

The geological purist may, nevertheless, safely recommend the book to any of his friends who may wish to absorb from our common intellectual heritage some knowledge of the record of the rocks. A little more than half the book deals with the architecture of the earth's crust, the fashioning of the raw materials into scenery, and the endless interplay of internal and external agencies. A chapter on geological time then introduces the dark ages of earth history, and the remaining chapters describe the dramatic procession of life with the skill that is to be expected of Prof. Schuchert. The book concludes with chapters on the ice ages and the coming of man. Authors and publishers are to be congratulated on a co-operation that has notably enriched the popular literature of science.

The Ramblings of a Bird Lover. By the Rev. Canon Charles E. Raven. Pp. xvi + 186 + 31 plates. (London: Martin Hopkinson and Co., Ltd., 1927.) 10*s*. 6*d*. net.

After reading this book, the two things the reader finds impressed upon him are these: first, that the author will insist on commencing most of his sentences with 'and' and, secondly, in spite of the weakness of his English, how very charming it all is. One finds that Mr. Raven can turn the catching of a gurnet into a poem of bliss, or can write a most interesting article on fish-bait. All that the author tells us in his book are things most of us knew in our early childhood, yet he awakens in us a fresh delight in our own knowledge.

The illustrations are almost as charming as the letterpress. The printing is good, and the general get-up of the book quite satisfactory. If the reader is irritated by the 'ands' when he starts reading, by the time he puts the book down he will be only too anxious for more.

Practical Vegetable Growing. By J. W. Morton. Pp. 180 + 8 plates. (London: Ernest Benn, Ltd., 1928.) 10*s*. 6*d*. net.

This is an excellent book, by an author who understands the practical side of the cultivation of vegetables. We are in agreement with his comment that far more knowledge may be definitely obtained from careful reading than is realised by the majority of those whose living depends upon the land. Here there is much to be gleaned that will encourage the market gardener, as well as those who work on allotments or maintain small garden plots in outer London and suburban areas. Cultivators in the last category are increasing in number without doubt, and have a special freemasonry of their own to boot.

The book has several useful illustrations, whilst the vegetables dealt with have been taken in alphabetical order. There is a satisfactory index.

Letters to the Editor.

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Oscillation in Ultrasonic Generators and Velocity of Longitudinal Vibrations in Solids at High Frequencies.

THE increasing use of piezo-electric quartz for the stabilisation of radio frequencies has promoted many investigations of the vibration of the quartz. In the last few years a mass of information has been accumulated disclosing the complexities of vibratory modes and types which may exist simultaneously in one and the same crystal plate or rod. Along with the longitudinal, flectural and torsional oscillations may exist, as well as overtones of any or of all. In this connexion mention may be made of the experiments of Cady, Tawil, Dawson, Harrison, Hund, Giebe and Schiebe, Meisener, Ny Tzi Ze, Crossley, Dye, and others.

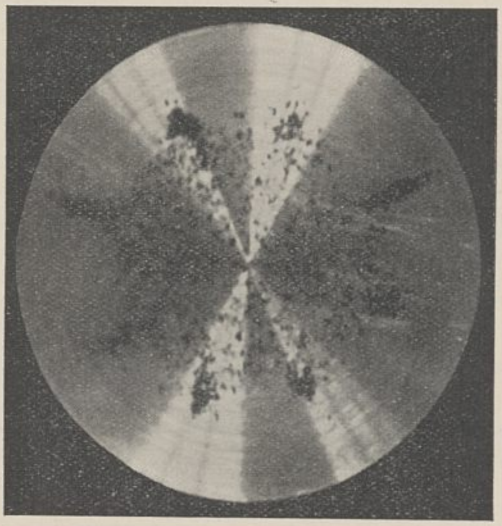

FIG. 1.

It is obvious that if the quartz is cemented to metallic plates or rods, as in ultrasonic generators, when vibrating it can transmit its motions to these bodies, and at very high frequencies, in the plates or rods themselves additional complicated oscillations may arise. A result is that often irregularities of distribution of amplitude, energy, and phase exist at the face of any ultrasonic radiator. Experimentally this was shown by the writer and assistants (*Trans. Roy. Soc. Can.*, **19**, p. 187; 1925) by surveying the energy distribution near the face of an ultrasonic generator operating in water, frequencies around 140,000 cycles per second.

A study carried out in this laboratory last year by Mr. Sproule on the behaviour of dust particles on the ends of vibrating metal rods, held vertically, and set into high frequency vibration by active quartz, revealed interesting examples of very complicated vibratory types. At certain resonant frequencies the dust arranged itself in patterns similar to some of Chladni's figures; four-, six-, eight-, and twelve-pointed stars could be obtained. At certain frequencies the particles were observed to move continuously in a circle about the centre of the section, sometimes those near the outer edge moving in a clockwise direction and those nearer the centre moving anti-clockwise. At times little whirls of dust were formed off centre. Evidently torsional vibrations and radial vibrations of other types could be set up in the rod. The photograph (Fig. 1) shows an example of an 8-pointed star so obtained. Here the rod was of duraluminum 5·1 cm. in diameter and 48·1 cm. long; frequencies of experiment ranging from 84,000 to 140,000 cycles per second.

Such work shows that very cautious judgment must be exercised when determining a resonant frequency, particularly the overtones, of any vibratory type; and mathematical computations of energy output, based on theoretical data alone, or on measurements taken near the radiator, or in any confined space in which the radiatory operates, may easily be misleading.

However, in the case of longitudinal vibrations of a rod of solid material set into high frequency oscillation by a piezo-electric plate, this method may be used, with due caution, to determine the velocity of sound in, and Young's modulus of, the rod at the frequencies of the fundamental note and lower overtones. Pierce, by setting rods of metallic alloys into longitudinal vibration by magnetostrictive action, has recently carried out very precise determinations of the same kind (*Proc. Amer. Acad. Arts and Sciences*, vol. 63, No. 1; April 1928).

For the natural modes of vibration of a free rod, the length of the rod is equal to an integral number of half wave-lengths ($l=k\ \lambda/2$); and the velocity $V=\sqrt{E/d}$ when the rod is thin (r/l small, for a circular section). But possible corrections may have to be applied in case of varying frequency and changing ratio r/l on account of the lateral inertia of the rod. For example, Rayleigh's correction ("Theory of Sound," vol. 1, p. 252; ed. 1894) makes the velocity a function of the mode of vibration, Poisson's ratio, and (rk/l). The work last year on the velocity of ultrasound in metallic rods of different proportions, using the method of high frequency piezo-electric excitation, indicated where the correction for lateral inertia should be applied (*Science Progress*, **89**, p. 92; July 1928). For example, with duraluminum, for $(rk/l)^2 < 0{\cdot}07$, the effect of lateral inertia is inappreciable and the velocity may be computed from $V=\sqrt{E/d}$. In the range $0{\cdot}07 > (rk/l)^2 < 0{\cdot}3$, Rayleigh's expression gave the velocity approximately enough for most purposes; but for $(rk/l)^2 > 0{\cdot}3$ the types of vibration could not be distinguished, the frequency of successive modes of any type followed no apparent law, and no known formula for velocity could correctly be applied.

Frequencies of 8000 to 200,000 cycles per second here were used with duraluminum rods of length varying from 4·1 to 61 cm. and radii of section from 0·63 to 2·55 cm.

Incidentally, the method was applied to determine Young's modulus of ice, for use in association with other problems. This physical constant is most uncertain in quoted values by other methods, but by the present method of high frequency longitudinal vibration it can be easily and quickly determined. The velocity of sound in ice just below 0° C. was found to be $3{\cdot}2 \times 10^5$ cm. per second and does not vary much with changing temperature or direction in the crystal. This velocity gives a value for Young's modulus of $9{\cdot}36 \times 10^{10}$ dynes per sq. cm.

R. W. BOYLE.
D. O. SPROULE.

University of Alberta,
Nov. 17.

Reproduction and Death in Invertebrates and Fishes.

IN NATURE some time ago (**115**, 155; 1925) Dr. Bidder raised again the interesting fundamental question of the cause of normal death in aquatic animals, and stated that so far as he knew there was no evidence of any marine animals dying a natural death, except those whose life is ended by the winter or the summer. Later, the same writer, after reviewing earlier discussions (*Proc. Linn. Soc.*, 1925, p. 17), argued that we have no reason to suppose that aquatic animals, such as plaice, carp, and sea anemones, ever die except by violence. It was stated that though both man and plaice, for example, increase by approximately geometrical progression in weight until the age of puberty, man after the age of twenty-eight declines in (significant) weight and must die; whereas plaice continue to grow indefinitely by positive increments, from which fact it is deduced that life in plaice—and similar animals—may be eternal. The renewal of interest in this subject is already producing practical results, and it is worth while discussing some other aspects of the problem.

The marine naturalist who sees populations of sponges, hydroids, worms, molluscs and echinoderms, and fishes, come and go, can scarcely resist the impression that the life-period is more or less proscribed in some way for each kind. The final violent effacement of soft-bodied marine animals may probably be agreed upon, but such may be only an unimportant effect of a preceding condition of moribundity; the inquiry may therefore be directed towards the possible conditions which may induce moribundity. In the first place, why do animals and other short life-period animals die? A reasonable answer is that this kind of animal dies as a result mainly of expending itself in reproduction; there may often be other contributory factors, but these may be regarded as of a second order of importance. In this type of death it would appear that the constitution of the animal is such that under certain environmental conditions the metabolism is concentrated overwhelmingly on reproduction; we may therefore define the (proximal) cause of death in such cases as the concomitance of the particular organic constitution with particular environmental conditions. (R. Pearl in "Biology of Death," 1922, expresses a similar conception.) For the sake of simplicity we may term this as death from *over-reproduction*. This fundamental conception of death—or moribundity—may be applied especially to marine invertebrates and fishes, to inquire whether reproduction may be a general predisposing cause of death in a less obvious manner than in the case of those animals whose life-period is brief.

The phenomena of death in the sponge, *Grantia compressa*, which disintegrates after becoming almost a mass of larvæ, may serve as a typical example of probable death from over-reproduction (in Child's terminology ("Senescence and Rejuvenescence," 1915) one might perhaps use the term over-senescence). Death in nudibranchs, jelly fishes, many isopods, polychætes, some shore fishes, and no doubt many other forms, may readily be interpreted in the same way. Species which exhibit this form of death are, however, adapted to their environment and survive, but are subject to great fluctuation in numbers from year to year. Other species, which do not die after the first or earlier phases of reproduction, normally pass through a recuperative stage, persisting in either a functional state, or avoiding metabolic unfitness by hibernating or æstivating, and may afterwards begin growth again. Nevertheless, the reproductive phase comes around again periodically, and it becomes necessary to know whether, later in life, reproductive activity increases at a greater rate than can ultimately be borne by the bodily increments between successive periods of reproductive activity.

It should be possible in many cases to express these two factors, for example, bodily increments, and increments in reproductive elements, in terms of weight, as Fullarton and—later—Miss Mitchell did in pioneer studies on a few fishes (Fishery Board for Scotland, 1908–1911, Cd. 6950); if it be found in this way, for example, that the acceleration in weight of the spent body eventually becomes significantly smaller than that of the spent body plus the reproductive elements, then, either death will follow from over-reproduction, as in *Grantia*, or what in practice is the same, the animal may become so unstable in its reproductive equilibrium that any accumulated sub-lethal factors along with the normal rigours in the environment—

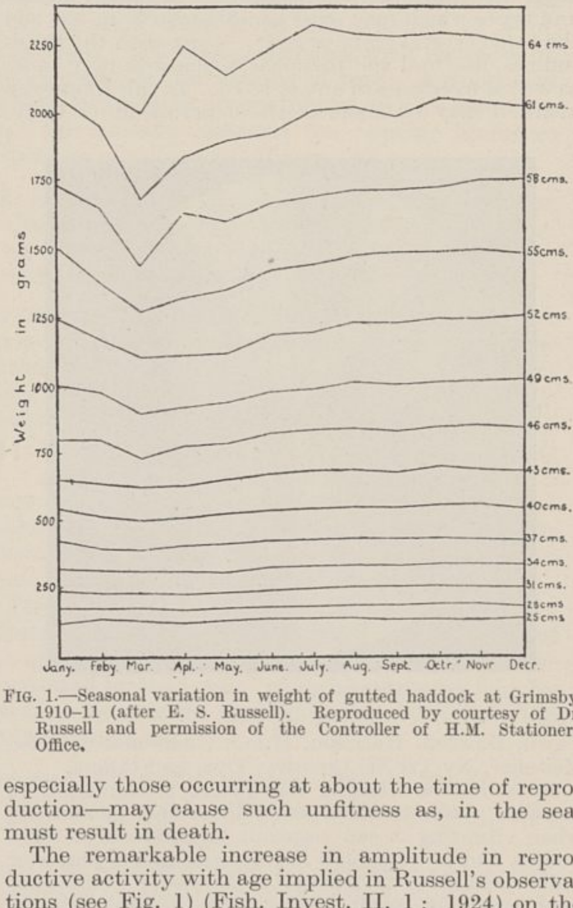

FIG. 1.—Seasonal variation in weight of gutted haddock at Grimsby, 1910–11 (after E. S. Russell). Reproduced by courtesy of Dr. Russell and permission of the Controller of H.M. Stationery Office.

especially those occurring at about the time of reproduction—may cause such unfitness as, in the sea, must result in death.

The remarkable increase in amplitude in reproductive activity with age implied in Russell's observations (see Fig. 1) (Fish. Invest. II. 1; 1924) on the haddock, along with somewhat similar demonstrations in plaice by Masterman (Board of Agric. and Fish. Cd. 5686; 1911) and D'Arcy W. Thompson ("Growth and Form," Cambridge, p. 100), illustrate how reproduction may eventually overbalance normal metabolism and result in death. Russell indeed suggests that in the larger haddock the gonad probably forms a *relatively greater* proportion of the total body weight than in the smaller fish. Other fishes and invertebrate aquatic animals may be expected to provide information of a similar type, so that it may be possible when significant data are known to fix the average probable age of death in particular cases: for such epitomes of the reproductive life-history, as that of the haddock shown above, may give the rate of increase in amplitude of the pendulum of senescence to a true critical point.

In marine invertebrates and fishes there is good ground for regarding breeding as a compulsory rhythm in the healthy individual, and that as a result there is apparently no escape from the periodically increasing strain of the reproductive cycle (accumulative senescence ?). If, on the other hand, we assume that breeding ceases in marine animals at an advanced age, we are probably admitting that death will follow, for a marine animal which is incapable of breeding is already (in a restricted sense) biologically dead ; the longevity of some aquatic animals in confinement may perhaps be due to their avoidance of the reproductive strain. The rate of increase in reproductivity with age in other marine animals than fishes is a relatively unknown subject, but in many forms valuable information could easily be acquired.

From my own data (*Jour. M.B.A.*, **15**, 2 ; 1928) on the oyster there is a strong indication that the weight of sexually mature individuals up to an age of about seven years increases at a greater rate than that of sexually spent individuals (taking similar estimated ages as a criterion of similar sizes), so that the amplitude of reproductive activity may be expected to increase with age in the same way as in the haddock, and life will apparently—or perhaps must—become unstable at the weakest point in the reproductive cycle (*sic*) at about the spawning time. On the difficult subject of normal mortality there is in the oyster—as in some other forms—probably a maximum at about the spawning period. Enough has perhaps now been presented to focus attention on the probable importance of over-reproduction—along with other contributory factors—in predisposing or causing death in marine animals. A collection of figures and facts—and especially facts regarding physiological states—is now required to bear on the problem before proceeding further, and in any event, mathematical expressions of the rate of reproduction (as defined) in a variety of aquatic animals would provide information of much general interest. J. H. ORTON.

Marine Biological Laboratory,
Plymouth, Nov. 13.

Rotation of the Earth and Magnetostriction.

IN 1926, Prof. E. W. Brown presented the evidence indicating remarkable changes in the rate of the earth's rotation (*Trans. of the Astronomical Observatory of Yale University*, vol. 3, part 6). Changes, more or less abrupt, were shown to have occurred about 1785, 1850, 1898, and 1918. Prof. Brown finds that the observational data are consistent with the hypothesis of an oscillatory change in the earth's mean radius. Why the earth should expand and contract, he makes no suggestion, but gives a study of the occurrence of earthquakes, which, however, shows no well-defined correlation. He cites a theory of Prof. Joly (*Observatory*, February, 1926) that the vertical oscillations of the earth's crust may be caused by a thermal effect of radium acting in a substratum of basalt.

Prof. W. de Sitter has discussed the relation of the earth's rotation and astronomical time in NATURE (Jan. 21, 1928, page 99). To satisfy the observations, he combines the effect of changes in the size or shape of the earth and the variable force of tidal friction. He does not explain what may expand or distort the earth.

