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NATURE

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REORGANIZATION OF THE NATION'S WAR EFFORT

THE concern with the organization of production and the strategy of the War, both diplomatic and military, which found expression in the debates on the campaign in Crete and more recently on war production arises entirely from the desire to strengthen the hands of the Prime Minister, from the general belief that insufficient use is still being made of our resources of materials and men, and that, great war premier as he is, he cannot win the war without long-term strategic plans or unsupported by the application of the keenest critical minds the Empire can supply. The Government showed a lamentable lack of appreciation of this position in a recent debate on production when the Minister of one Department and the Parliamentary Secretary of another were left to meet criticisms which came from all parts of the House of Commons and raised questions far wider than any departmental issues. The insistent call for a better distribution of effort, more effective planning and a more scientific method of organization was deliberately ignored, nor can it be said that this call was fairly met by the Prime Minister in his statement opening the subsequent debate on July 29.

Such neglect is disservice to the Prime Minister himself. Appreciation of the magnificent service he has rendered and continues to render to the cause of freedom throughout the world is in no way diminished by a growing conviction that his service would become even more invaluable if he could be relieved of some of the heavy burdens the present system and organization place upon his shoulders. Moreover, the changes recently announced—the appointment of an advisory committee to the Production Executive and the attachment of the regional boards to the Production Executive—like the appointment of Lord Beaverbrook as Minister of Supply and Mr. Morrison's arguments against a Ministry of Civil Defence are suggestive more of shreds and patches than of a concerted policy and the formulation of a grand strategy. Taken with the rather petulant reply of the Prime Minister himself to questions regarding the recent appointment of Mr. Oliver Lyttelton as Minister of State resident in the Middle East, they are calculated to arouse, rather than to dispel, public misgivings.

That the time has come for recasting strategy and replanning the War is widely believed. Parliament clearly means to see that the Prime Minister is provided with the best political, diplomatic, administrative, industrial and military machine the Empire can create. It is determined that the burden is no longer to be on one man alone, and the demand for a small War Cabinet of men of highly developed critical faculties, moral courage, clear and imaginative minds and a good working knowledge of strategy and industrial planning grows stronger every day. Only from such a Cabinet can we look for what is the more imperative as help from the United States increases—a

definite decision as to the kind of war we mean to fight, how and where we mean to fight it, and the forces required for success.

Such decisions are essential to the devising of an adequate and flexible plan and to the organization of the home front whether for civil defence or production. They cannot be expected of the bureaucratic mind and there must be utter ruthlessness in sweeping away the type of official who regards the State or some department of it as his own affair, in which no one outside has any right to interfere except under his orders. That this is the temper of the nation was shown clearly in the recent debates on production with their demand for leadership. Examples could be multiplied over almost the whole field of national endeavour to show how for lack of imaginative and constructive leadership opportunities are being missed, enthusiasm damped, and the national effort checked of its full power.

In these circumstances, Lieut.-Colonel Clive Garsia's "Planning the War", just published as a "Penguin Special", is of particular interest, and may well serve to focus constructive thought upon the aims of Allied strategy, the means by which they are to be achieved and the organization of all our resources to that end. Obviously, there is much that the Government cannot disclose of both planning and strategy, but there are too many signs of the absence of planning where it should be evident for uneasiness in this respect to be lightly dismissed. A trenchant article by Sir William Beveridge, for example, in *The Times*, pointed out that the formation of a national fire-fighting service was at least six months overdue when it was initiated, and disposed convincingly of Mr. Morrison's arguments against a Ministry of Civil Defence.

That co-operation between existing Ministries and local authorities is still imperfect, that the degree of readiness in different areas does not correspond to the degree of danger, and that the Fourth Arm of our defences needs a single head as much as the other three arms is scarcely questioned by those who have experience of severe air attack. A similar impression prevails in the field of production through failure of the Government to use its compulsory powers and give positive direction and not merely advice, for example, in the numerous problems which arise in the concentration of industry and the direction of labour and enterprise from distribution or non-essential work to the war production industries. Indeed, the omission to take the nation into its confidence, to explain exactly why certain changes in occupation, in habit, or diet are required and then firmly and impartially enforce them, whether the use of brown bread in place of white, the discouragement of inefficient forms of food production or conversion, such as pig-keeping, poultry and eggs, the allotment of shipping space to non-essentials, or the elimination of retailers whose trade is too small for economic distribution, is doing more harm to the national morale than the Government realizes or admits.