I have taken considerable interest in the variable rotation of the earth, and recently have tried to relate it with magnetostriction. Why may not the earth pulsate under varying magnetic force ? An iron bar may be lengthened a millionth part by magnetisation even in a moderate field. In stronger fields it suffers contraction, but we are not concerned with such fields. Now the earth has an iron core at the centre, which may perhaps be expanded by increase of magnetic force. With expansion, the earth's rotation would be retarded. It might be that the increase of the earth's diameter would be in the line of the magnetic poles. However these are far enough from the axial poles to produce some effect. It may be questioned how much of the iron core, on account of its heated condition, might become magnetised. If the magnetisation is at the periphery of the iron deposits surrounding the core, that may accord with one of the calculations of Brown, in which changes in pressure are conceived as taking place in an outer stratum.

Of the measures of terrestrial magnetism, observations of the declination are in general the most trustworthy. In seeking a correlation, it seemed best to use the secular change. *Special Publication of the U.S. Coast and Geodetic Survey*, No. 126, gives the change in declination with time for places distributed over the whole of the United States at intervals of 2° of latitude or longitude. The secular change was easily derived by taking differences of the tabular values. I have plotted curves for many of these stations, using the secular change (+ to west) for 10-year intervals. Although many shifts and variations occur for different parts of the country, yet there are three striking features. A pronounced minimum occurs in the vicinity of 1900. A maximum is found near 1850 for eastern sections, and about 1890 for western sections. On many of the plots we find another maximum about 1920. It seems remarkable that these maximum or minimum points should occur so near the dates found by Brown for changes in the length of the day. I have studied also data for a few stations in Europe with similar results.

Some of these changes have been noted elsewhere. Chree (" Enc. Brit.," vol. 17, page 359) remarks : " The rate of movement of the needle to the east at London —and throughout Europe generally—fell off markedly subsequent to 1880. . . . Thus in 1902 it was at least open to doubt whether a change in the sign of the secular change were not in immediate prospect. Subsequent, however, to that date there was little further decline in the rate of secular change, and since 1905 there has been a very distinct acceleration." Discussing further, in particular concerning the anomalies of secular change in the United States, he writes : " Auspices do not all point one way, and the future is as uncertain as it is interesting." Since that time we have had the maximum which set in about 1920.

Much work has been done at various places to relate sunspots and magnetic declination. Without expecting much, I have put together sunspot data. Plotting curves of Wolf's sunspot numbers, and then connecting maximum points, the curve so drawn shows a minimum about 1905. This proves very little, as a still lower point of the curve occurs about 1804 and 1816.

It must be said concerning the hypothesis of magnetostriction producing oscillations in the earth's diameter that the force of the magnetic field of the earth is quite weak. Moreover, the interior of the earth contains not only iron but also nickel, which contracts in all magnetic fields. These are complicating factors. The correlation between the secular changes in declination and the change in the rate of the earth's rotation appears important. It may be that the changes in declination are pressure effects arising from the slight adjustments of the structure within the earth. The rearrangement of the strata sufficient to produce the changes in the length of the day, might also, by magnetostriction, affect the earth's magnetic conditions. We would then be dealing with results from a common cause.

The whole question is of great interest, and I shall pursue the inquiry further. Meanwhile, I have written this note in the hope that others, better acquainted with the magnetic and geophysical aspects of the problem, may pass their judgment.

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Nov. 21.

Oxide Films responsible for the Tints on Heated Copper.

MUCH has been published on the tints of heated copper, but disagreement prevails regarding the oxide responsible for the colours; Dunn (*Proc. Roy. Soc.*, **111** [A], 211; 1926) apparently attributes them to cuprous oxide, and Constable (*Ibid.*, **115** [A], 583; 1927) to a "veneer of cupric oxide." Recently the oxide films have been isolated from their basis, the metal being dissolved from below by anodic treatment in concentrated potassium sulphate solution; the oxide films, thus undermined, peel off in curling flakes, which retain the grooves and ridges left by the abrasive treatment used to clean the copper before oxidation. The thicker films can also be removed mechanically.

The two oxides present in the films are quite different in appearance and can be distinguished by chemical tests. At thicknesses above the interference colour range, cuprous oxide films appear brown by transmitted light and exhibit by reflected light a characteristic colour best described as pale chocolate; but a veneer of cupric oxide produces a dark grey reflex without a trace of brown or red. Residual metallic copper, where it exists in the films, has a bright red lustre and is opaque; its presence may be revealed by the action of silver nitrate, which produces a microscopic 'silver tree.'

It has been found that the colours are due to cuprous oxide. Cupric oxide is indeed formed under strongly oxidising conditions, but it obscures the colours, and must be avoided if the later tints are to be obtained. Thus Constable, working under conditions favourable to the production of cupric oxide, obtained no colours beyond the middle of the second order, the tints darkening and passing into the black characteristic of cupric oxide. This has been confirmed, but it was found that if the formation of cupric oxide is avoided, the sequence can be followed to the fourth order; the tints then pass gradually into the characteristic colour of cuprous oxide. The easiest way to prevent the formation of cupric oxide is to use a *mildly* oxidising gas mixture—preferably obtained from a flame of pure alcohol.

Within the interference-colour range, the cuprous oxide films are quite transparent. On the whole, the oxide film taken from copper tinted to an early colour is more transparent than that taken from copper displaying a high-order tint; but in the latter case fragments of thin, highly transparent films are also separated along with the thicker skin. This is apparently due to the fact that the skin cracks as it thickens, allowing air access to the metal exposed at the crack, so that another film is formed below the first; this lower film will be generally thinner than the first and will diminish in thickness with the distance from the crack. The formation (at a crack) of one skin below another has been directly observed at high temperatures, and there is evidence that the phenomenon is general; for it is found that copper heated rather too strongly for interference colours nevertheless yields—on stripping—flakes which display bright colours, the tints varying from place to place as the result of varying thickness.

The colours of the stripped films are often brilliant by reflected light, rose, blue, and green hues being obtained; by transmitted light the interference tints are largely masked by the yellow hue due to selective absorption, but there is a slight variation of colour with thickness between yellowish-green, bright yellow, and brown.

The films isolated from copper tinted to the early first-order colours usually contain opaque spots due to included metallic copper, and the metallic residue increases on passing to films taken from copper heated insufficiently to produce colours. In films removed from copper merely exposed (after abrasion) to dry air at *ordinary temperatures*, the opaque areas generally predominate over the transparent areas, although the character of the composite oxide-metal layer varies with the nature of the abrasive treatment employed. The composite layer appears to be formed as follows: Abrasion produces a network of cracks, increasing the true surface area, as found by Bowden (NATURE, **112**, 647; 1928). On exposure to air, the walls of these cracks become oxidised, and the internal oxide-sheaths obstruct to a large extent the anodic removal of metallic copper, so that the layer left (after the unchanged basis has been dissolved away) consists of both metal and oxide. Clearly with increasing temperature or time of exposure to oxygen, the proportion of residual metal in the layer stripped will diminish, and hence the films obtained from copper tinted to any of the later colours are practically free from metal.

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Radio Echoes and Conditions for their Occurrence.

SINCE October 24, the emission of signals (see NATURE, Nov. 3 and Dec. 8, 1928) from the short-wave emitter PCJJ (Holland) has been continued twice a week, and sometimes more frequently. Through the Norwegian Telegraph Office a series of receiving stations has maintained a continual watch, and an oscillograph has been ready for use at all times, but no echoes have been heard, either in Norway or in Eindhoven.

It appears from this, and from the long silence during experiments in the spring and summer, that the echoes constitute a very rare phenomenon and owe their occurrence to a series of favourable coincident circumstances. The wave-length must be the most favourable one, and the emission must be sent out in the right direction and with sufficiently great energy. (A transmitter station in the tropics would probably be better than a station in Holland.) The Kennelly-Heaviside layer must be penetrable by the outgoing and returning waves, and must also be favourable for the hearing of both signals and echoes, and the receiving apparatus must be sufficiently sensitive and exactly adjusted.

Further, there must be good conditions for hearing without too many atmospheric disturbances, and, last but not least, the emission of electrons from the sun must take place in such a way that reflecting surfaces in space outside the orbit of the moon may be formed and may have the most favourable shape for a good reflection of the waves.

As regards the last point, the mathematical theory of the motion of electric corpuscles around a magnetised sphere shows that the chances of obtaining a well-defined toroidal space round the earth are good when the direction to the sun lies near the magnetic equatorial plane (perpendicular to the magnetic axis).

This result is in close agreement with a remarkable experiment made by the late Prof. Birkeland [1] which is reproduced in Fig. 1.

Here cathode rays are sent from an aluminium plate near the magnetic equatorial plane of the magnetic sphere, and a part of the toroidal space is very well seen with corners of rays descending to the polar regions of the sphere, corresponding to the

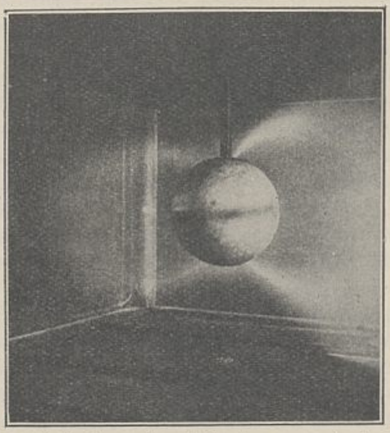

FIG. 1.—Cathode rays in relation to a magnetised sphere.

production of polar auroræ. On the two occasions, Oct. 11 and 24, when echoes were heard, the sun was not far from the earth's magnetic equatorial plane. But such favourable occasions disappeared towards the end of October and will not recur before the middle of February. Thus, if this explanation of the most favourable situation of the sun is correct, it is improbable that echoes will be heard again before that time.

CARL STØRMER.

Oslo, Dec. 12.

[1] See "The Norwegian Aurora Polaris Expedition, 1902–1903," vol. 1, Second Section, Fig. 265A, p. 712. (Longmans, Green and Co., London.)

Soap Film Pressure Gauge.

IF a soap film is formed across a circular aperture in one side of an otherwise closed box, and if then air is introduced into, or removed from, the interior, the surface of the film becomes part of a sphere, and therefore the pressure within the box differs from that outside by a quantity which is directly proportional to the surface tension of the film, and inversely proportional to the radius of the sphere.

If R, r, and T are respectively the radius of the hole, the radius of the sphere, and the constant of surface tension, the difference of the air pressure inside and outside the box is $4T/r$ (since both surfaces of the film contribute to the tension) and the difference is + or − according as to whether air has been introduced or withdrawn.

The radius of the sphere can never be less than R, and when $r = R$ the surface of the film is a hemisphere. Thus $\pm 4T/R$ is the greatest difference of pressure which can be balanced by the surface tension.

For any condition which makes the bubble less than a hemisphere, the film may be used as a pressure gauge, since the difference of pressure within and without the box can be determined if T is known and r measured. There are several ways by which the radius of a bubble can be found, that which I have generally used being to measure the size of the virtual image, reflected by the film, of an object of known size and distance. This allows of the determination of r with considerable accuracy.

Convenient apparatus for the purpose can take many forms which need not be described here, but it is worth while to note the order of pressure difference which can be measured by soap films as compared with various other forms of barometric measurement. A good barometer or aneroid will indicate the difference of level between the surface of the table and the floor on which it stands, say a head of 30 inches of air. For a soap film, suppose, for example, that T has a value of 3 grains per linear inch and that $R = 1$ inch, then the maximum pressure difference which can be sustained by surface tension is 12 grains per square inch—equivalent to a head of about 3 feet of air. Thus for this particular case the greatest pressure difference which can be dealt with by the soap film is not far from the minimum which can be observed by the aneroid. With a soap bubble, however, the radius can without much trouble be determined with sufficient accuracy to allow of the measurement of pressure difference equivalent to heads of a few hundredths of an inch of air.

I used this form of pressure gauge to find out whether, when a chimney smoked, the pressure in the room rose or fell. A rise of pressure would show that the wind blew down the chimney, and a fall that there was negative pressure on the lee side of the house. In stormy weather I found many instances of both kinds, and the type which prevailed depended, as might be expected, on the direction of the wind.

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Delayed Metamorphosis in a Predaceous Mosquito Larva and a Possible Practical Application.

ON June 10 of this year, in a rot-hole in a tree at Epe in Southern Nigeria, I secured a young specimen of the predaceous larva of the mosquito *Megarhinus* (*Toxorhynchites*) *brevipalpis*, Theo. With the intention of bringing the insect alive to England, it was retained in two or three ounces of its natural water and given a very restricted diet in the form of an occasional *Stegomyia* larva.

It was eventually brought to England in the middle of August, and was maintained at 24° C. without any special attention, until it died on Nov. 18 without having passed the larval stage.

My reason for recording these observations is that it has been suggested (Buxton and Hopkins: "Researches in Polynesia and Melanesia"; London, 1927) that members of this predaceous genus of mosquito, which breed exclusively in rot-holes, should be introduced into Fiji, Samoa, and other South Pacific islands as a measure of control of the local vector of filariasis (*Aedes* (*Stegomyia*) *variegatus*) which breeds in the same situation. The nearest locality for *Megarhinus* in that part of the world is, however, the Bismarck Archipelago, and the difficulty and expense of establishing (as has been deemed necessary) intermediate stations in the conveyance of the insect from New Guinea to Queensland and thence to Fiji and Samoa—a distance of some 3000 miles—has prevented any attempt at the experiment.

It now appears from the observation recorded above that by simply limiting the food supply the larval stage of this insect can be prolonged by at least five months, which would afford ample time for the transmission of larvæ direct, and thereby greatly facilitate the carrying out of the experiment in question.

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Nitrogen Fixation: the Growth of a New British Industry.

THERE have always been those who delight in prophesying catastrophes to the human race, just as there have always been those who do not listen to them. The future of mankind may, indeed, be violently affected by some unexpected and extremely disconcerting cosmic disturbance; it is certain to be influenced in a less spectacular although equally impressive manner by limitations in the natural productivity of the earth's surface, and in the extent of the remaining reserve areas of virgin soil. In a mere comparison of rates of productivity we appear to have ample material wherewith those so minded can, without much risk of contradiction, anticipate a first-class human disaster; we also have an indication that the so-called 'nitrogen problem' is not a transient condition, but a situation which in our own day needs courageous, systematic, and world-wide measures for its solution. We may assume that between a date which remains controversial and A.D. 1800 (perhaps half a million years, perhaps more) the population of this earth reached 800 millions of human beings, whilst from A.D. 1800 to 1900 it rose to 1730 millions; if this rate of increase continues—and there is no reason to anticipate the contrary—an early intersection of the population curve and the soil productivity curve is necessarily to be expected. Indeed, it has been estimated that the present methods of farming will lead to a definite food scarcity before the end of the present century.

However unpleasant an episode in the history of our race such an intersection might indicate, it would be more profitable to consider, while there is yet food enough and to spare and while any inadequacy of clothing is due to causes other than lack of raw materials, the alternative policies which are open to us. We may be compelled to find a means of restricting the rate of increase of the population, or we may submit to restriction by starvation; we may even discover forms of food which are not agricultural in origin. The obvious line of advance is, however, to seek to increase substantially the average output of the soil under cultivation. This course involves not only a development of improved methods of farming, but also a cheaper and more abundant supply of inorganic fertilisers—particularly of suitable compounds of nitrogen.

Both of these matters are major problems with which the intelligent world finds itself confronted, and both are of dimensions which are scarcely amenable to parochial, even strictly national, treatment. In the course of their development, for example, the primitive methods of cultivation in Eastern countries will gradually be replaced by more modern methods, in which the liberal, but always scientifically controlled, application of fertilisers not originating from previous agricultural operations will play their part in safeguarding the world's food supply and raising the standard of living. It has been computed that in pursuance of this policy an annual addition of 125,000 tons of fixed nitrogen, that is, nitrogen in the form of suitable compounds, to the world's productive capacity is immediately necessary, and that in the future the amount will need to be larger.

The nitrogen in the atmosphere cannot in general be assimilated by plants, although certain classes, particularly leguminous plants, are able with the assistance of appropriate bacteria associated with their roots to draw upon this enormous reserve of nitrogen, and thereby, in fact, to enrich the soil. It will be remembered that in 1852, Lawes and Gilbert showed that non-leguminous plants require for their growth a supply of nitrogenous compounds, and that the ammonia in the air, supposed by Liebig to be the source of the necessary nitrogen, was insufficient for the purpose; the stages in the investigations leading to Hellriegel and Wilfarth's discovery of the effect of bacterial action in the assimilation of atmospheric nitrogen by leguminous plants form a chapter of considerable interest. Rothamsted, the home of Lawes and Gilbert's, and of a continuous succession of similar, experiments enjoys the distinction of laying a not inconsiderable part of the foundations of scientific farming and of the nitrogen industry, not only in Great Britain, but also throughout the world.

In his address to the British Association in 1898, Sir William Crookes said: "The fixation of atmospheric nitrogen is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilised races of mankind." Before 1914 the world's requirements of nitrate-nitrogen were supplied from Chile, where immense deposits of sodium nitrate (associated with a small proportion of iodine in combination) were discovered only a hundred years ago. Apart from similar nitre beds in Peru and Bolivia, all rainless districts, no other extensive deposits are known or anticipated to exist. Exportation from Chile commenced about 1830, and by 1912 had reached more than two and a half million tons, representing 57·5 per cent of the total world's output of fixed nitrogen; 38 per cent was accounted for as by-product ammonium sulphate, originating from the illuminating gas and metallurgical coke industries. Various estimates have been made of the probable life of the South American deposits; apart from considerations of economics, it is probable that they would be able to supply requirements for at least a century—a 'breathing space' but not a very long period in the normal life of an animal species.

The agricultural prosperity of the British Empire has therefore been to an appreciable extent dependent on the goods exported by another nation, and this subjection the British chemical industry has the power, and the intention, to neutralise. The existence of the British Empire was, not very long ago, dependent on its opportunity to purchase nitrate from Chile and its ability to transport the material to our own ports. This three-fold dependence is one which, it is to be hoped, will never again exist. The intention in this article is not to dwell on the place of the nitrogen industry in the defence of the British Empire, but it would be an affectation to ignore the undisputed fact that that position is vital. God forbid that it should ever again be necessary for Great Britain to defend her shores with arms, but only while she can fix her own nitrogen has she the certainty of possessing the raw materials for her munitions. So crucial, indeed, is the supply of fixed nitrogen in such an emergency, that voices have been raised against allowing the British industry to be under any control but that of the State; on the other hand, the record of State fixation of nitrogen in Great Britain is not such as to lend undue support to the contention.

The methods which have been employed in solving what is commonly known as the 'nitrogen problem' are familiar. Apart from the striking development of natural supplies already mentioned —supplies of by-product ammonia being stationary, or even on the decline—methods based on the union of atmospheric nitrogen with oxygen or with hydrogen, either directly or indirectly, have been worked out on a laboratory scale, applied to a technical process, and have met with considerable, although naturally fluctuating, economic success. The three most important processes are:

(*a*) The arc process, in which nitrogen and oxygen are exposed to the very high temperature of an electric arc, whereby 1·15 per cent of nitric oxide is formed, this gas then being oxidised by air to nitrogen dioxide, which by reaction with water or alkaline liquids yields nitric acid, nitrites, and nitrates. This process is losing ground on account of the high production costs and power requirements, and is manifestly unsuited for use in Great Britain, where cheap electrical energy is not available; in Norway, however, and elsewhere, it continues to be employed. It has the advantage of employing free materials and a small amount of labour, and of producing nitric acid directly; on the other hand, the installation costs are high, and nitric acid is not a convenient product for transportation and agricultural use. For this purpose calcium and ammonium nitrates are manufactured. The credit of invention of the process, or rather of the successful technical adaptation of Lord Rayleigh's method for combining nitrogen with oxygen, belongs to Prof. Birkeland of Christiania, and Dr. Eyde, a Norwegian engineer; subsequent developments in furnace construction are associated with the names of Schönherr and of Pauling.

(*b*) The cyanamide process, in which impure calcium carbide is exposed at a high temperature to the action of nitrogen, producing calcium cyanamide, $CaCN_2$, which when subjected to hydrolysis in an autoclave affords ammonia. This process has been in use at Niagara since 1909, and is a familiar process elsewhere; it was the process chosen for use at the great war factory erected at Muscle Shoals, Alabama—a factory which cost twenty million pounds but never came into production. Here again Great Britain suffers from the disadvantage of the high cost of electrical energy necessary for producing the carbide from lime and coke, and for heating it in contact with nitrogen; admittedly Great Britain (except in the Scottish Highlands) lacks adequate water power, but she has been slow to harness such natural power as is available.

(*c*) Haber's catalytic process, in which a mixture of hydrogen and nitrogen under pressure is heated to a moderate temperature in chrome-steel bombs in the presence of a suitable catalyst, such as pure iron mixed with small quantities of alkalis and acidic oxides, the ammonia so formed being removed by dissolution in water. This process makes no extravagant power demands, and is suitable for development in Great Britain; for reasons which will appear later, it is, nevertheless, associated with technical difficulties of no mean order. The hydrogen can be produced by the electrolysis of water, by the action of iron on steam, from water-gas, or in the fermentation process for the production of acetone and butyl alcohol; the nitrogen can be obtained by fractionation of liquid air. In the Bosch process the mixture of nitrogen and hydrogen is obtained from producer gas and water gas. The famous German factories at Oppau and at Merseburg are devoted to the direct synthesis of ammonia. Claude's modification of the process employs pressures of the order of 1000 atmospheres, and removes the ammonia by liquefaction.

These three methods, as has been explained, form the backbone of nitrogen fixation as a technical operation subject to economic considerations. Any process which produces ammonia is naturally to be combined with an oxidation process if—as is the case when munitions of war or intermediates for the chemical industries are concerned—it is desired to manufacture nitric acid. This is accomplished by a catalytic method, generally known as Ostwald's method, in which a mixture of gaseous ammonia with air or oxygen is passed over heated platinum, whereby nitric oxide, afterwards oxidised by the further action of air or oxygen to nitrogen dioxide, is obtained. On dissolution in water under oxidising conditions, this gas affords nitric acid. Numerous variations in the arrangement of the catalytic converter have been worked out and employed in Great Britain and elsewhere. Incidentally, it has been found that the catalytic oxidation process can be profitably applied to the production of nitrogen oxides in the lead chamber process for manufacturing sulphuric acid; indeed a British report on the subject was issued so early as 1917.

Passing reference may also be made to other and less successful processes for the fixation of nitrogen. The Serpek process is based on the production of aluminium nitride when nitrogen is passed over a mixture of carbon and impure aluminium oxide; the reaction may be carried out under pressure. On hydrolysis of the product with sodium hydroxide solution in an autoclave, ammonia and sodium aluminate solution result, the latter affording pure alumina (suitable for the manufacture of aluminium) on treatment with carbon dioxide. In Bucher's process, nitrogen is passed through a mixture of sodium carbonate and carbon, together with a little finely divided iron as catalyst, heated at about 950°, when sodium cyanide and carbon monoxide are produced; the sodium cyanide is then decomposed by steam yielding sodium formate and ammonia. Partington and Parker ("The Nitrogen Industry," 1922) state that the United States Government made careful investigations of this process, and that a large plant was said to be ready to begin operations in 1918.

However, the direct catalytic synthesis of ammonia is probably to be regarded as providing the key to the world problem of nitrogen supplies. The atmosphere contains enough—some 4×10^{15} tons, it is said—and to spare; Haber's process makes no excessive demands as regards power or fuel, and it now holds a pre-eminent position in the field of nitrogen fixation. In view of its proved success and its established position in Germany under conditions both of war and of peace—manufacture there having been proceeding since 1913, and production in Germany to-day being of the order of 600,000 tons per annum of nitrogen—it is not surprising that in the development of the nitrogen fixation industry, which continues to extend rapidly in most European countries, as well as in the United States of America and in Japan, new plants should envisage the application of this process almost exclusively. The advantages which direct synthesis of ammonia offers are, in fact, such as to introduce the method into Norway, the home of the arc process.

(*To be continued.*)

The Skull of Lord Darnley.[1]

IN the year 1869 Mr. J. W. Belt presented to the Royal College of Surgeons a skull—minus a mandible—and a thigh bone, believed by the donor to be those of Lord Darnley. He had obtained them from Mr. Grimshaw, a dealer, who had bought them four years earlier at a sale by Messrs. Sotheby and Co. of certain effects belonging to the Hon. Archibald Fraser of Lovat. The Conservator of the Museum, looking the gift horse in the mouth, entered the bones in the Museum catalogue, with the remark that "the internal evidence afforded by both bones conclusively negatives their authenticity. Darnley at the time of his death in 1567 was about 22 years old, and the bones are those of a man considerably more advanced in life and of great muscular development. The almost complete absence of frontal elevation, which is one of the most striking features in the skull, finds no corroboration in any of the known portraits and descriptions of the young Earl, and the femur could not be that of a person invariably described as 'tall' or 'long,' as calculating at the usual ratio of 27·5 to 100 it would give a height of only 5 feet 2·2 inches." So adverse a decision would be sufficient to deter most from further inquiry, but not Prof. Karl Pearson, who has attempted, with what success we shall see, to establish the authenticity of the more important of the relics, namely, the skull.

In 1880 Mr. T. M. Grimshaw—presumably the same man from whom Mr. Belt obtained the bones mentioned above—offered the Conservator of the Museum of the Royal College of Surgeons a femur bearing a manuscript label to the effect that it was "the thigh bone of Lord Darnley, husband of Mary Queen of Scots, murdered and blown up, February 10th, 1567." This, he stated, had been bought at a sale at Sotheby and Wilkinson's, together with two other bones, "the thigh bone of Little John, the companion of Robin Hood, and the shin bone of Humphrey, Duke of Gloster"; no mention is given of the date of this sale. The femur was purchased and entered in the Museum catalogue as "that of a very tall man, probably the real thigh bone belonging to the skull," presented eleven years earlier by Mr. Belt, an assumption which is almost certainly correct, for skull and femur exhibit the same peculiar coloration, "such as usually obtains," to quote the new catalogue, "in bones that have lain long in a peat bed."

If we accept, as we think we safely may, the single origin of the two relics, namely, the skull presented in 1869, and the femur purchased in 1880, then clearly, from the point of view of authenticity, they must stand or fall together. The authenticity of the femur gains support from the manuscript label, but suffers from the strange company in which the bone appears, company for which Prof. Pearson has no use, dismissing them summarily as "bones of most absurd attribution." In this we think Prof. Pearson has done wrong, for a little inquiry would have shown that the bones might very well be those of the more or less venerable Englishmen to whom they were ascribed. 'Little John'—or such part of him as was not apocryphal—was a big, stalwart man, whose grave is still to be seen in Hathersage churchyard. The grave was rifled, we are told, in 1782, and again in the early years of last century, when a thigh bone, measuring, it is said, 32 inches, was taken from it.[2]

Humphrey, Duke of Gloucester, murdered at Bury St. Edmunds, was buried in St. Albans Cathedral. The leaden coffin containing his body, and "full of pickle," was opened in the reign of Queen Anne; the body was taken out of the preserving fluid, and "reduced to a skeleton, the smaller bones of which the vergers permitted visitors, for a due consideration, to carry away."[3] If, then, the two bones can scarcely be described as Daniels come to judgment, they are nevertheless not the guys which at first sight they appeared. They further serve the useful purpose of restoring our confidence in the good faith of Sotheby and Grimshaw, a not unimportant matter, seeing that they are among the sponsors for the relics. Sir Arthur Keith[4] thinks it "most probable" that

[1] *Biometrika: a Journal for the Statistical Study of Biological Problems.* Edited by Karl Pearson, assisted by Egon S. Pearson. Vol. 20 B, Part 1, July. Pp. 104+46 plates. (London: Biometric Laboratory, University College, 1928.) 21*s.* 6*d.* net.

[2] "Guide to Buxton, the Peak, Dovedale, etc." (London: Ward, Lock and Co.)

[3] "Saint Albans" (Bell's Cathedral Series).

[4] *British Medical Journal*, Sept. 8, 1928.

the femur presented by Mr. Belt with Darnley's skull was the femur of 'Little John.' This can scarcely be, but, granted a certain confusion, and such appears to have occurred, and was not unlikely in a saleroom, where such objects as bones can be so easily mislaid, forgotten, and wrongly ascribed, it is not impossible that the femur in question is that of Humphrey, a man of no little importance in his day, own brother as he was of Harry of England.

It is now time to record certain strange events which followed on the death of Darnley. His body, blown up by the explosion at Kirk o' Field on the morning of Feb. 10, 1567, was bowelled and embalmed with perfumes and spices, and four days later buried in the Royal Vault in the south-east corner of the Abbey Church at Holyrood. There the body lay in undisturbed privacy until January 1683, when, in the removal of certain seats, the Royal Vault was discovered and found to contain six leaden coffins. Of these, two contained the bodies of children, the infant sons of James V.; three bore on them, or near them, inscriptions indicating that they contained the bodies of James V., his first Queen, Magdalen, and his illegitimate daughter, the Countess of Argyll. James's body was coloured black with the balsam which preserved it, which was like melted pitch. The sixth and largest coffin contained a body not so long as that of James V., with the muscles of the thigh seemingly entire, and with balsam stagnating in some quantity at the foot of the coffin: it bore no inscription, but it was generally and confidently supposed to be that of Lord Darnley.

In 1688 the 'Glencairn purging' included the violation of the Royal Vault, but apparently the bodies were left more or less intact, for in 1735—incredible though it seems—they were seen "lying open to the view," the coffins having been broken into by the mob in 1688. Still later, in 1776, they were seen by Arnot, "the head of Queen Magdalen being entire and even beautiful." In 1778 the same antiquary reports that both the Queen's head and Darnley's skull had vanished. It will be noticed that references are to Darnley's skull, not to his head, from which we may presume that the embalming, always "an hazardable piece of art," had not been so successful in his case as in that of Queen Magdalen. No mention is made of the colour of his skull, but it seems not unreasonable to assume that it was like that of James V., black.

We next hear of the skull through Alexander Campbell, who wrote that it "is preserved among the curiosities of the Antiquarian Society of Scotland, exhibiting melancholy proof of the effects of his incontinence"—a significant remark, for it implies that some part or parts of the skull had been eaten away, the popular and not unscientific conception of the effects of syphilis, and further explains the relative ease and confidence with which the relic was followed in its subsequent wanderings. In spite of Campbell's statement, no mention of the skull has been found in any of the catalogues of the Scottish Society of Antiquarians, an omission attributed with some reason to its being the personal property of James Cummyng, the secretary of the Society, who would naturally hesitate to make it publicly known that he was in possession of so important a relic, obviously nefariously acquired. At his death it is believed it was sold by his executors with other of his effects, passed into the hands of an Edinburgh sculptor, and finally into those of Archibald Fraser of Lovat. No mention, it will be noted, is made of the thigh bone until it appeared with the skull in Sotheby's catalogue.

Such, then, is the historical evidence—not, it is true, absolutely convincing, and yet not, we think, to be lightly set aside in view of the general and confident identification of the body in the large coffin, of the early recognition of distinctive marks on the skull, and of the reputation of the various witnesses. The chain of evidence is complete, but not all the links are strong.

We now pass to a consideration of the actual relics, for confirmatory or rebutting evidence. First, as regards their colour: this varies from a light brown to a blue-black. Dr. H. A. Harris, in a recent article,[5] attributes both the colour and the polish, here and there apparent, to the bones having been painted with shellac. Prof. Pearson attributes them to the body having been embalmed, to the "stagnating balsam" to which reference has already been made. The question cannot, we infer, be decided by the chemist, as both shellac and balsam are resinous substances. Of the two explanations, we are inclined to accept that of Prof. Pearson. The extreme variations in colour, thickness, polish,—the patchy distribution are all against the coating being due to the undiscriminating 'dead' hand of man working with a uniform medium, and in favour of the more or less natural 'wash' of a solution of varying composition, picking out for different treatment different anatomical areas. We would particularly instance the appearance of the posterior surface of the neck of the femur, there being a sharp distinction between the colour and patina of the upper and lower parts, the line of separation agreeing exactly with the line of attachment of the capsule of the joint. It is difficult, again, to explain on Dr. Harris's hypothesis why the interior of the cranium is similarly coloured to the exterior.

If, then, we are inclined to accept Prof. Pearson's explanation, we might hope to find some evidence of embalming, in clinging remains of soft tissues: these we find in the interior of the cranium, for not only is part of the general dura mater still evident, but we can actually see on the left side of the mid-line the lacunæ laterales stretching from frontal to occipital region—a piece of evidence not available to Prof. Pearson when he wrote his monograph, for at that time the skull had not been opened. That the skull was never buried in the usual way is almost certain. Sir Arthur Keith has shown that there is an entire absence of earth in any of the natural cavities, such as the cranial cavity, external auditory meatus, tympanum, sphenoidal sinus. It may, however, be argued that

[5] *British Medical Journal*, Sept. 15, 1928.

the skull was that of a criminal whose body had been handed over to an anatomical department. This might be so, but in such case we should expect the calvaria to have been removed, and the bones, if kept, completely macerated. The evidence for the belief that the skull and femur are from an embalmed body is, in our opinion, strong. The description of the appearance of the body of James V., and the statement that Humphrey's coffin was full of pickle, will convey some idea as to what the results of embalming in certain circumstances might be.

We now come to the strangest of all the features of the skull, the presence of a large number of more or less circular pits on the vault—" the melancholy proof of the effects of his incontinence," to quote again Alexander Campbell. These, by many, if not by most, have been attributed to syphilis, and Prof. Pearson is at great pains to prove that Darnley suffered from this complaint, which, presumably, had reached the tertiary stage at the time of his death. We do not propose to enter into the arguments for this opinion, for we are convinced that the pits are not due to disease, the complete absence of all signs of inflammatory reaction, as both Dr. Harris and Sir Arthur Keith have pointed out, definitely negativing such a theory. If, then, as Prof. Pearson asks, they are not due to syphilis, to what are they due ? Dr. Harris confidently dismisses them as artefacts made with some such instrument as a bradawl. He gives no reason for so singular a procedure on the part of an 'unknown,' but no doubt the idea of faking evidence might be advanced. Dr. Harris's theory leaves unexplained the inequality in the size of the pits, the singular manner in which they are grouped, and their confinement to, practically, one side.