Consciousness of this danger is the true source of some of the concern regarding the Ministry of Information itself, but uneasiness at the co-ordination of our war effort is widespread. Too many problems of civil defence, priorities, fuel, agriculture, and so on, appear to be handled on departmental lines with little indication of relation to an overruling plan and strategy. Evidence of waste of man-power and materials is widespread, and there is growing impatience at excessive leniency towards offenders in such matters as absenteeism, mismanagement and offences against rationing. Too often the people hunger for leadership and are not fed.

It is not to be expected that the incomparable leadership of the Prime Minister should be all that is provided. Something of that quality must reach down from him through all ranks and to all sections of society. Nor is the long-range planning or even the medium-range planning essentially the task of a War Cabinet. That should rightly be delegated to professional subordinates whose special and sole business it is, whether industrial, naval, military, scientific or political. This is the first characteristic of the system of planning outlined by Lieut-Colonel Garsia. It starts from the bottom and works upwards, not from the top downwards as in the present system which the Prime Minister defended in his statement on January 22. Free from both planning and executive functions, except in so far as its members participate individually as chairmen of co-ordinating planning committees, the vital responsibility of the War Cabinet he suggests is to give decisions on matters of major importance.

The second essential feature of Colonel Garsia's system is that instead of being based on past experience—what he calls the static method—it takes account of the potentialities of the situation ; not merely the resources available at the moment, but those which might be made available to implement a strategic concept which when the problem is first approached appears to be quite unattainable. This is what he terms dynamic planning, and he quotes a passage from Mr. Churchill's "World Crisis" which illustrates how this concept was present in the Prime Minister's mind more than twenty-five years ago.

This system of what Colonel Garsia terms automatic planning thus originates at the perimeter and not at the head of the organization. Stimulating and utilizing creative thought at all levels, it also

facilitates rapid and decisive elimination of the less promising alternatives as well as the integration of activities while the plan is still nebulous. Responsibility for medium- and long-range planning and the essential staff work involved are delegated to a series of planning committees each of which covers one of the specific fields into which the whole is necessarily subdivided. Use of the proper technique and submission of a reasoned appreciation and plan covering the field for which each committee is responsible enables the co-ordinating Control Planning Committee, the chairman of which would be the secretary of the Committee of Imperial Defence, readily to synthesize a comprehensive plan for the consideration of a War Cabinet relieved of the detailed work and executive duties which might prevent proper attention to major strategy in every field of operation.

This War Cabinet represents the apex of the system. Small and selected for acute analytical minds rather than representing special interests or political parties, and limited to at most three or four in addition to the Prime Minister and the Minister of Defence, under the Prime Minister's leadership, untrammelled by military or other duties, unburdened by quasi-departmental responsibilities, it would supervise and direct all these activities, intervening with decisive authority wherever required. It would, in fact, be in keeping with the Cabinet visualized in the Haldane Committee's report and with the proposals advanced in 1938 by Brigadier Sir Edward Tandy in his lecture before the Royal Society of Arts on "The British Cabinet and its Increasing Burden".

"Planning the War" is a timely and significant contribution to the theory of planning and organization which cannot but make a special appeal to the scientific worker. Moreover, apart from the range and complexity of our existing war effort, our growing relations with the United States impose fresh problems and burdens on our war organization. We cannot expect that partnership to yield its fullest results unless co-operation is effectively organized and planned, and Anglo-French experience prior to 1914 as well as in the opening of the present war well attests the truth of Colonel Garsia's emphasis on the importance of planning in Anglo-American co-operation. Indeed he goes so far as to assert that Anglo-American planning has not yet come into existence.