Our own theory of the pits is that they are due to the action of some burrowing insect. We arrive at this partly because, excluding the two theories already mentioned, little else remains, partly because it is well known that an extensive fauna preys upon the bodies of the dead, but mainly because of certain positive reasons. A close scrutiny of the pits will show that their circumferences not infrequently intersect, that the pits often occur in pairs, that at times part of the circumference shelves, giving a pyriform outline to the pit, at times a shallow groove leads from one pit to another, producing a dumb-bell appearance. Such features are, we consider, in keeping with what we know of the action of burrowing larvæ, which, when they meet anything uncongenial, are in the habit of moving a little aside and then proceed to burrow afresh. The varying size and shape, the number, arrangement, and distribution of the pits, all lend support to such an explanation. Can we obtain any corroboration ?

Sir Arthur Keith, when in Glasgow lately, observed certain skulls somewhat similarly pitted : two of these have now been lent by Prof. Bryce to the Royal College of Surgeons, where we have had an opportunity of examining them. They are from a medieval graveyard at Crosschurch, Peebles. Although the pits on these skulls are not so numerous or so cleanly cut as those on the 'Darnley' skull, they are, in our opinion, essentially of the same character. Further, near a pit on one of the skulls we have noticed a collection of what appears to be bone debris and earth, stuck to the skull possibly through admixture with some animal excretion, reminding us forcibly of the description by Prof. Elliot Smith of the collections left by beetles on Egyptian skulls.[6] Prof. Elliot Smith, however, is insistent on the fact that beetles only attack skulls which have been buried, a restriction with which of course the Crosschurch skulls conform, but not, if we are correct in our 'embalming' theory, Darnley's. Our ignorance, however, of the conditions within the large lead coffin both before and after the contents were exposed is such as to prevent us from offering any opinion as to whether they were more or less favourable to insect life. The pits do not appear to us to have any significant bearing on the question of the authenticity of the skull.

We have now to consider the form of the bones, and finally the age of the individual to whom they belonged. The femur clearly is that of a tall, spare individual of no marked muscular development. We are fortunate in knowing what Darnley's legs were like, for we have an admirable full-length portrait of him, aged seventeen, in doublet and hose, by Hans Eworth. Although, admittedly, there is little individuality in legs, those of the portrait are exactly those which we should expect the owner of the 'Darnley' femur to possess.

As to the skull, we fail to find those signs of great muscular development to which the Conservator of the Royal College of Surgeons in 1867—Sir William Flower—refers. We venture to think that if the skull were macerated and bleached, it would in a large measure lose such indications of muscular development as it may be thought to show. The outstanding feature of the skull is, however, as Sir William Flower pointed out, the absence of frontal elevation. Of this, it will be remembered, he found no corroboration in any of Darnley's portraits ; on the other hand, we find no certain refutation. In considering this question we must remember that portraits in early life are misleading, for then the skull is naturally of a different shape from that which it ultimately attains, and in no region, unless it be in that of the jaws, is the difference greater than in the frontal region. All the portraits on canvas which we possess of Darnley are full-face, and hence any absence of frontal elevation is, or may be, relatively unapparent. The so-called Cenotaph portrait was painted some time after death, and is, for reasons which Prof. Pearson makes plain, entirely untrustworthy. There are, however, two portraits on medals commemorating the marriage of Darnley and Mary—a third is apparently a copy of one of the others—which show Darnley in profile. They are too crude to justify any confident expression of opinion, but they go some way towards corroborating the authenticity of the skull. By the use of Coradi's

[6] *Lancet*, 1908.

pantograph, Prof. Pearson has superimposed skull on portrait, and brought out still more clearly the resemblance. We agree, too, with Prof. Pearson in finding more than a hint of a low, retreating forehead in the important full-face portrait belonging to the Duke of Devonshire, masked though it be by 'cap and hair.' On the whole, we consider the evidence of the portraits not antagonistic to the claim of authenticity.

We now come to the most critical of all the questions, for clearly, if it can be definitely shown that the bones are not compatible with their being those of a man of Darnley's age, $21\frac{2}{12}$ years, then the whole of the argument falls to the ground. To answer such a question we naturally turn to the epiphyseal lines of the femur, the spheno-occipital joint, the sutures of the cranium, and to the teeth —although all these last are missing, the empty sockets are available. We may say at once that an examination of these parts by the unaided eye gives no justification for denying the authenticity of the bones. Dr. Harris, who has paid much attention to these matters, studying them, moreover, with the aid of X-rays, thinks otherwise, and puts the age of the individual to whom the bones belonged at not less than twenty-five. He confirms his view by reference to the size of the diploic veins. Even if we accept, as with certain reservations we are disposed to do, Dr. Harris's generalisations, we would point out that the range of variation in all departments of human anatomy is wide, and nowhere perhaps wider than in such matters as those under consideration, and that in these circumstances we must allow a corresponding latitude in judgment. Nor, we would add, are the results of X-ray photography as a rule only open to one reading and interpretation.

A review of the evidence, historical and anatomical, leaves us no option, we think, but to conclude that, while certainty is denied, there is very strong probability that the relics considered, once formed part of that young, proud prince who caught the eye and won—if only for a season—the heart of perhaps the most romantic figure of modern times —" red star of boyhood's fiery thought."

Although this is neither the time nor the place to enter into considerations of Mary's character and of the part she played in Darnley's murder, we cannot conclude without paying high tribute to the learning and eloquence of the latest of her apologists. We remain, however, unconvinced. "Has he shown," as David Hume was in the habit of asking, "that she didn't marry Bothwell?" Alternatively, what of Chastelard? It was her participation, active or passive, in the two tragedies of Darnley and Chastelard, which more than all else was responsible for the bitter and almost universal hatred of two great nations, neither notably lacking in generosity and sentiment, and which drove her, a fugitive queen, to seek refuge in a foreign land.

WILLIAM WRIGHT.

News and Views.

IN continuation of a practice that NATURE has pursued for the past four years, there is printed elsewhere in this issue the first instalment of a new calendar, which will be devoted to items of importance and interest from the records of British and other patents for inventions. No apology is needed to our readers for the choice of this subject, for it will be fully realised that the literature of patents (which now includes amongst a mass of other material upwards of four million separate specifications of inventions from all countries) forms a survey of the industrial progress of the world from the seventeenth century onwards that stands unrivalled. Not much of this literature, of course, is concerned with epoch-marking inventions, but a great deal of it refers to lesser-known patents which have had no little influence on subsequent developments. Some of these have made their contribution direct, whilst others, though not themselves put into practical use, have yet stimulated later inventors, and have often formed the basis on which the final success has been achieved; others, again, have had their day and (perhaps only for a time) have passed into oblivion. It is with this class rather than with the well-known inventions that the calendar is intended mainly to deal, whilst it is felt also that a few notes should be included on some of those fruitless and extravagant ideas that are scattered through the records and have resulted in nothing but the shattering of life-long ambitions. Of necessity, the bulk of the material will be taken from British records, since these cover a longer period of time than any others, and are for the most part more easily accessible; but foreign dates of interest will also be included from time to time.

No part of Africa suffered more from the War than the Mandated Territory of Tanganyika, which comprises most of what was formerly German East Africa. From practically the beginning to the end it was a scene of conflict, with consequent breakdown of the administrative services, dislocation of its communications, interference with the normal occupations of the native inhabitants and the destruction of lives, their villages, crops, and domestic livestock. The task of repairing the havoc had to be undertaken by British officials who replaced the deported Germans. Most of these British officials were unfamiliar with the country and its peoples. They deserve the greatest credit, therefore, for the way they have coped with the difficulties of their situation. Their success can best be measured in terms of the trade of the country. The present exports and imports show a marked increase on those of pre-War years. New varieties of crops have been introduced, and the cattle industry is in a flourishing condition. The education and other social services have been greatly extended. Hundreds of miles of new railways have been constructed.

IN September next, under the presidency of the governor, Sir Donald Cameron, Tanganyika is to hold its first Agricultural and Industrial Exhibition, which is intended to be representative of the varied agricultural products grown by the native and European farmers, of the cattle industry, the country's forest resources, and its mineral wealth—the development of which is still in its infancy. At the same time, it is expected that machinery manufacturers will instal actual working exhibits of the plant and machinery used in the cultivation and preparation of such crops as sisal, cotton, coffee, oil seeds, tobacco, tea, rice, and other grains. It is hoped that the exhibition will be well attended by representatives of trading and manufacturing concerns in Great Britain. Those members of the British Association who are visiting East Africa after the South Africa meeting would probably find it interesting to break their journey at Dar es Salaam to visit the exhibition.

AUSTRALIA has large tracts of land with a soil and climate well adapted for dairying and beef production. These fertile areas have, however, not yet been fully developed and are very sparsely populated. If this Dominion is to maintain its 'all white' policy, it is necessary that the settlement of these lands should be accelerated. The best means of accelerating the settlement is by increasing the prosperity of primary industries based on the land. During the present year, at the invitation of the Australian Government, Sir Arnold Theiler, formerly director of the Veterinary Research Station at Onderstepoort, South Africa, and Dr. J. B. Orr, director of the Rowett Institute, Aberdeen, visited Australia to meet the executive of the Council of Scientific and Industrial Research, and research workers, to discuss the organisation and extension of research in animal health and animal nutrition.

DR. ORR was able to stay in Australia for only a few weeks, but Sir Arnold Theiler made an extended tour of six months' duration, during which he was able to make observations on some of the common animal diseases in Australia and offer valuable suggestions with regard to the efforts being made for their elimination. Both of these authorities have submitted reports with recommendations for the development of research in their respective subjects. The reports emphasise the value of the work already being done in Australia, but agree that there is still a vast field for applied science, and that the co-ordination and extension of research effort is likely to yield economic results through the decrease of disease and the increase of production. It is understood that the Council for Scientific and Industrial Research has decided to undertake an extensive research scheme on a Commonwealth basis, and that work under the scheme is likely to be begun in the immediate future.

THE function of a telephone circuit is to convey ideas from one person to another, and hence a measure of the efficiency of the circuit is the ratio of the number of ideas transmitted to the total number of ideas sent over the circuit. The value of this fraction is called the 'intelligibility' of the circuit. Its value is obtained by speaking a number of sentences, so designed that each conveys a single intelligible idea, into the microphone, and a listener at the telephone recording what he thinks he has heard. An example of a sentence used is 'The man hit the big dog.' The method is laborious, since a large number of such sentences must be spoken before a trustworthy average can be obtained. This and similar problems are ably discussed in a paper by Mr. John Collard, entitled "A Theoretical Study of the Articulation and Intelligibility of a Telephone Circuit," published by the International Standard Electric Corporation, of Connaught House, Aldwych, London. Mr. Collard points out that from the subscriber's point of view the efficiency of a telephone circuit should be judged by the relative time required to convey a given number of ideas over the circuit. For this purpose a quantity called the 'time efficiency' is defined. It is the ratio of the time required to transmit a given number of ideas over an ideal circuit to the time required to transmit the same ideas over the given circuit.

MANY other quantities are considered by Mr. Collard in his paper; as, for example, the 'syllable articulation' obtained by speaking a number of random syllables into the circuit. The results obtained are wonderfully constant, and the author develops a theory which gives algebraical relations between the various quantities. When a telephone circuit passes through different countries, it is usual to standardise the language of one of the countries as the operating language. So far as 'intelligibility' goes, the Italian language is the best, and next come German, English, and French. The actual time, however, to transmit a given number of ideas over a telephone circuit is least for French, and then come English, German, and Italian. It is best, therefore, to use a language like French or English. It is quicker to speak a language of short words, even when some of the sentences have to be repeated owing to the low intelligibility, than to speak a language of long words which has a relatively high intelligibility.

MANY reasons are given to explain why so many countries in Europe have electrified their main railway lines. Two of the most popular reasons given are either that they desire to be independent of foreign coal supply or that, as in Switzerland, they desire to make use of their waterfalls. Neither of these explanations has anything to do with the electrification of the main railway connecting Rotterdam and Amsterdam, two of the most important towns in Holland. In this case it was simply that the continually increasing volume of traffic made it difficult for steam locomotives to work the line satisfactorily. Although the section from Rotterdam to the Hague had been operated by single phase current since 1908, it was decided a few years ago to adopt direct current at 1500 volts, which is now the standard system in England and France. A description of the substations and rectifier apparatus for converting the a.c. generated into d.c. for the locomotives on the Dutch railway is given in the *Brown Boveri Review* for December. This is the first time that fully automatic rectifier substations have been employed in Europe for a main line railway. From the data given in this paper we learn that mercury arc rectifiers enclosed in steel cylinders are being widely used for converting alternating current into direct current for traction purposes. As compared with rotary converters this method has advantages. The efficiency of the converters is more than 95 per cent, the yearly cost of maintenance is small, and an appreciable saving in labour is effected by their use. These high-power rectifiers seem particularly adapted for traction work and have been working satisfactorily for several years. The New South Wales Government will soon have ten 1500-kilowatt automatic rectifier equipments on its railways and tramways.

The catalogue of spectrometric apparatus which has just been issued by Messrs. Bellingham and Stanley, Ltd., contains particulars of new apparatus. One of the most interesting instruments is a small quartz spectrograph of the Littrow type, which is supplied at the low figure of £18, 10*s*. Unfortunately, the dispersion given by the instrument is not stated, but it is recommended for chemical analysis, particularly for quantitative work, depending on relative intensities of lines, and for the examination of many of the non-ferrous metals. Another quartz spectrograph, of entirely new design, is arranged so that the slit and photographic plate are horizontal. This facilitates observation of the spectrum, particularly for the study of fluorescence, and permits greater rigidity than the ordinary arrangement. A dispersion of 130 mm. between the wave-lengths 6000 and 2100 A. is produced, and the price of the spectrograph is £65. Another useful instrument, designed for the examination of the spectra of feeble sources of light in the visible region, is a glass spectrograph of the ordinary type, of which the lenses have an effective aperture of F/2 and a focal length of 5¼ in. It is specially recommended for the study of fluorescence, spark spectra, and neon stroboscopic photography. The cost is £190. For the comparison of spectra taken on different plates, a simple spectro-comparator has been designed at £17, 10*s*., with an additional charge of £6, 5*s*. for optional accessories. It is specially intended to facilitate chemical analysis, and is recommended in particular for determining the exactness or otherwise of apparent coincidences of spectrum lines when high dispersion is not available. Several other instruments also are described in the catalogue. Messrs. Bellingham and Stanley's work is known to reach a high standard of excellence, and their instruments may be depended upon to do all that is claimed for them.

Dispatches in the *Times* of Dec. 22 and 27 from Sir Hubert Wilkins and his pilot, Lieut. C. B. Eielson, announce important discoveries in the Antarctic. The expedition had been waiting at Deception Island for some weeks for favourable conditions for the aerial survey work which is planned, and it was not until Dec. 19 that Sir Hubert and Lieut. Eielson were able to set out in their Lockheed monoplane. They made a flight of about 1200 miles, during which they found that Graham Land is an island separated from the Antarctic continent by an ice-filled channel, and discovered six hitherto uncharted islands. Taking a southerly course from Deception Island across the Bransfield Straits, they reached Graham Land; an ice shelf appears to cut Graham Land in half, the northern portion being a table-land while the southern half is more irregular, with mountains rising to 8000-9000 ft.; the coast line is much indented. About Lat. 70°-71°, Long. 60°-70° is apparently low-lying land, mostly snow-covered, and immediately to the south is a strait 40-50 miles in width. Beyond this strait is the ice cliff bordering the Weddell Sea. At this point the monoplane was turned back and reached Deception Island safely, having been nine hours in the air. Sir Hubert Wilkins is to be congratulated on the good beginning to his projected survey of the coast line of the Antarctic continent.

The curtain was finally rung down upon the Glasgow meeting of the British Association on Wednesday, Dec. 19, at a meeting held in the City Chambers, Glasgow, when final reports were received, the actions of the various committees approved, and the local executive committee discharged. Various speakers, including the Lord Provost, who presided, and Principal Sir Donald MacAlister, gave expression to the widespread feeling of gratification that the citizens of Glasgow had done their part so well in making the meeting a success. Attention was directed to the fact that, thanks to the skilful administration of the honorary treasurer, Sir John Samuel, the finance committee was in a position to make a return of five shillings in the pound to subscribers to the guarantee fund. Cordial votes of thanks were accorded to the Lord Provost, Sir Donald MacAlister, and others who, as officials or members of committees, had contributed to the success of the meeting; and more than one speaker emphasised in particular the immense debt due to the administrative genius, accompanied by unstinted labour, of Sir John Samuel, who filled the office of acting secretary in addition to that of honorary treasurer.

On Dec. 20, Mr. J. Swinburne gave a historical account of the invention and development of the Swan carbon incandescent lamp to the Institution of Electrical Engineers. This lamp was first shown in public at Newcastle-on-Tyne on Dec. 18, 1878, fifty years ago. The invention of a platinum-iridium lamp by Staite in 1845 first directed Swan's attention to the possibilities of an incandescent lamp. He carbonised narrow strips of paper and lighted some of them with a battery of 50 cells, but they soon burned out. This was between 1855 and 1860. A few years later, the Sprengel pump was invented and electric lighting became a possibility. Swan then associated with C. H. Stearn, an enthusiast in high vacuum work. When a straight carbon conductor was used, variations in its length and local heating at points on the filament caused great difficulties. Swan's first good results were obtained with thin straight carbon rods. These lamps were exhibited in 1878. In 1880 he found that he got better carbons by using parchmentised paper, such as is made for covering jam jars. Good results were obtained by treating knitting cotton with sulphuric acid of suitable strength and washing and drying it. In 1884–85, Swan, assisted by Stearn and Topham, worked out the squirting process, using pyroxylin and reducing it. Other makers then adopted other solutions in a similar way. Hence Swan, working almost independently, developed and produced the carbon incandescent lamp which was almost universally used until the advent of the tungsten filament.

THE Society for Experimental Biology held a conference at University College, London, on Dec. 14 and 15. Among many interesting papers, Dr. R. K. Cannan gave an account of modern views of oxidation systems in the cell; Miss A. M. Copping and Prof. J. C. Drummond reviewed the controversy as to the necessity of 'bios' for yeast growth, and showed that the disagreement between various workers is attributable to variations in different yeast species employed. Dr. H. A. Harris gave an analysis of the conditions required for proliferation on one hand, and differentiation on the other, in the development of tissues. During the third session a series of papers on the relation of anterior pituitary to sterility and on the nature of pseudopregnancy were followed by an excellent discussion led by Dr. B. P. Wiesner and Dr. A. S. Parkes. In the second session many demonstrations were given; Prof. J. Brontë Gatenby and his colleagues showed a beautiful demonstration of Golgi bodies, vacuome and mitochondria stained *intra-vitam*, and Dr. E. Bozler gave convincing illustrations of his interpretation of muscle structure in various phyla of the animal kingdom.

WE much regret to announce the death, which occurred on Dec. 23, of Sir William Thiselton-Dyer, K.C.M.G., C.I.E., formerly Director of the Royal Botanic Gardens, Kew, at the age of eighty-five years.

THE triennial award of the Coopers Hill War Memorial prize and medal, which fell in 1928 to the Institution of Electrical Engineers, has been made by the Council to Mr. W. Phoenix for his paper on "Electricity in Agriculture, with special reference to Electro-Culture."

A NEW publication, entitled "Civil Aeronautics," compiled by the office of the Legislative Counsel, United States Senate, has been issued by the Government Printing Office, Washington, D.C. It contains 178 pages, full of valuable information regarding the legislative regulation of civil aeronautics. It contains the text of the Air Commerce Act of the United States, of 1926, and material relating to the legislative history of that act, including committee reports, and a comparison of the bills as passed by the Senate and by the House; extracts from reports and articles on the legal problems of civil aeronautics, including publications of the American Bar Association and the Conference of Commissioners on Uniform State Laws; extracts from reports on legislation on civil aeronautics of the States of the United States, including decisions of State courts, and the text of international agreements relating to civil air navigation. The entire field of the legislative regulation of civil aeronautics is covered comprehensively right up to Aug. 1, 1928. Among the valuable articles included in it are several reports prepared by the Committee on Air Law of the American Bar Association. Copies of this publication may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C.

Our Astronomical Column.

THE COOKSON FLOATING ZENITH TELESCOPE.—This instrument was designed by the late Mr. Bryan Cookson, and presented at his death to the University of Cambridge Observatory; it was in use there for two years, and was lent in 1911 to the Royal Observatory, Greenwich, where it has been in use from 1911 to the present time. The observations are discussed in periods of seven or eight years, in order to separate the annual term from the 14-month term in the variation of latitude. The discussion of the observations of the second period (1919–1927) has just been published by the Royal Observatory in a small volume of 67 pages.

The Talcott method of observing pairs of stars at equal distances north and south of the zenith is employed. The trails of the stars are recorded photographically. The telescope is floated through 180° in its circular trough of mercury between the exposures.

The final value for the aberration constant from the whole period 1911–1927 is $20{\cdot}445'' \pm 0{\cdot}009''$. The second period (1919–1927) gave a value $0{\cdot}005''$ greater than the first (1911–1918). Taking the velocity of light as 299797 km./sec. (Mt. Wilson, 1926–1927) and the equatorial radius of the earth as 6378·355 km., the resulting solar parallax is $8{\cdot}815'' \pm 0{\cdot}004''$.

A plate shows graphically the variations of latitude for the fifteen years 1912–1927; the results of the international latitude stations are shown for comparison. On the whole, the agreement between them is very good. The chief differences are in 1916, where the Greenwich maximum is distinctly higher than the other, and in 1919, where Greenwich shows an abnormal minimum that is only faintly hinted at in the international curve.

VARIATION IN LIGHT OF POLARIS.—This star was for some time taken as a standard in stellar photometry, which makes the accurate determination of the period and amount of its light change of special importance. *Bulletin of Astron. Institute of the Netherlands*, vol. 4, No. 160, contains a discussion of it by A. de Sitter. He uses seventy-eight pairs of plates taken at Leyden by N. W. Doorn, between July 1925 and July 1928; he combines the results with those of eight other determinations, extending back to 1879, and obtains the period 3·968148 days $\pm 0{\cdot}000055$. The variation is analysed as a simple sine-curve, which appears to give a sufficiently good representation.

DIMENSIONS OF THE PLANETS.—W. Rabe gives an exhaustive discussion in *Astr. Nach.*, No. 5601, of the most probable values of the diameters of the planets. He collected all the most trustworthy measures, in which he included some recent ones of his own. Taking the solar parallax as 8·80″, he finds the following diameters in kilometres: Mercury 5140; Venus 12,620; earth (equatorial) 12,756; Mars (equatorial) 6860, (polar) 6820; Jupiter (equatorial) 143,600, (polar) 134,800; Saturn (equatorial) 120,600, (polar) 109,000; Uranus 53,400; Neptune 49,700. Outer diameter of Saturn's ring 278,500; inner diameter of crepe ring 144,000.

Research Items.

Lions in Europe.—It is known that lions inhabited Europe in historical times ; the fact is mentioned by both Herodotus and Aristotle. Herodotus (480 B.C.) even determines the area in Macedonia inhabited by lions, and recounts that during the march of Xerxes through Macedonia, lions attacked and destroyed the Persian carrying camels. Aristotle (384–322) speaks of the same area, but mentions that lions are rare there. There are no later indications of their occurrence. Some investigators (O. Keller) do not attribute much value to this ancient information, supposing the group of lions to have been brought by Persians during their previous campaigns, which had lingered for more than a hundred years in the wild mountains of Macedonia, whilst the majority holds that the Macedonian lions were the last of lions, spread throughout Europe during the Pleistocene age, which later, under the oppression of man and deteriorating conditions of life, trekked south. Whatever may have happened, the existence of lions in Europe in historical times is not affirmed by any palæontological discoveries, and in this sense the discovery to which we are referring is unique. V. Gromova, in *Priroda* No. 10, mentions that among the rich palæontological materials collected by the Russian Academy of History of Material Culture between the years of 1901–1927, in the district of the rich ancient Greek city Olvia in S.W. Russia, a piece of the upper jaw of a lion, together with the upper canine tooth, was found. The tooth differs greatly from the canine tooth of a tiger by its shape, and from that of the other members of the cat family by its large size. However, as there was only one such discovery, its explanation should be approached with great care. It is quite probable that the lion was brought from Asia Minor, where the existence of lions, even up to the Mediterranean, in ancient times, is confirmed by a series of literary notes and discoveries of bones. It is well known (O. Keller, "Die Antike Tierwelt," pp. 29-31) that people of distinction and their wives kept lions as domestic pets, which accompanied them during walks, campaigns, etc. Above all, lions played a prominent part in the circus fights. It is quite probable that such is the origin of the Olvian lion ; moreover, the solitary tooth is of the small size, such as is found in lions kept in zoological gardens only, and probably denotes a sign of degeneration. Thus the palæo-zoographical value of the discovery remains doubtful.

Fresh-water Eels of New Zealand and Australia.—In the course of his work on the freshwater eels of the genus *Anguilla* throughout the world, Prof. Johs. Schmidt has now come to those of New Zealand (*Trans. N. Z. Inst.*, vol. 58 ; 1927) and of Australia (*Records Aust. Museum*, vol. 16, No. 4 ; 1928). In both papers the author emphasises the necessity of employing numerical characters, such as the number of vertebræ and of fin rays, in the identification of species. In the case of the New Zealand eels, however, he finds that the number of vertebræ is not such a good distinctive character as in most other cases. The distance between the front of the dorsal fin and the vent $(a-d)$, expressed as a percentage of the total length (t), is the most important distinguishing feature. Two valid species of *Anguilla* are thus found in New Zealand—*A. aucklandi*, in which the average value $\frac{a-d}{t} \times 100 = 11{\cdot}05$, and *A. australis* with an average value of 2·41. The former is distributed mainly in the south and west, the latter mainly in the north and east, but further data are required on this point. On the continent of Australia four species of eel are recorded—*A. australis*, *A. reinhardti*, *A. obscura*, and *A. bicolor*. Of these, the last named is an Indian form found in northwest tropical Australia. The three others are Pacific forms found on the east coast, one of which, *A. obscura*, is represented by only one specimen from the Burdekin River in the tropical part of Queensland. Between the *A. australis* of Australia and New Zealand there is an average difference of one vertebra, which in the author's opinion indicates a difference in their life history and breeding places. These two papers on *Anguilla* are of particular interest and value, not only as further contributions to our knowledge of that genus, but also as examples of the application of variational statistical methods to the identification of species.

Inheritance of Weight in Rabbits.—In former crosses between large and small rabbits by Punnett and Bailey and Castle, the large size was not recovered in F_2, and it appeared that inheritance of weight might not conform to ordinary Mendelian behaviour. But the numbers of animals bred were not very large. Mr. Michael Pease (*Jour. of Genetics*, vol. 20, No. 2) has since repeated these experiments on a larger scale. He crossed a Polish doe with a Flemish buck and bred an F_2 numbering 309 animals. The complete range of adult weights was obtained, from the mean of the small Polish stock to beyond the mean of the large Flemish stock. It thus appears that weight in rabbits can be explained on the multiple factor hypothesis. The mean weight for the Polish stock was about 50 oz. and for Flemish twice as much. The F_1 was intermediate and showed no sign of hybrid vigour. Only a few F_1 animals gave the whole range of weights in F_2, the majority giving a much more restricted range. Some of the light F_2 animals bred true in F_3, but no heavy animals bred true. It is not decided whether there is one predominating weight factor ; but it is concluded that the weight factors act in a logarithmic manner. The Polish stock appeared to contain a simple factor for sterility, but there was also a slowly diminishing fertility which must be otherwise explained. The growth curve and times of maturity of these rabbits has also been carefully studied, as well as the relation of weight to sex, colour, and size of litter. From the F_2 population one strain was selected which matured in 172 days, and another in 300 days. In many of these rabbits there is no correlation between heavy weight and slow maturity.

Chromosomes of the Earthworm.—L. Monné (*Bull. Int. Acad. Polonaise Sc.*, B ; 1928) has investigated the chromosomes of the earthworm *Allolobophora fœtida* and finds that in the cells of the epidermis, nervous system, gut epithelium, and the developing muscles, nephridia, and septa, the number is 22, 11 pairs. The oogonia are known to have 22 (Foot and Strobell) and the author finds the same number in the spermatogonia.

Pairing and Oviposition in the Indian Apple-Snail.—Prof. K. N. Bahl (*Mem. Ind. Mus.*, **9**, pp. 1-11 ; 1928) records observations on pairing and oviposition in the Indian apple-snail, *Pila globosa*. After a prolonged period of æstivation underground during the dry months, these snails come to the surface at the outset of the rains and at once pair in water on the ground at the edge of a pool. Pairing may last three hours, during which time the copulating animals may be handled and the principal relations of the male and female ducts ascertained. Prof. Bahl found that by electrocution he was able suddenly to kill a couple of pairs, and by subsequent dissection to make out the precise details of the copulation. The vas deferens of the male terminates in a papilla lying in the mantle cavity close to the rectum. The penis-sheath and penis are outgrowths of the mantle and are independent of the male opening. Transference of the sperms from the vas deferens to the penis after the latter has been inserted into the mantle cavity of the female is effected by the genital papilla at the end of the vas deferens being directed into a depression at the proximal end of the penis. The sperms then pass along the penis into the aperture of the vagina of the female. Deposition of eggs takes place a day or two later in some sheltered hollow in the ground. Each egg, after passing out of the vaginal opening, travels down an oblique tube formed by two temporary folds on the right side of the foot and is delivered into a dome-shaped cavity under the foot formed by the arching of the creeping sole. Each egg has a sticky covering, so the eggs, from 200 or 300 to 800 in number, adhere to form a mass. When egg-laying is completed the snail leaves the egg-mass ; there is no incubation of the eggs.

CROSSES BETWEEN WHEAT AND RYE.—Successful reciprocal crosses between wheat and rye are reported from the Saratov Experiment Station by Miss Nina Meister and Mr. N. A. Tjumjakoff (*Jour. of Genetics*, vol. 20, No. 2). The variety of wheat used was *Triticum vulgare* var. *erythrospernum*, and the rye was a local Russian form, 'Jelissejev.' It was found that the reciprocal hybrids were alike, both resembling wheat and both sterile. This is to be expected, since the wheat supplies 21 chromosomes and the rye but 7. No F_2 could be obtained, but the F_1 plants were crossed back with wheat or rye. The pollination of rye by wheat appears now to be accomplished for the first time. It is much more difficult than the reciprocal, giving only 2·5 per cent of successful fertilisations, as against 60 per cent for wheat and rye. These results are very different from those obtained by Gaines and Stevenson in 1922, and it is suggested that the rye-plants obtained by them from rye and wheat were not true hybrids.

BOTANICAL CARTOGRAPHY OF EUROPEAN RUSSIA.—The geo-botanical department of the Leningrad Botanical Garden started some years ago, under the general editorship of Prof. N. I. Kusnezow, and with the co-operation of a number of Russian botanists, the compilation of a botanico-geographical map of European Russia on the scale 1 : 1,050,000, that is, approximating closely to the scale 1 : 1,000,000 suggested for the maps of this kind by the International Botanical Congresses. The whole map will be on twenty sheets. Ten of these are ready, and three are already published covering the south-eastern provinces, that is, the regions adjoining the middle and lower course of the Volga and the Caspian steppes. The map is produced in colour and shows the distribution of different types of vegetation and partly even of the various associations. As admitted in the explanatory pamphlet (such pamphlets, containing a brief description of the vegetation of the respective areas, will be published with each sheet), the map is not equally exact in all details, since it it based on numerous disconnected local vegetational maps, reports of expeditions, etc. Some corrections will therefore be necessary after more detailed studies, and one of the main purposes of the map is to get together all results of previous botanico-geographical explorations, so that the gaps will be obvious and may be filled. Thus, the map is regarded as only the preliminary to another on the international scale. Apart from the vegetational map, an additional sheet, on transparent paper, has been published with the fourteenth sheet (middle Volga region), showing some floristic data (limits of distribution of various typical plants) and the boundaries of the glacial deposits. A general map of the vegetation of European Russia, on the scale 1 : 4,000,000, on a single sheet prepared by Prof. N. I. Kusnezow, has also been just published by the Leningrad Garden.

MARINE MOLLUSCA OF THE CHATHAM ISLANDS.—Collections of shells were early made from the Chatham Islands, and Capt. Hutton in his "Catalogue of the Marine Mollusca of New Zealand," 1873, was the first to give a connected account of their fauna. Collections from several sources have now been studied by Dr. H. J. Finlay (*Trans. New Zealand Inst.*, vol. 59), who is able to record the occurrence of 202 species, of which 30 appear to be endemic. The author considers that the present fauna is not a remnant, or evolution of the Tertiary faunas found there, but a repopulation from the mainland in post-Pliocene times, yet still long enough ago for characteristic regional species and subspecies to have evolved. The active factor in this repopulation has been ocean currents, acting from both north and south, but predominantly the latter. In this list Dr. Finlay treats all group names equally as full genera, this being in his opinion the handiest method for future reference, a course which those who have to consult the list, however, will scarcely agree with him is a matter of "no inconvenience." A more serious drawback to the list is that Dr. Finlay has followed the order of families and genera given in Hedley's "Check List of the Mollusca of New South Wales." He has fortunately reverted to the usually adopted order of the classes, but a very cursory inspection would have shown him that the whole of Hedley's MS., confessedly sent off to the printer at short notice, must have got badly disarranged ere it reached the compositor, and never have been submitted in proof to the compiler. How else to account, amongst other lapses, for the presence of the Gymnoglossa and the Architectonicidæ in the Opisthobranchia ? It is a great pity that further currency should now be given to this unfortunate jumble. Nevertheless, Dr. Finlay's list will prove of great use to students of antipodean mollusca.