It is possible to criticize Colonel Garsia's proposals as somewhat too theoretical. They appear, however, in the main to be in harmony with established principles of scientific management, and his emphasis on the importance of sound organization and efficient technique is most timely. There is real danger that the conduct of the war may be endangered and victory delayed by imperfect or inferior staff work in these fields. If we are to make the most effective use of our resources and advantages, our staff work and organization must be equal if not superior to that of our enemy, and there will be widespread agreement with Colonel Garsia's view that our primary requirement to-day is not tanks and guns, but a central organization and technique competent to plan the combined war effort of the British Empire and of the United States.

The main objectives of any reorganization are not in dispute. It should secure the clearest possible definition of strategic purpose in the broadest sense. Planning machinery staffed by specialists must be devised to secure the swift and orderly fulfilment of that purpose, measuring its requirements and marshalling in its service in turn all the resources of man-power and materials available in Great Britain, its allies or partners. Such proposals as those of Colonel Garsia are designed to strengthen, not to weaken, the Government; to avert dangers which a continuance of the present system is likely to precipitate; and to place the Government in a better position to investigate rapidly and constructively the whole conduct of the war and of the allocation of the war output with the one object of organizing that total effort for speedy victory. Above all it is intended to lift from the Prime Minister's shoulders something of the great burden resting upon them and to enable him to assert even more decisively and inspiringly the full vigour of his matchless leadership. That is the real purpose behind the criticism voiced in Colonel Garsia's book, in the debates in the House of Commons, and in many quarters outside, on civil defence, on man-power and on production. The warmth with which Mr. Churchill's subsequent promise of a full and comprehensive statement in a third day's debate on production in public session was welcomed is an eloquent testimony both to the universal regard for his own magnificent leadership, and to the determination that any shortcomings in the organization and management of our war production must be rectified with the utmost dispatch and without regard of persons.

The statement so eagerly awaited was made in the House of Commons on July 29. Mr. Churchill outlined the steps which were taken to prepare a general programme of munitions production at home and in relation to imports, which was approved by the War Cabinet in March last. He then dealt, one by one, with the more specific criticisms which were made in the earlier debate.

It was not to be expected that Mr. Churchill would give facts and figures of production, which would obviously be of the greatest value to the enemy, but he was nevertheless able to dispose of

some misunderstandings. Further, he expressed himself as satisfied with present arrangements—or at least, he declared he was unable to accept the suggestion for a Ministry of Production as likely in present circumstances to give better results. The delays and difficulties which had occurred are now, he said, largely matters of the past, and were due to such factors as the dispersion of factories, the dislocation caused by air raids, enforced changes of diet, and the dilution of skilled industry, and he remarked, "The House must, therefore, be content with my assurance that progress and expansion on a great scale are continuous and remorselessly spurred on".

The debate which followed was wound up by the Minister of Labour, Mr. Bevin. In reply to the criticism that so many skilled workers have been drafted into the Services, he reminded the House that the need for tradesmen in the Services is ten times as great as in any previous war. The Royal Air Force and the Navy have been able to train the great proportion of skilled workers they require, and he expressed the belief that the Army will do the same as its mechanical expansion proceeds. Dealing with industry, however, he agreed that there has been difficulty in building up supervision and management to cope with the sudden development of Governmental activity, and stated that he would like to see management "become a profession".

Looking back now on that debate and its predecessor, on matters of policy of vital import in the conduct of the war—debates which could not take place under a totalitarian regime—surely we can regard them as symbols of the vitality of democracy, and a guarantee that it is capable, when the time comes, of leading the nations to peace and prosperity.

NATURALISM AND SUPERNATURALISM

An Essay on Nature

By Frederick J. E. Woodbridge. Pp. xi+351. (New York : Columbia University Press ; London: Oxford University Press, 1940.) 20*s*. net.

THIS is an unusual book, attractively written and well worth reading. It is a direct and general statement of belief such as one seldom gets from a modern philosopher. At this late day a new faith is necessarily suspect. Prof. Woodbridge would probably not claim that his was new, but he could well claim a sane and judicious outlook and a freshness of expression which throws new light on old truths.

Prof. Woodbridge's starting-point is that of naturalism, a candid and, so far as possible, a complete acceptance of the world of fact. This means that Nature is all that can be discovered by the help of experience. Nature "is the field of knowledge and as that field she is pre-eminently the familiar visible world. The problems of knowledge are all problems of formulating her coherences" (p. 331). On this view it is a profound mistake to divide the natural world into two parts, one that is seen but not understood, another that is understood by means of scientific theory but not visible. A consequence of the stress laid on the unity of Nature is the conclusion that the relations of the sciences have been generally misconceived. "Nature, not the wit of man, gives to knowledge its integral character. This suggests a science of nature which is neither physics nor chemistry and the like nor the social sciences and their like and which is, in a somewhat Hegelian way, a special science because restricted to what is not specific, but general. Had the history of the sciences been kind in its preference for Greek words this special science might well have been called 'physics' and all others summed up under 'metaphysics', subdivided in terms of specific subject matter" (pp. 58–59). If Prof. Woodbridge is right, this general science scarcely exists as yet.

Granted a candid recognition of facts, Prof. Woodbridge argues that one among those to be recognized is the fact that men pursue other ends besides knowledge, ends that may be summed up as 'happiness'. For knowledge Nature is primary, but for happiness, secondary. "The important fact is that the pursuit of happiness leads to the question whether that pursuit is worth while. That is the great question that has haunted mankind for ages. In a way it is an odd question. Nobody ever seems wholly content to take the positive fact that happiness is pursued as an answer" (p. 334). If the pursuit is to be justified, it is justified by faith in (not knowledge of) the 'supernatural'. Prof. Woodbridge prefers the term 'supernatural' to the more popular term 'ideal', although, as he says, it is commonly disliked and supposed to imply superstition. But superstition is not faith ; it is the attempt to deal with the supernatural by blackmail or bribery. The distinction is that between Job, who kept faith though he were to be slain, and Saul, who consulted the witch of Endor. This is perhaps the main conclusion of the book, that supernaturalism is not the antithesis of naturalism but its necessary complement. On one hand, claims to knowledge

are invalid unless they follow from an acceptance of the realm of facts; on the other, human interests are unsatisfied, even the interest in knowledge, without the realization that the realm of facts is in itself incomplete. In other words, without faith in something else, for which Nature is secondary, there is no motive for trying to understand Nature.

There is one criticism to be made, concerned rather with the method of statement than with any substantial point. The author speaks of Nature as being pre-eminently the visible world and this is to a large extent true. Such a statement, however, obscures the fact that the physical sciences could be studied by blind men possessing the other senses, but not by beings possessing sight only. Measurement, as Berkeley pointed out long ago, is of tangible objects even though referred to visible objects and expressed in visual terms. Newton's laws of motion describe the operation of tangible things. If they are applied to the stars, it is because these visible objects are treated as though they were tangible.

A. D. RITCHIE.

PHYSICS OF OIL PROSPECTING

Geophysical Prospecting for Oil

By L. L. Nettleton. Pp. xi+444. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s*.

IN the last few months a number of very welcome books have been published in the United States on the subject of geophysical prospecting. Of these, the present work fulfils a very useful purpose, as it is written mainly for the layman, that is the petroleum geologist and the petroleum engineer. These, as a rule, do not participate actively in this branch of oil prospecting; nevertheless they should be in a position to appreciate the possibilities and limitations of the various methods which can be employed for this purpose, and also they should be able to understand the implications of any geophysical survey. In such a subject as geophysical prospecting, in which the technique is advancing rapidly, there are obvious difficulties in the way of the layman who wishes to keep in touch with the latest developments. Nettleton's book, giving a reliable and co-ordinated picture of the present state of geophysical prospecting in relation to oil, should do much to remove these difficulties and to form a background against which future developments can be assessed.

In common with most books on the subject, it is divided into four sections, three of these being devoted to the most important methods of oil prospecting, namely the gravitational, the magnetic and the seismic methods respectively, and these occupy nearly 90 per cent of the whole. The remaining section, devoted to the electrical applications (including electrical coring) and to miscellaneous methods, is contained in less than fifty pages and is by far the weakest part of the work. The book is generously illustrated, and for those who wish for further detail on the main points, each section is furnished with a brief bibliography of the more important papers on the subject.