SUBMARINE WAVES IN GIBRALTAR STRAITS.—An upper lighter layer of variable depth lies upon denser water below ; this upper, less saline, layer streams from the Atlantic into the Mediterranean, while the more saline water below runs out into the Atlantic, a certain amount at the boundary between the two layers mixing with the water above and being carried back into the Mediterranean. G. Schott, in the *Journal du Conseil International pour l'Exploration de la Mer* (vol. 3, No. 2, September 1928), reviews the available data bearing upon undulations which have been observed to occur in the boundary between the two layers. This rises and falls twice a day with a well-marked tidal period, the rise taking place in the Straits while the tide is falling at Gibraltar. The amplitude of these submarine waves is considerable, water at 14° C. with a salinity of 37·4 per mille in the trough at 180 metres below the surface, rising to 100 metres below the surface when on the crest of the submarine wave some 7 h. 40 m. later. It is shown that the boundary between the two layers is nearer the surface in the area over the ridge between Gibraltar and Africa than on either side. The explanation of these movements of the boundary layer advanced by R. de Buen, as 'injections' of water from below into the upper stratum, is disproved.

THE DIFFRACTION OF ELECTRONS BY MICA.—A note published by S. Kikuchi in the October number of the

Proceedings of the Imperial Academy of Tokyo contains a remarkable reproduction of an electron diffraction pattern. It was produced by passing a pencil of cathode rays—rendered homogeneous by magnetic sorting—through a very thin sheet of mica, and more than one hundred and fifty spots appear on it. They are arranged in an equilateral triangular pattern, from the dimensions of which the spacing of the molecules in the mica was calculated to be 5·11 A., the corresponding value obtained by an X-ray analysis being 5·18 A. The author has also had under investigation the relative intensities of other types of diffraction beams that are produced when electrons pass through thicker pieces of mica, and finds that there is a close parallelism betweem the distribution of intensities in electron beams and in the analogous beams of X-rays. The same is true of beams reflected from the cleavage faces of crystals, and electron diffraction has now been observed in this way with calcite, mica, topaz, zincblende, and quartz.

ELECTRON WAVES.—A very simple and convincing demonstration of the undulatory properties of electrons has been given by E. Rupp, who has described in a recent paper in the *Zeitschrift für Physik* (vol. 52, p. 8) how they may be diffracted by a ruled metal grating, with rather more than a thousand lines to the centimetre. His apparatus was essentially a spectrometer of the type used for obtaining X-ray spectra at grazing incidence under similar conditions, the electromagnetic waves being replaced by slow cathode rays moving with speeds corresponding to between 70 volts and 300 volts. The set of spectrum photographs which has been reproduced shows distinctly that the cathode ray pencil passes away from the grating in certain privileged directions, as many as three orders of interference being apparent in one instance. The quantitative agreement of the results with the de Broglie wave theory is also satisfactory, the predicted and measured wave-lengths of the electrons agreeing to within a few per cent, whilst there seems to be no need to invoke the presence of an internal potential of the solid in this case. No evidence was found that the electron waves were polarised, the author's conclusions in this connexion being confirmed by some new experiments by Drs. Davisson and Germer which are mentioned in a recent *Bulletin* (No. 5) of the American Physical Society.

RADIUM AND GEOLOGY.—A short account by C. S. Piggot of the relationship of radioactivity to geological phenomena is given in the *Journal of the American Chemical Society* for November. There are three aspects of the problem, namely, the determination of the amount and distribution of radium throughout the lithosphere; the heat energy made available and the part it plays in mountain building; and, lastly, the estimation of geological time from the uranium-lead ratio. The amount of radium present in a rock may be determined by decomposing it by fusion with a flux and measuring with an electroscope the radium emanation thus liberated. The estimation of the age of a mineral from the uranium-lead ratio cannot be entirely trustworthy until further data are available concerning the disintegration of the thorium series. A measure of the relative amount of the lead derived from uranium would remove further uncertainty, and the author describes a method by which it is hoped to determine this by using Aston's mass-spectrograph.

AUTOMATIC SUBSTATIONS IN INDIA.—The development of automatic electric substations with supervisory control is making rapid progress. In the *Metropolitan Vickers Gazette* for October there is a full description of the use made by the Bombay, Baroda, and C.I. Railway of automatic stations. The economic value of these automatic stations is now widely recognised. By their use the capital expenditure on buildings is reduced and there is a large saving in wages. Complete and immediate information is given to the engineers at the generating station by means of suitable visible and audible signals. There is no loss of time in receiving telephone reports and transmitting instructions to operators. Should any machine become overheated, the fact is automatically signalled to the control office. A red lamp glows on the symbol for the machine on the control panel and an alarm bell rings. The supervisor then starts another set and the red lamp glows until the overheated machine cools to its working temperature. Blue lamps indicate when fuses blow, and when the fuse is replaced all the lamp signals are automatically checked. Yellow lamps glow intermittently when selecting impulses are being sent out from the panel. These and similar devices make supervisory control very effective. Owing to the lack of skilled operators, it is particularly useful abroad. The B.B. and C.I. Railway is claimed to be the largest and busiest in India, and the electrified section has the heaviest traffic. All the electric power is got from the Tata hydro-electric station situated in the Western Ghats, about 100 miles distant from Bombay. It is transmitted by three-phase alternating currents at a pressure of 110,000 volts. It is transformed to 22,000 volts, and then transmitted by underground cables and overhead transmission lines.

PERMALLOY ON SUBMARINE CABLES.—In a paper communicated to the Royal Society in 1855, Lord Kelvin laid the foundation of the theory of submarine telegraphy. This theory has since been greatly developed by mathematicians, and recently the discovery of magnetic alloys of constant permeability has enabled the theory of Heaviside to be utilised in practice. Notwithstanding these great developments, comparatively little attention has been devoted to familiarising electrical engineers outside the small circle of submarine cable engineers with these advances. The paper read to the Institution of Electrical Engineers by A. E. Foster, P. G. Ledger, and A. Rosen on Dec. 6 was the first paper on the subject for about thirty years. The discovery of permalloy made possible the loading of telegraph cables and greatly increased the speed of signalling. They explained the precautions that have to be taken during manufacture and the subsequent process of annealing. A full description of the annealing furnace through which the cable passes is given. The inductance of the cable varies largely with the annealing temperature. Further experimental investigation seems necessary to determine the best cycle of temperatures for heating and cooling. The inductance also varies with the hydrostatic pressure. The troubles introduced into cable working by the presence of electric power cables near their ends are not serious. It is more difficult to overcome the interference due to natural causes. These causes seem to be of the same nature as ‘ atmospherics ’ in radio communication. Electromotive forces are set up and disturbances travel in both directions along the cable. These may originate anywhere along the line, but the evidence shows that the disturbances are very small when the depth of the cable is 500 feet. In order to get over interruptions due to natural phenomena, the earthing core is connected with the sheath at a point where the depth is at least 500 feet. In several cases, however, these situations are unfortunately several miles from the shore.

Combustion in Gases.

USEFUL service is rendered by *Industrial and Engineering Chemistry* to those engaged on the chemistry of flames in bringing together in a special number the papers presented at the symposium on combustion, held last September, by the Gas, Fuel, and Petroleum Divisions of the American Chemical Society.

The first paper is one that claims attention both on theoretical and practical grounds, for it sets out to explain what is happening in the ordinary ' diffusion flame ' of a gas jet burning in air. The authors, Messrs. S. P. Burke and T. E. W. Schumann, seek to diminish the complexities of the problem by the use of a concentric-tube arrangement in which the inner tube conveying the combustible gas is half the diameter of the outer tube conveying the air or oxygen, and the flow of the two streams is maintained at an equal rate. Under these conditions, the authors claim that any increase in temperature due to the flame is counterbalanced by an increase in the rate of inter-diffusion, and that variations in pressure do not affect the size of the flame.

It will be noticed that such elongated flames as the authors employ are not strictly comparable with ordinary gas flames in air, which do not vary in height directly as the gas-flow, and are affected by pressure; but nevertheless the results obtained are interesting—especially the comparison of the analyses of the products taken along the axis of the flame, with the theoretical deductions from the assumption that the flame front represents the boundary where the diffusion of oxygen inwards is just such as will combine completely with the gas diffusing outwards.

An interesting contribution by A. G. Loomis and G. St. J. Perrott, of the Bureau of Mines, deals with the temperature of non-luminous flames determined by the optical method of Kurlbaum-Fery. The method depends on comparing the ' brightness ' temperature of a solid radiator (heated electrically) with the brightness of the radiation from the gas-air flame coloured with sodium vapour at a given spectrum line. When the sodium lines from the coloured flame appear dark upon the brighter background of the continuous spectrum of the radiator the flame is cooler, but when the radiator is cooler than the flame, the sodium lines appear as bright lines. By adjusting the current through the tungsten-band lamp, the lines can be brought just to the ' reversal ' point, when the temperature of the tungsten measured by the optical pyrometer gives the temperature of the flame —after correction for absorption by the focusing lens.

In this way the authors measured the temperatures of a solid air-gas flame (close to the orifices of the silica burners), when methane, propane, and carbon monoxide were mixed with different volumes of air. The percentages of gas giving the maximum flame temperatures were found to be:

	Per Cent of Gas.	Max. Temp. of Flame.
Methane	9·8	1876° C.
Propane	4·2	1930° C.
Carbon monoxide . .	36-37	1960° C.

To check the results the authors measured the temperature of a natural gas-air mixture by the reversal method, and by the method used in the National Physical Laboratory at Teddington, in which the relation between the heating current and temperature of a refractory wire *in vacuo* and in the flame is determined. By the reversal method the temperature of the flame was found to be 1750° C.; by the N.P.L. method the flame was 1770° C.

Prof. W. E. Garner discusses the effect of the presence of small amounts of hydrogen on the radiation of the carbon monoxide-oxygen flame measured through a fluorite window at the end of an explosion-tube 80 cm. long. Measurements made in his laboratory at Bristol show that the radiation from the flame is reduced to one-seventh by the addition of 2 per cent of hydrogen to the mixture, and the diminution is still considerable when the hydrogen is reduced to 0·005 per cent. A marked change in the radiation—it is almost step-like—was observed as the hydrogen content passes the 0·02 per cent point; this discontinuity would require for its explanation the occurrence of two different mechanisms of chemical action. As bearing on this, it may be recalled that Weston has shown that the spectrum of the flame of the well-dried carbon monoxide-oxygen mixture, fired under high pressure, is far more luminous than the flame produced in the presence of hydrogen, and this has been interpreted to mean that carbon monoxide may combine directly with oxygen and also indirectly by the reduction of steam.

Messrs. F. A. Smith and S. F. Pickering exhibited photographs of propane-air and acetylene-air flames produced by forcing the mixtures through a tube, and either allowing access of secondary air or excluding it. In some cases the flames become polyhedral, and can be made to rotate slowly or rapidly according to the gas-content of the mixture.

A photographic study of the ' flicker ' shown by ordinary luminous flames was presented by Messrs. D. S. Chamberlin and A. Rose, of the Lehigh University. With a kinematograph camera taking 32 pictures per second, the upper portion of the flames was shown to move upwards, and then to fall very rapidly, or be extinguished—for in some cases two completely separated flames are photographed on the same picture. With natural methane, ethane, and ethylene burning from an orifice rather less than 1 mm. in diameter, the rate of flicker was about 10 per second, and the amplitude about 4 to 5 cm.

Mr. F. W. Stevens, of the Bureau of Standards, has made photographic measurements of the spread of the flame in carbon monoxide-oxygen mixtures when fired centrally in soap bubbles, by which device the flame may be imagined to spread through a gas mixture unconfined in space—and under constant pressure. The flame was found to proceed at a uniform rate, but the rate deduced from the inclination of the line of the flame front (being the rate through space) is greater than the velocity of the ' reaction zone ' relative to the gas it is entering. Mr. Stevens shows that the true rate of the flame is greatest with the theoretical mixture $2CO + O_2$. The rate of the flame in methane-oxygen mixtures has also been studied, and the author finds that when the methane is increased beyond that required for complete combustion, the rate of propagation of the reaction zone falls off abruptly. Generally, the author is convinced that the bubble is an efficient experimental gas engine operating with minimum heat losses and negligible friction against the pressure of the surrounding atmosphere.

The work of the Sheffield School (1) on the slow uniform phase of gaseous combustion, and (2) on the initial spread of the flame and its arrest when gas mixtures are fired centrally in a cylindrical tube, is summarised by Dr. Payman.

(1) The speed of flame in the limit mixtures (*i.e.* those just propagating flame) of various inflammable gases with air has been found to be close on 20 cm./sec.; but notable exceptions are presented by hydrogen and acetylene mixtures.

(2) When hydrocarbon-air mixtures are fired in the centre of a cylinder 5 cm. in diameter, and the flame is photographed on a moving film through a narrow horizontal window, the front of the flame towards each end is seen to increase in speed until it is suddenly checked and then proceeds at a nearly uniform rate to the end of the cylinder. As the point of arrest is shown to coincide with the moment when a belt of the expanding globe of flame reaches the cold walls, it is suggested that the arrest is due to the cooling (or extinction) of the flame by the contact, and to the consequent loss of pushing power behind the flame-fronts. Very rapid snap-shots of the flame in clear cylinders show that it starts as a sphere from the central spark, then becomes egg-shaped, and finally breaks into two when the equatorial belt reaches the side wall. The snap-shots also show the re-illumination of the central portion after the flame has reached the ends of the vessel, indicating that the combustion was not complete when the flame-front has traversed the cylinder.

Messrs. J. V. Hunn and G. G. Brown describe an apparatus in which the passage of a flame may be photographed on a moving film at the same time that pressures are registered at four points along a cylinder of 3 inches diameter. Using carbon disulphide with excess of oxygen, the authors show that a pressure-wave travels from the igniting spark ahead of the flame-front and, being reflected from the farther end, returns to the firing-end, passing through the flame *en route*; again reflected from the firing-end, but travelling faster through the heated gas, it may overtake the flame-front, and in so doing cause a halt and even a reversion of the flame. This is a new interpretation of the 'halt,' and one not easy to follow on the published photograph. Obviously the method is a promising one and should be pursued.

In the United States, where it is said a motor-car is registered for every five inhabitants, a conference on gaseous combustion was bound to deal with 'knock' and 'anti-knock.' Prof. Wheeler and G. B. Maxwell contribute the results of their experiments in a 6-inch cylinder of 15 inches length, in which pentane- and benzene-air mixtures were fired with a spark near one end-plate and a pressure-gauge in the other end. The flame was photographed through a narrow window. When a 3 per cent pentane-air mixture is fired at atmospheric pressure, the flame travels with accelerating speed until, just beyond half-way, it is checked and then proceeds slowly to the end: the pressure recorded shows an even rise, a check corresponding to that of the flame, and then a rise to the maximum when the flame reaches the end. When the pentane is increased to 3·5 per cent the flame begins to vibrate after the central check, and when it reaches the end sends back a very rapid luminous wave. With increase of initial pressure to 2 or 3 atmos., the explosions are distinctly audible, and the vibrations are more violent with the 3·5 per cent mixture. The gauge shows a sudden rise of pressure as the flame reaches the end, and the photographs show an intense glow traversing the cylinder. Similar benzene-air mixtures gave but feeble vibrations and no shock-wave.

The addition of lead tetra-ethide, 2·5 ounces to the gallon of pentane, greatly increased the violence of the explosion; but when the lead compound was first decomposed, and the cloud swept in with the charge, a continuous combustion was observed and no shock-wave was recorded. These experiments confirm the view of Egerton and Gates on the anti-knock effect.

Messrs. T. E. Layng and M. A. Youker describe a glass apparatus for determining the rate of oxidation of various fuels when heated in oxygen. They show that *n*-heptane is oxidised fairly readily at 160° C.; but this oxidation is prevented by small additions of lead ethide or of potassium ethylate. On the other hand, kerosene could be kept for eight hours in oxygen at 180° C. with very slight alteration; but the addition of 0·05 per cent of lead ethide to the liquid produced marked oxidation, while the addition of 1 per cent of aniline or of diphenylamine had no effect. It is suggested that an efficient anti-knock must retard gas-phase oxidation and accelerate liquid-phase oxidation.

Other interesting papers deal with the partial oxidation of methane and ethane in the presence of catalysts, and the relative rates of oxidation of the olefines in flames and liquid oxidising agents.

Development Commission Report, 1927–28.[1]

THE reports of the Development Commission show how great a stimulus the Development Fund has been to research in agriculture and horticulture since its introduction in 1911. Grants-in-aid prior to this were dispensed with a meagre hand, hence major investigations requiring a large equipment and manifold repetition, as in the case of animal diseases, could scarcely be carried on. This eighteenth report conveys, however, an impression that the progeny of the Fund have become too numerous, and that the expansion inevitable in scientific investigations has outrun the capacity of the Fund. Thus large supplementary grants have been given by the Empire Marketing Board to the Welsh and Scottish Plant Breeding Stations for buildings, etc., to research in woollen industries, and to agricultural economics research at Oxford.