From the author's preface, it appears that the book had three objects. The first, and most important, is to present a reliable picture of the principles and practice of geophysical prospecting for oil, primarily for the layman. At the same time, as a second object it is tentatively suggested that much of the material will serve as a useful reference for the specialist. Finally, and really part of the first aim, the writer hopes to give the student an appreciation of geophysical maps, the immediate product of any survey.

On the whole, the first of these objects has been attained reasonably well, and in certain chapters extremely well. Thus, the section dealing with direct gravity-measuring instruments is an excellent example of the standard suitable for the beginner, particularly the geologist. It is profusely illustrated with twenty figures in less than thirty pages, the diagrams themselves being, in many cases, almost self-explanatory. These, supplemented by short paragraphs in the text, give a clear, if somewhat simplified, picture of the modern instrument. On the other hand, certain parts are treated in a more mathematical manner, for example, the theory of the torsion balance, the vertical force variometer and many of the factors involved in interpretation. Although the treatment is elementary, it is likely to prove heavy for the non-mathematically trained geologist, and is more suitable for the physicist. The second object is obviously incompatible with the first, for those aspects which are likely to appeal to the beginner cannot contain the detail to which the specialist will have occasion to refer. Certain features of use to the professional are certainly included, such as the average physical properties of rocks, gravity tables, charts and tables for terrain corrections, etc., but the list is far from being comprehensive. Formulæ for the computation of effects are very sparse, referring only to the simplest shapes, and these are used mainly to illustrate certain factors involved in the interpretation of results. The most serious criticism which can be made is the lack of examples of actual geophysical surveys. In the gravitational and magnetic sections, not a single

geophysical map is given, while in the seismic section only two or three examples appear.

Nevertheless, the petroleum technologist who is interested should derive much benefit from the book, for the mathematical treatments are usually preceded by a section devoted on the physical principles involved, and the physicist should find it an easy introduction to the subject. Both, however, would find it necessary to supplement the volume with practical examples before the true purpose of the book was achieved.

J. McG. BRUCKSHAW.

MODERN SURVEYING

(1) Plane and Geodetic Surveying for Engineers
By the late Prof. David Clark. (Text Books of Civil Engineering.) Vol. 1: Plane Surveying. Third Edition, revised and enlarged by James Clendinning. Pp. xvi+620. (London: Constable & Co., Ltd., 1940.) 27*s*. 6*d*. net.

(2) Engineering Surveys
By Harry Rubey, Prof. George Edward Lommel, and Prof. Marion Wesley Todd. (Engineering Science Series.) Revised edition. Pp. xv+322+142. (New York: The Macmillan Company, 1940.) 15*s*. net.

(3) Route Surveying
By Prof. George Wellington Pickels and Prof. Carroll Carson Wiley. Second edition. Pp. xv+427. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 21*s*. net.

(4) Introduction to Mine Surveying
By W. W. Staley. Pp. vii+276. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1940.) 21*s*. 6*d*. net.

IN a general text on surveying, as is pointed out by the author of one of these books, there is little room for originality except in treatment. Regarded as a branch of mathematics or as a conventional system of making, recording and plotting earth measurements, the subject is one which demands strict adherence to well-established rules. The improvements in instruments made possible by better designs and by increasing precision of manufacture whereby the degree of accuracy has risen from 1 in 5,000 to 1 in 30,000, cause changes to take place such as the substitution, in certain cases, of traversing for the more laborious method of triangulation.

(1) As an example of a text-book which has been maintained in close relation to modern tendencies, Clark's "Plane and Geodetic Surveying" may be cited. The third edition of vol. 1 deals with practically all the knowledge required of the average civil engineer and is distinguished by the clear terms in which instruments and methods have been described and explained. To bring it into line with recent developments the editor has added a chapter on linear measurements and has extended the original section on traversing so that it is now represented by one dealing with field work and another with office computations. Other important additions include instruction on the theory of errors, on road transition curves and on the important aid to hydrographic surveying provided by the echo-sounding apparatus.

(2) "Engineering Surveys" deals in a more concise but equally clear way with the same general subject from the point of view of the present-day engineer. In the revised edition, the excellent Macmillan Mathematical Tables have been retained and one giving the average air correction for barometric levelling temperature has been added. Otherwise, changes made in the text are matters of detail introduced to ensure a practical up-to-date presentation of the subject eminently suitable either for instruction or for casual reference.

(3) "Route Surveying" is more limited in scope and deals with the essentials of railroad, highway and other route surveys as required for transmission lines, pipe lines, canals, drainage, etc. The major changes introduced include extensive new matter on circular curves and spirals and on the string-lining method as applied to the realignment of existing railroad curves. Although the spiral is usually regarded as complex and difficult, the presentation of it here from the point of view of change of curvature makes it appear but slightly more difficult than a simple curve, and the treatment is probably as complete as any so far available.

(4) In "Mine Surveying", another branch of the subject is presented. It is a new book devised to make good the deficiency of works on the subject and is largely based on a questionnaire sent to prominent companies in North America engaged in gold, silver, copper, lead and zinc mining. The author, from his own experience, has supplemented and organized the important information thus obtained as to present-day practice. As the reader is assumed to have a basic knowledge of plane surveying, the text is wholly devoted to the specialized methods and instruments devised for use in mines, and represents well-authenticated practice of the present day.

CHARLES CHREE AND HIS WORK ON GEOMAGNETISM*

By Prof. S. Chapman, F.R.S.

CHARLES CHREE, a son of the manse, an Aberdonian scholar brilliant in classics as well as in science, distinguished later at Cambridge as a mathematical expert on the theory of elasticity, in 1893 took up new and very different labours as superintendent of the magnetic and meteorological observatory at Kew. When he retired in 1925 he was president of both the international organizations concerned with geomagnetism.

British Contributions to Geomagnetism

In the earth sciences, most of all, international co-operation is a necessity for progress; yet each nation may feel pride in its own contributions to the common stock. In geomagnetism Britain has a long and distinguished record. Queen Elizabeth's hydrographer Robert Norman was the first to measure the magnetic dip (1576); her physician William Gilbert wrote "de Magnete" (1600), the first modern scientific treatise. Gellibrand, Gresham professor, discovered the secular magnetic variation (1634); Halley made the first scientific voyages (1698–1700) to measure the magnetic declination, and also constructed the first magnetic chart (1701). Graham, the London instrument maker, discovered the transient magnetic variations (1724).

In the nineteenth century Sabine fostered the British Colonial magnetic observatories, discovered the 11-year cycle in geomagnetism, and like Broun of Trevandrum, made notable studies of the lunar geomagnetic tide. Balfour Stewart was the first to realize the existence of the ionosphere as the primary source, through dynamo action, of the daily magnetic variations (1882). Schuster applied Gauss's method of spherical harmonic analysis to these variations (1889), and developed Stewart's dynamo theory (1908). Maunder made brilliant studies on the connexions between the sun and magnetic storms (1904–16).

Chree and his Contemporaries

Chree, contemporary with Schuster and Maunder, was in this distinguished succession, and his name will endure in the history of geomagnetism. Other notable contemporaries were Bauer, the initiator and first director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, and Schmidt, van Bemmelen and Moos, the directors of the magnetic observatories at Potsdam, Batavia and Bombay; like Chree, they were not content with maintaining a high standard of accuracy in the magnetic measurements under their charge; they had also the energy, ability and inward impulse to undertake the scientific discussion of their records.

Chree maintained the reputation of Kew as a magnetic centre of the first rank; he standardized magnetic instruments, trained many young men to use them, notably on polar and other magnetic expeditions, and gave immense time and effort to the discussion not only of the Kew data, but also of records obtained by four Antarctic expeditions. He brought to his work, besides untiring industry and devotion, a meticulous attention to detail, and a clear, critical and scrupulously exact mind.