The total advances from the Development Fund for 1927–28 were about £383,000, as compared with £403,000 the previous year. The ordinary Development Fund contributed £253,000, the residue coming from the Special Fund (Corn Production Acts, 1921), but this latter source appears from the accounts now to be exhausted. The larger part of the funds is applied in aid of two schemes, research institutes in agriculture and advisory centres. The grants detailed for each centre show little change from the previous year. The new grants include two for investigations on the virus diseases of the potato, to the Cambridge and Scottish Plant Breeding Institute, respectively. A committee set up to investigate foot-and-mouth disease received the substantial grant of £15,000. An important development, still in its initial stages, is the Scottish Dairy Research Institute, which has been rendered possible by a private gift of a mansion and estate at Auchencruive, near Ayr, valued at £20,000, and a bequest of £26,000. The Development Commissioners have agreed to recommend sums up to £52,000, subject to local contributions, over a period of four years.

Amongst the reports on institutes there is evidence of considerable activity in those devoted to horticulture, which appear to be well supported by grants.

Reference is made to the much debated subject, how best to secure co-ordination of research. This was discussed at some length at the Imperial Agricultural Conference in 1927, and at least one scheme was proposed for exchange of reports on work, which was over-elaborate. A summary of agencies available

[1] "Development Commission. Report of the Development Commissioners for the year ended March 31, 1928." (London: H.M. Stationery Office, 1928.) 3*s*. 6*d*. net.

in Britain for conference and exchange of information shows that home workers have reasonable opportunities, but there is still room for linkage with other parts of the British Empire. Endeavours have been made to fill the gap by conferences, but of course attendance is possible only for a limited number and at considerable cost.

This leads to the vexed question of technical publications. Few research institutes have libraries anything like adequate for their needs, and in recent years estimates for libraries have been severely pruned, and the situation exists that institutes receiving State aid have to purchase government publications at booksellers' prices. The same economy is evident when an institute wishes to publish its results, and to circulate them. Printing estimates are censored, so that authors must wait their turn for publication in journals already overcrowded.

The present report suggests that the policy to aim at is the wider distribution of semi-popular publications and bulletins. Much depends on the meaning attached to 'semi-popular,' for matter set out for a newspaper or a farmer's weekly would probably be of little use to the specialised investigator, but what the report suggests seems to be the condensed summary such as a specialist presents to his colleagues at a conference. Some good examples of the kind of information useful for co-ordination will be found among the summaries of work in this report. These occupy the greater part of the report, and with the appendices (30 pages) giving the titles of monographs, etc., published during the year by each institute receiving grants, indicate the wide field of research covered by the Development Fund.

University and Educational Intelligence.

LONDON.—The title of professor of zoology in the University has been conferred on Dr. H. G. Jackson as from Aug. 1 last, in respect of the post held by him at Birkbeck College. Prof. Jackson was appointed to the University readership in zoology at that College in May 1921, and has published numerous papers on isopods in the *Proceedings of the Zoological Society*, the *Annals and Magazine of Natural History*, and other biological journals.

IT is about two years since what is frequently referred to as the Hadow Report was issued. So powerful an impression did it make, and so widely was it discussed, that it seems almost unnecessary to explain that it was a report by the Board of Education's Consultative Committee dealing with the organisation, objective, and curriculum of courses of study for children (other than those attending secondary schools) who will remain in full-time attendance up to the age of fifteen years, regard being had to their probable future occupations. The report received almost general approval from all types of educational and social workers. The Board of Education has since issued its Circular 1397 and its "New Prospect in Education," in which it indicates how some of the recommendations of the Hadow Report may be applied to the educational system. In a pamphlet entitled "The Hadow Report and After," the Executive Committee of the National Union of Teachers has attempted to set forth constructive criticism of these documents. It is made clear that the purpose of any criticism is not to impede advance, but to offer the results of the N.U.T.'s experience in the solution of the very difficult problems involved. To the detailed arguments in chapters which include the regrading of education, unity in the post-primary system, barriers to unity, age of transfer, size of classes, and curriculum of the senior school, are added fifty-five recommendations. The work, which is being widely circulated to interested persons, ought to do much to stimulate thought in connexion with the important problems discussed. The pronouncements made, of course, are those of the National Union of Teachers; we cannot avoid feeling that, since other teachers' associations are so closely concerned, the securing and inclusion of their views would have been a considerable advantage.

THE Collège des Ecossais, founded by Prof. Patrick Geddes as a hall of residence for students pursuing courses of study in the University of Montpellier, has justified the hopes of its founder and demonstrated the existence of a demand for such accommodation in excess of its capacity. Plans have now been completed for erecting beside it a new and larger building. This will more than double the accommodation at present available, which only suffices for about twenty students. The foundation-stone of the new building was laid on Oct. 18 by the Rector of the University, M. Coulet, who, in his inaugural address, recalled the fact that Prof. Geddes had himself been a student there forty years ago, and emphasised the significance of the new undertaking as an agency promoting international understanding and world peace. The Mayor of Montpellier added his felicitations and promised to give all the help he could in regard to such matters as electricity and water-supply, while the Secretary-General on behalf of the Prefect hailed Prof. Geddes as a valued friend of France and of Montpellier. A telegram was received in the course of the proceedings from the Franco-Scottish Association of the University of Edinburgh, where Prof. Geddes is well known for his indefatigable labours in the cause of improving the conditions of residence of the students. At Montpellier special courses are offered by the faculty of sciences in chemical engineering and in œnology and there is a fuels institute for advanced students. In connexion with the zoological laboratories is a marine biological station at Cette. Attached to the well-known botanical gardens is the Mont Aigonal laboratory for research on mountain flora.

THE Royal Technical College, Glasgow, has sent us its report on the session 1927–28—the twenty-fifth since King Edward VII. laid the memorial stone of what is claimed to be the largest single structure in Britain devoted to education. Experience has demonstrated the enormous benefits accruing from the establishment under one roof of laboratories belonging to the various departments—physics, chemistry, metallurgy, engineering, bacteriology — formerly housed in seven detached, scattered, and obsolete buildings. It has also justified the extensive scale on which the chemical laboratories were planned—a scale strongly criticised at the time as extravagant. Since then much of the more elementary work and the whole of the craft classes have been transferred to the Glasgow Education Authority, and accommodation has thus been made available for a great expansion of advanced study and research in connexion with the countless scientific problems arising in the various industries with which the College is associated. The staff has increased during this period from 29 to 93. A significant event in the recent history of the College is the establishment of the New Development Fund initiated by the former chairman of the governors, Sir George Beilby, and indications of the success that has attended the administration of this fund are to be found in the fifty-eight original papers which have been published in the College *Research Journal*, now in its fifth year, and in the large and increasing number of requests from local firms for help in dealing with problems arising from the use of new alloys and other materials.

Calendar of Patent Records.

January 1, 1905.—Previous to 1905 no question as to the novelty of an invention for which a patent was being sought was raised by the British patent office, but under the provisions of the Patents Act, 1902 (2 Edw. 7, cap. 34), which came into force on Jan. 1, 1905, an official search for novelty was instituted; the examination, however, extending only to completed British patent specifications on applications not more than fifty years old. This limited search has not been altered by later Acts and is still the practice of the office, some 21,000 specifications being so examined each year.

January 3, 1561.—One of the earliest of English industrial monopoly patents was for the manufacture of soap. Soft soap was at that time the only kind made in England, and the patent is evidence of an attempt to introduce into this country the hard soap industry of Marseilles and Spain. The grant was for ten years from Jan. 3, 1561, to Stephen Groyett and Anthony Leleuryer to make white hard soap "like of goodness fynes and puritie as the sope is which is made in the sope houses of Triana or Syvile," and it contained a clause to the effect that two at least of the workmen were to be of English birth. The grant also stipulated that the soap was to be subject to inspection by officers appointed by the Lord Mayor and the Lord Chancellor, and that the patent would be voided if the soap were found to be deficient in quality. It is improbable that the invention was put into successful operation.

January 3, 1839.—The atmospheric system of railway propulsion attracted general attention in England and on the Continent during the forties of last century. Under it a train was propelled by means of atmospheric pressure acting on a piston working in a continuous tube laid between the rails, a vacuum being created in front of the piston by stationary engines situated at convenient intervals along the line. The piston was connected to the first carriage or 'locomotive' by means of a rod working through a slot in the top of the tube, and the great difficulty of the early experimenters lay in the design of a valve for the slot which would open and shut satisfactorily on the passing of a train. Samuel Clegg was the first to find a practicable solution, and he patented his invention on Jan. 3, 1839. In conjunction with Jacob Samuda, of the Southwark Bridge Iron Works, he laid a short length of line for the Dublin and Kingstown Company between Dalkey and Kingstown which was opened in March 1843. Other lines were projected, notably one from Croydon to Epsom and London, part of which was built and opened, but the cost of working and other difficulties proved too great, and all the lines were closed down before 1848.

January 5, 1769.—It is unnecessary nowadays to emphasise the fact that James Watt did not invent the steam engine, but his achievements nevertheless entitle him to rank as one of the world's outstanding inventors. His first engine—the patent for which was granted on Jan. 5, 1769—doubled the efficiency of the old Newcomen engine and directly contributed to the great expansion of industry that took place during the latter part of the eighteenth and the nineteenth centuries. In 1775, Parliament extended the life of the patent, and it was not until 1800, after Watt himself had retired from active business, that the monopoly rights expired. By this time the new business of steam and mechanical engineering, which the success of the Watt engine had called into being, was definitely established.

January 7, 1625.—Wheeled coaches were introduced into England about the middle of the sixteenth century, and became increasingly popular in spite of restrictive legislation which, until the coming of the Turnpike Acts, attempted to fit the traffic to the roads rather than to improve the latter. Many attempts were made to render the coaches more comfortable and safe. A patent was granted to Edward Knappe on Jan. 7, 1625, for a coach in which the wheels and axle-trees were so placed and constructed "as in an instant of tyme the wheels maie be shutt closer together where the narrownes of the waie shall require itt, without anie danger, or to be enlarged and sett wyder as shall be most safe and easey for the passenger . . . as alsoe by hanging the bodie of the coach to the carriage by two springs of steele before and two behinde for the more ease of the treveller." No specification was enrolled and nothing is known about the actual construction. Springs did not come into use until some time later.

January 7, 1714.—Though typewriters were not in general use until toward the end of last century, British patent records and those of other countries show that for a long period there had been a serious and sustained effort to solve the problem of 'mechanical writing.' The earliest patent for such a machine was granted in England to Henry Mill, the engineer of the New River Company, on Jan. 7, 1714, with the title "An artificial machine or method for the impressing or transcribing of letters singly or progressively one after another as in writing, so neat and exact as not to be distinguished from print." No description of the apparatus has come down to us.

January 9, 1854.—Glycerine was discovered by Scheele in 1779, but it did not find extensive application until very much later. It was known that it formed a large part of the spent lyes from soap-making, but there was no great demand for it and no suitable method for its recovery, the small quantities which were required for medicinal purposes being made by saponifying oil with litharge. It was not until G. F. Wilson, of Price's Candle Co., introduced the process of separating the glycerine from the fat acids by means of steam at a high temperature that a pure glycerine could be economically obtained in large quantities. Wilson's process was based on that of R. A. Tilghman, which consisted in forcing an emulsion of fat and water through a coiled pipe heated in a furnace to a temperature of about 330°, for which a patent was granted on Jan. 9, 1854. The discovery of nitroglycerine as an explosive by Nobel in 1863 greatly increased the demand for glycerine.

January 9, 1857.—'Aerated bread' was made under the patent (2293 of 1856) granted to John Daughlish, which was sealed on Jan. 9, 1857. The invention consists of a process for aerating the dough without the addition of yeast or the usual chemical compounds. Carbon dioxide is forced into water under pressure and the charged water is then used for converting the flour into dough, the operation being carried out in a kneading machine in which the pressure is maintained until the kneading is completed.

January 11, 1841.—Alexander Bain was one of the pioneers in the application of electricity to clocks, his first patent, which describes a master clock system, being dated Jan. 11, 1841. The pendulum of his clock carries a coil in place of the bob, which moves in the field of two fixed magnets with north poles adjacent, a make-and-break device regulating the current to the coil so that the pendulum receives an impulse once in every swing to the right.

Societies and Academies.

Dublin.

Royal Irish Academy, Dec. 10.—**A. Farrington**: The pre-glacial topography of the Liffey basin. In pre-glacial times the present Liffey basin was divided between the catchments of two separate streams. One of these catchments included the hill-encircled basin of the upper Liffey and the Kings River. From this area the drainage escaped in a westerly direction. The second catchment was that of the Rye-Water river, which flowed eastwards to Dublin Bay. The portion of the present Liffey which connects these two basins is post-glacial in date. The theory that the diversion of the upper Liffey was due to the lowering of the valley by glacial scour is discussed and rejected. The development of the present course of the Liffey is traced from its initiation as a consequent stream on a westward-sloping plain. This plain was certainly post-Cretaceous and is probably of mid-Tertiary age.

Rome.

Royal National Academy of the Lincei, Communications received during the vacation, 1928.—**G. Giorgi**: New observations on the functions of matrices.—**Q. Majorana** and **G. Todesco**: Preparation of the thallium photoelectric cell. A quick-acting photoelectric cell, at least as sensitive as that of Case, may be prepared from thallium sulphide.—**L. A. Herrera**: Imitation of organised forms by albumen and hydrofluoric acid. Treatment of egg-albumen with hydrofluoric acid, either pure or diluted with water or glycerine, gives rise to structures having the microscopic appearance of hyaline or granulated masses, either nucleated or non-nucleated.—**T. Boggio**: Riemann's homography relative to a curved space.—**J. Delsarte**: The composition of second space.—**H. Geppert**: Adiabatic invariants of a differential generic system. A rigorous definition is given of the conception of adiabatic invariant for any differential system; the problem of finding these invariants in the case of two or more dimensions is to be resolved later.—**R. Caccioppoli**: The definition of the area of a surface. The author's semi-analytic definition of the area of a curved surface, based on the notion of an element of area, is supplemented, and is shown to be of value in integrating and throwing light on certain recent observations of various authors.—**A. Rosenblatt**: The singularity of the solution of a system of ordinary differential equations.—**A. Signorini**: Asymptotic expression of a formula of Levi-Cività.—**E. Pistolesi**: Further observations on Kutta-Joukowski's theorem in the case of a plane lamina. From a discussion of various papers which have lately appeared on this subject, it is concluded that, owing to the essential singularities presented by the current at the angles of the lamina, the problem cannot be solved by the 'orthodox' methods of analysis, but that it requires treatment as a limiting case of a contour devoid of singularity which, by deformation, tends to become confused with the segment counted twice; that the suction at the corners, necessary for the validity of Kutta-Joukowski's theorem, naturally finds a place in the problem so considered; and that such validity may be assumed also for Cisotti's lamina and in all analogous cases.—**E. Persico**: Optical resonance according to wave mechanics. The approximate method proposed by Fermi for taking account of the reaction of radiation in wave mechanics is applied to the development of the theory of optical resonance from the point of view of Schrödinger's mechanics.—**R. Deaglio**: The Volta effect in air and moist surface films. Experiments show that, in a dry medium, the pile effect disappears completely, whereas the Volta effect remains practically unchanged. Hence the moisture of surface films, necessary to create the pile effect, is without sensible influence on the Volta effect.—**E. Oddone**: Interpretation of superficial seismic waves. Explanation of surface seismic waves is somewhat simplified on the basis of the probable existence of Mohorovicic's surfaces of discontinuity and on the values of the velocity of longitudinal waves in and beyond the earth's crust, 57 kilometres in thickness. The slow waves may be considered as analogous to the infra-sounds of acoustics, that is, as waves transformed by distance and multiple reflections.—**B. Castiglioni**: Circulation in the southern Adriatic (2). The currents governing the circulation of the water through the Straits of Otranto are discussed.—**G. Scagliarini** and **P. Pratesi**: The reaction between sodium nitroprusside and sulphides. Stable, homogeneous crystalline compounds, such as $K_2Fe(CN)_5NO, K_2S$, may be obtained by treating a dry nitroprusside with an anhydrous sulphide in absolute methyl alcohol solution. The action of the sulphide on the nitroprusside appears to be analogous to that of alkalis.—**P. Gallitelli**: Laumontite from Toggiano. Two types of laumontite exist: (1) a compact form of almost fibrous structure and nacreous lustre; and (2) a finely granular, almost earthy variety, which crumbles at the slightest shock and differs in composition from the other principally in its lower content of water. The percentage losses of water in the two cases are nearly the same for temperatures below 400°, but diverge at higher temperatures. It seems unlikely that the friable form has originated by dehydration of the more compact kind.—**M. Anelli** and **A. Belluigi**: Confirmation of geological inductions and of geophysical results.—**B. Monterosso**: Cirrepedological studies (4). Phenomena which precede anabiosis in *Chthamalus*.—**F. Dulzetto**: Observations on the sexual life of *Gambusia holbrooki* (Grd.). Contrary to statements made, the sperms of *G. holbrooki* are capable, under certain conditions, of preserving, in the body of the female, their fertilising power from one year to another. The sex of the generations produced in such conditions is under investigation.—**Maria De Cecco**: Application of ultraviolet rays to the examination of fluorescent substances in plants in relation to certain phenomena of vegetable pathology.