Geomagnetism has need of men of widely different gifts: of the organizer and administrator; of the man of affairs, who can influence Governments or private benefactors to provide resources for the science; of the navigator and explorer; of the instrument designer and maker; of the patient, skilled and resourceful observer, often far from social and technical centres; of the faithful computer, zealous for detailed accuracy; of the investigator, theorist and writer.

Bauer was a man of enthusiasm and energy, who took wide views and realized great projects; but his eagerness to reach conclusions, where sometimes judgment was better deferred, met a useful corrective in Chree's critical detachment, which later administered some cooling draughts to my own youthful optimism. Schuster, though perhaps not Chree's equal as a mathematician, nor with a tithe of his detailed knowledge of geomagnetism, could make brilliant sorties into the subject, leading to striking theoretical conclusions; by labours trifling compared with Chree's, he lifted some parts of the subject to a new level. Maunder had a daily familiarity with the sun's aspect, as well as with the Greenwich magnetic records; this enabled him to perceive certain remarkable associations between the sun and magnetic storms; his work stimulated Chree to some of his finest achievements.

Whereas Schuster, Maunder and Bauer were ready to make hypotheses, Chree held that a theory was not necessary as a guide to research, and he refrained from speculation; nevertheless his work was greatly influenced by the speculations of Maunder and Arrhenius on the magnetic effects of streams of particles emitted from the sun.

* From the first Charles Chree Address to the Physical Society, delivered on July 25. The latter part of the address, referring to the future of world magnetic surveying, is not included in this summary.

DOES GEOMAGNETIC DISTURBANCE LAG BEHIND SOLAR ACTIVITY?

Chree showed that when there were many or large spots on the sun, days of geomagnetic calm were rarer than on days of no or few spots; but the difference was very slight. He concluded that geomagnetic disturbance could not depend directly in any large degree on the simultaneous area of spots on the sun, but that his results might easily be reconciled with Arrhenius's view that geomagnetic disturbance lagged two or three days after the solar cause, because of the time taken by the solar particles to travel from the sun to the earth.

To study this possibility, Chree in 1908 devised a new method of great value and power, which I have called the *method of superposed epochs*. He examined how, on the average, the sunspot area varied during a number of intervals, each of 4 days, and each ending with a day of selected geomagnetic character (either calm or disturbed): thus in the averaging, the epochs of these selected days were superposed. Later he and his followers considered intervals of greater length, extending after as well as before the selected superposed days; he also considered in the same way the average variation of the geomagnetic activity before and after days of selected sunspot character.

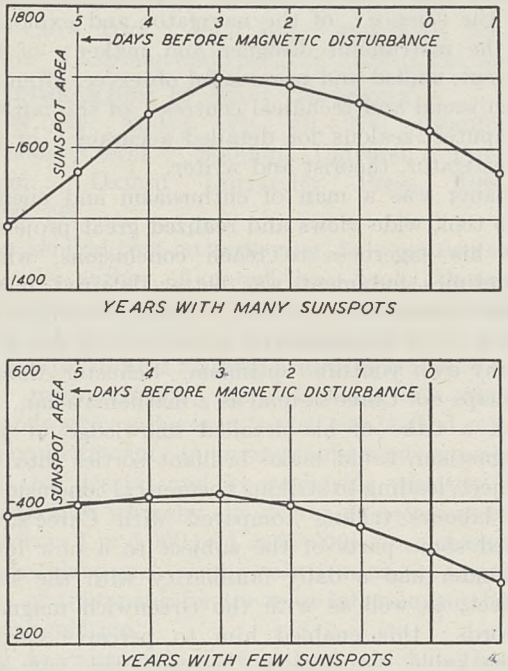

Fig. 1*.

AVERAGE SUNSPOT AREAS, EXPRESSED IN MILLIONTHS OF THE SUN'S DISK, FROM 6 DAYS BEFORE UNTIL 1 DAY AFTER DAYS (EPOCH 0) SELECTED AS MAGNETICALLY DISTURBED.

Above: averages for 250 sets of days in years with many sunspots. Below: averages for 116 sets of days in years with few sunspots. After J. M. Stagg.

* This, and the other illustrations, are from "Geomagnetism", by Prof. S. Chapman and Dr. J. Bartels (Oxford University Press, 1940).