Sydney.

Linnean Society of New South Wales, Oct. 31.—**I. M. Mackerras**: New Australian Mydaidæ (Diptera). Description of five new species, one of *Diochlistus* and four of *Miltinus*, and notes on other species.—**J. R. Malloch**: Notes on Australian Diptera. No. 17. The paper contains notes on the Ceroplatinæ (fam. Mycetophilidæ), the genus *Pachyneres*, some Asilidæ, and some already described species of *Cyclorrhapha*.—**Rev. H. M. R. Rupp**: Notes on *Corysanthes* and some species of *Pterostylis* and *Caladenia*.—**H. J. Carter**: Revision of *Hesthesis* (Cerambycidæ) together with description of a new genus and species of Buprestidæ. Three new species (or subspecies) of *Hesthesis*, a new species of *Epania*, and a new genus belonging to the group Anthaxites of the Buprestidæ are described.—**I. V. Newman**: The life history of *Doryanthes excelsa* (Corr.). Part 1. Some ecological and vegetative features and spore production. The development of the floral organs suggests the leaf-shoot nature of the flower, the carpels showing very clearly the form of involute leaves. The microsporangium suggests that of eusporangiate Filicales. *D. excelsa* appears to be primitive among the Amaryllidaceæ.

Washington, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 10, Oct. 15).—**L. Brillouin**: Is it possible to test by a direct experiment the hypothesis of the spinning electron? Suppose that a beam of electrons enters a weak magnetic field nearly normally; the electrons will begin to move in spirals towards the pole of the magnet, and an electrode placed near the pole would collect the electrons. If the electrons have an electric moment, the current to the electrode will drop suddenly to half its value as the direction of the incident electrons approaches the normal to the magnetic field. The experiment will be difficult to carry out.—**Benedict Cassen**: On the distribution law in locally rapidly fluctuating fields which are steady when averaged over a sufficient time interval. In determining the time average electrical potential round the nucleus of a heavy atom, the use of the statistical distribution law of an ideal gas in a steady field is not justified; a 'correlation potential' must be used.—**Frank Peat Goeder**: The crystal structure of potassium sulphate. A quantitative three-dimensional structure is proposed which gives diffraction effects in good agreement with those observed in X-ray powder photographs.—**Carl Barus**: Further experiments in microbarometry.—**Jos. E. Henderson and Elizabeth R. Laird**: Reflection of soft X-rays. The curves showing the relation between percentage reflection from glass and glancing angle have no discontinuity corresponding to a critical angle and total reflection such as is found with short wave-length X-rays. The results can be explained by taking into account the absorption.—**Mabel K. Slattery**: Fluorescence and solid solution. Small quantities of uranium dissolved in fused alkali fluorides gives brilliant and resolved fluorescence spectra at the temperature of liquid air. It seems that the uranium goes into uniform solid solution, replacing an atom of the alkali element here and there in the crystal lattice, and produces no measurable change therein.—**E. C. Kemble and V. Guillemin, Jr.**: Note on the Lyman bands of hydrogen.—**Lee A. DuBridge**: Systematic variations of the constant A in thermionic emission. A form of the Richardson-Dushman equation is developed in which the observed variations of A can be ascribed to a small temperature variation of the surface work function.—**R. C. Williamson**: (1) The photoelectric long wave limit of potassium vapour. There appear to be two types of *molecular* ionisation, one without and the other with dissociation.—(2) Emergent energy of photoelectrons in potassium vapour.—**Edwin H. Hall**: Electric conductivity and optical absorption of metals. An argument based on the associated-electron theory of conduction, namely, that conduction is partly by free electrons sharing the thermal energy but mainly by the interchange of electrons in encounters between atoms and positive ions, the latter being naturally equal in number to the free electrons.—**Clyde E. Keeler, Evelyn Sutcliffe, and E. L. Chaffee**: A description of the ontogenetic development of retinal action currents in the house mouse. Using the intact unanæsthetised animal, it is found that the first visible potential difference on illumination occurs on the 13th-14th day after birth. The reaction in young mice is different from that in older animals, but it gradually takes on the adult form.—**L. C. Dunn**: A fifth allelomorph in the agouti series of the house mouse.—**G. A. Miller**: Determination of all the groups which contain a given group as an invariant subgroup of prime index.—**Charles E. Hadley**: Colour changes in excised pieces of the integument of *Anolis equestris* under the influence of light. Patches of dorsal skin of this Cuban lizard in physiological salt solution in direct sunlight change from green to dark brown in 40 sec., and 12 sec. after removal to the shade become green again. Similar changes occur in the live animal, and also with the stimulation of excitement, but much more slowly. As regards the excised skin experiments, the melanophores must be capable of expansion and contraction when isolated from the action of hormones and the nervous system; possibly impulses are received from end organs left intact in the skin, or light may have a direct effect on the melanophores.

Official Publications Received.

BRITISH.

Proceedings of the Royal Society. Series A, Vol. 121, No. A788. Pp. 477-681+xlii. (London: Harrison and Sons, Ltd.) 8s.

Royal Agricultural Society of England. Agricultural Research in 1927. Pp. viii+190. (London: John Murray.) 1s.

Observations made with the Cookson Floating Zenith Telescope in the Years 1919-1927 at the Royal Observatory, Greenwich, for the Determination of the Variation of Latitude and the Constant of Aberration, under the direction of Sir Frank Dyson. Pp. 67. (London: H.M. Stationery Office.) 7s. 6d. net.

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board for the Year 1927-8. Pp. iii+18. (London: H.M. Stationery Office.) 6d. net.

FOREIGN.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 80. Fishes from Florida and the West Indies. By Henry W. Fowler. Pp. 451-473. (Philadelphia, Pa.)

Ministry of Public Works, Egypt: Physical Department. Paper No. 24: The Measurement of the Discharge of the Nile through the Sluices of the Aswan Dam; Final Conclusions and Tables of Results. By Dr. H. E. Hurst and D. A. F. Watt. Pp. v+44+4 plates. (Cairo: Government Publications Office.) 10 P.T.

Civil Aeronautics. Legislative History of the Air Commerce Act of 1926, Approved May 20, 1926, together with Miscellaneous Legal Materials relating to Civil Air Navigation. Revision of the 1923 edition of Law Memoranda upon Civil Aeronautics. Corrected to August 1, 1928. Pp. v+178. (Washington, D.C.: Government Printing Office.)

Reprint and Circular Series of the National Research Council. No. 83: Sixth Report of the Committee on Contact Analysis. By Robert E. Burk, in collaboration with other Members of the Committee. Pp. 47. 50 cents. No. 84: i. The Fourth Census of Graduate Research Students in Chemistry, 1927; ii. Support of Graduate Research in Chemistry in American Universities, 1927-1928. Compiled by Clarence J. West and Callie Hull. Pp. 13. 20 cents. (Washington, D.C.: National Academy of Natural Sciences.)

Cornell University Agricultural Experiment Station, Ithaca, New York. Bulletin 467: Tomato Fertiliser Experiments in Chautauqua County, New York. By Paul Work. Pp. 24. Bulletin 469: The Collection of General-Property Taxes on Farm Property in the United States, with Emphasis on New York. By M. Slade Kendrick. Pp. 51. (Ithaca, N.Y.)

Diary of Societies.

FRIDAY, JANUARY 4.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Dr. H. R. Mill: Capt. Cook's Quest of the Southern Continent (Christmas Lectures to Young People) (II.).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Major A. W. Farrer: The Engineer Salesman Abroad.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Informal Meeting of Pictorial Group), at 7.—Discussion on the Prints in the Holcroft Collection.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Café, Swansea).—A. Grounds: Preparation of Coal for the Market.

SATURDAY, JANUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—A. Wood: Sound Waves and their Uses (V.): The Ear and What it does (Juvenile Christmas Lectures).

MONDAY, JANUARY 7.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. H. S. Allen: Remarks on Band Spectra.—Dr. I. Sandeman: The Fulcher Bands of Hydrogen.—F. B. Hutt: (a) On the Relation of Fertility in Fowls to the Amount of Testicular Material and Density of Sperm Suspension—Studies on Embryonic Mortality in the Fowl; (b) Part 1. The Frequencies of Various Malpositions of the Chick Embryo and their Significance.—F. B. Hutt and A. W. Greenwood: (a) Part 2. Chondrodystrophy in the Chick; (b) Part 3. Chick Monsters in Relation to Embryonic Mortality.—L. A. Harvey: The Oogenesis of *Carcinus mænas* Penn., with Special Reference to Yolk Formation.—J. Wishart: The Correlation between Product Moments of any Order in Samples from a Normal Population.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Dr. W. Bell Dawson: The Hebrew Calendar and Time Periods.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (in Laboratories of Applied Electricity, Liverpool University), at 7.—W. B. Woodhouse: Overhead Electric Lines.

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—A. M. Chapman: The Application of Worsted Yarns to Dress Goods and Coatings.
SOCIETY OF CHEMICAL INDUSTRY (London Section, jointly with the Fuel Section) (at Burlington House), at 8.—J. I. Graham: The Action of Hydrogen upon Coal.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Dr. O. Faber: The Expansion and Contraction of Building Materials due to Temperature, Humidity, Stress, and Plastic Yield.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. H. Karius: The First Crossing from the Fly River to the Sepik, New Guinea.
INSTITUTION OF THE RUBBER INDUSTRY (London Section) (at Blackfriars Theatre, E.C.).—F. W. Bennett: Factory Organisation in the Rubber Industry Affecting the Conditions of the Worker.

TUESDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3.—A. Wood: Sound Waves and their Uses (VI.): How Sounds are Recorded and Reproduced (Juvenile Christmas Lectures).
INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 5.30.
ROYAL SANITARY INSTITUTE, at 5.30.—Prof. A. Bostock Hill and others: Discussion on Cleanliness: Is it the Basis of Health?
INSTITUTION OF CIVIL ENGINEERS, at 6.
INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. Calderwood: The Diesel Engine for Passenger Ships and Fast Cargo Liners.
INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—J. L. Carr: Recent Developments in Electricity Meters, with particular reference to those for special purposes.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. H. Blake: London through the Eyes of Hogarth.
BURNLEY TEXTILE SOCIETY (at Mechanics' Institute, Burnley), at 7.15.—H. C. Barnes: Conditions in Cotton Manufacturing Abroad.
INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. T. Butterwick and others: Informal Discussion on Shipbuilding.
QUEKETT MICROSCOPICAL CLUB, at 7.30.—W. N. Edwards: Microscopical Study of Fossil Plants.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—Dr. F. W. Lanchester: Coil Ignition.
HULL CHEMICAL AND ENGINEERING SOCIETY (Grey Street, Hull), at 7.45.—G. R. Adamson and C. F. Tinker: Electric Cranes.
ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Discussion: The Use of Artificial Sunlight in Mental Hospitals.
PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (North Metropolitan Branch) (at 17 Bloomsbury Square), at 9.—G. Fletcher: Ireland: Its Scenery and People.

WEDNESDAY, JANUARY 9.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. O. T. Jones: The History of the Yellowstone Cañon, Yellowstone National Park, U.S.A. (Lecture).
INSTITUTE OF METALS (Swansea Local Section) (at Thomas Café, Swansea), at 7.—G. E. K. Blythe: Pulverised Coal in Metallurgy.
INSTITUTE OF FUEL.—H. A. S. Gothard: The Application of Pulverised Fuel Firing for Lancashire Boilers.

THURSDAY, JANUARY 10.

ROYAL SOCIETY OF ARTS, at 3.—Capt. Sir Arthur Clarke: Ships and Lighthouses (Dr. Mann Juvenile Lectures) (II.).
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Capt. J. M. Donaldson, Capt. J. G. Hines, and others: General Discussion on A Study of the Future Development of Demand and the Economic Selection, Provision, and Layout of Plant, as illustrated by Telephone Systems on the one hand and Power Systems on the other.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—F. R. Newens: Demonstration of Flashlight in Colour Photography and the Desensitising and Development of the Agfa Colour Plate.
LITTLEBOROUGH TEXTILE SOCIETY (at Central Council School, Littleborough), at 7.30.—H. Sutcliffe: Some Power Transmission Problems.
INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—H. C. Lancaster: The Lead Industry.
OIL AND COLOUR CHEMISTS' ASSOCIATION (30 Russell Square), at 7.30.—B. Campbell: Nitro-cellulose Lacquers.
INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch).
INSTITUTE OF CHEMISTRY (Manchester Section) (at Manchester).—H. D. K. Drew: Pregl's Micro-methods of Analysis.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 5.
PHILOLOGICAL SOCIETY (at University College), at 5.30.—L. C. Wharton: Dialect Developments.
MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in Mining Institute, Newcastle-upon-Tyne), at 6.—W. J. Drummond: Coal used in its Raw State.—Dr. W. T. K. Braunholz: Fuels obtained by the Treatment of Coal.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—J. A. H. Lloyd: Telephone Repeaters.
BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—Dr. P. Bean: The Dyeing of Artificial Silk.
KEIGHLEY TEXTILE SOCIETY (at Kiosk Café, Keighley), at 7.30.—Lecture on Artificial Silk.
OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—Dr. J. J. Fox: The Examination of Paints.
SOCIETY OF CHEMICAL INDUSTRY (Manchester Section).—N. S. Humphries: The Efficiency of the Present-day Finishing Stenter.
SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group).—Prof. B. P. Haigh: The Relative Safeties of Mild and High-Tensile Alloyed Steels under Alternating and Pulsating Stresses.

EXHIBITION.

TUESDAY, WEDNESDAY, AND THURSDAY, JANUARY 8, 9, AND 10.

PHYSICAL SOCIETY AND OPTICAL SOCIETY (at Imperial College of Science).—Exhibition of Scientific Instruments.—Discourses during the Exhibition, at 8 each evening:—
On Jan. 8.—Prof. F. Lloyd Hopwood: Experiments with High Frequency Sound Waves.
On Jan. 9.—C. Beck: Lenses.
On Jan. 10.—A. J. Bull: Some Colour Problems in Photo-Engraving.

PUBLIC LECTURE.

TUESDAY, JANUARY 8.

UNIVERSITY OF LEEDS (in Philosophical Hall, Leeds), at 6.—O. E. Simmonds: The Wonders of Flying.

CONGRESSES.

JANUARY 4.

CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College).
Friday, Jan. 4, at 11 A.M.—British Broadcasting Corporation.—Demonstration of Educational Broadcasting.
At 2.30.—Medical Officers of Schools Association.—Dr. A. A. Mumford: Physical Activity and Physical Training in Relation to Scholastic and University Progress.

JANUARY 4 AND 5.

GEOGRAPHICAL ASSOCIATION (at London School of Economics).
Friday, Jan. 4, at 10 A.M.—E. J. Orford and others: Discussion on Educational Re-organisation and the Teaching of Geography.
At 11.45 A.M.—Sir H. G. Lyons: The Geographer and his Material (Presidential Address).
At 2.30.—Prof. C. B. Fawcett: The Balance of Urban and Rural Populations.
Saturday, Jan. 5, at 10.30 A.M.—Dr. Vaughan Cornish: On Linguistic Frontiers in Central Europe dating from Heathen Times.
At 11.45 A.M.—Hon. Secretary: Summary of the Results of Discussions held on the previous days.

JANUARY 4 AND 5.

NORTH OF ENGLAND EDUCATION CONFERENCE (at Heaton Secondary Schools, Newcastle-upon-Tyne).
Friday, Jan. 4, at 10 A.M.—A. R. Pickles and others: Free Place Examinations.
At 11.15 A.M.—Miss L. Jowitt and others: Social Activities in Education.
At 2.45.—A. Watson and others: Education in Relation to Industry and Commerce.
Saturday, Jan. 5, at 10 A.M.—F. A. Hoare and others: The League of Nations and the Schools.

JANUARY 7 AND 8.

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College).
Monday, Jan. 7.
At 4.—H. G. Forder: The Axioms of Geometry.
At 5.30.—Prof. H. M. Levy: Modern Mathematical Problems in Aerodynamics.
Tuesday, Jan. 8.
At 10 A.M.—Miss E. R. Gwatkin and others: Discussion on Should a Candidate for School Certificate be allowed to take, in place of the Mathematics and Science Group, a Group containing Drawing and Music and possibly other Subjects?
At 11.45.—N. J. Chignell: The Use and Abuse of Formulæ.
At 2.30.—Dr. W. F. Sheppard: Variety of Method in the Teaching of Arithmetic.
At 3.45.—Prof. J. E. A. Steggall: Methods of Voting in Theory and in Practice.

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.