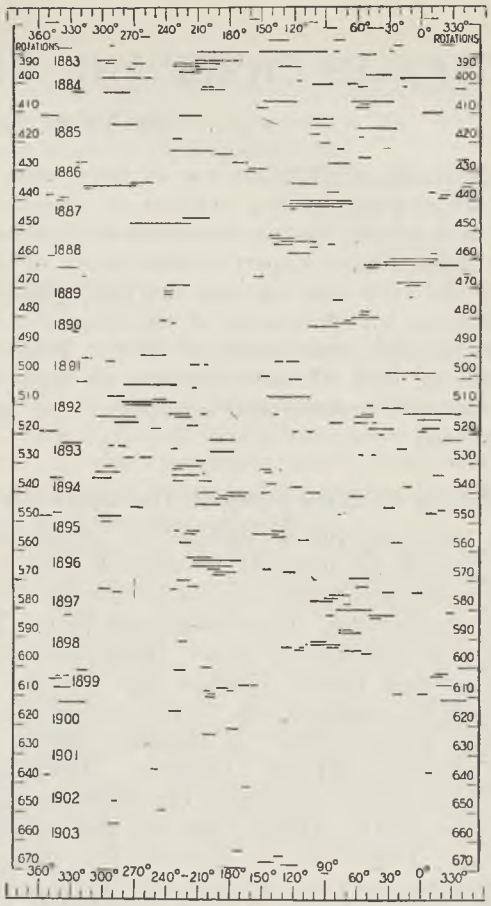

Fig. 2.

DISTRIBUTION OF MAGNETIC DISTURBANCES, 1882–1903, ACCORDING TO THE HELIOGRAPHIC LONGITUDE OF THE CENTRE OF THE SUN'S DISK AT THE TIME OF THEIR COMMENCEMENT. After E. W. Maunder.

In the hands of Maurain, and later of Stagg, using much more material than Chree, results were thus obtained which leave little room for doubt that on the average, on days of notable geomagnetic disturbance, the sunspottedness is declining from a maximum value attained two or three days earlier (Fig. 1); but the sunspot peak is shallow, and may be obscured by accidental circumstances if the material is too scanty to average these out. This is the less surprising because sunspots are at least not the sole cause of magnetic disturbance, which sometimes occurs during intervals of many days free from sunspots.

THE 27-DAY RECURRENCE TENDENCY

Chree's method was thus successful in elucidating an important interrelationship between solar and geomagnetic data. Chree also made a still more

beautiful and successful application of his method, to test a time relationship appearing in the geomagnetic data by themselves. This is a tendency for geomagnetic conditions of exceptional calm or exceptional disturbance to recur, generally with diminished intensity, after about 27 days; it is therefore called the 27-day recurrence tendency.

This had been recognized by Broun (1858) and by many others after him, who had directed attention to a 'period' of 27 or 28 days in magnetic and auroral phenomena. But its nature was not understood, and even its existence was often doubted or overlooked, until Maunder rediscovered it and demonstrated its real character in 1904. Some of his predecessors had thought it might be connected with the lunar month; but Maunder, deeply imbued with a knowledge of the succession of both solar and magnetic phenomena, was quite clear as to its solar origin. He regarded the sun as intermittently ejecting limited streams of corpuscles which, like water from a fire-hose, may sweep the earth at successive rotations of the sun, if the emission is sufficiently prolonged. His presentation of his discovery was made with this idea in view, and from the point of view of the solar physicist.

His demonstration was graphical, by means of a diagram (Fig. 2) in which the solar longitude of the centre of the sun's disk (as viewed from the earth) is measured along a succession of horizontal lines drawn at equal vertical intervals; each line represents one rotation, occupying 27·3 days, of a certain standard meridian on the sun. If during any such rotation one or more geomagnetic storms occurred, Maunder marked the part or parts of the horizontal line for that rotation, between the solar longitudes corresponding to the beginning and end of the storm; the remaining part of this and other lines, not corresponding to the occurrence of a storm, was obliterated (or rather not drawn). The diagram shows that many of these storm lines fall nearly on the same vertical, corresponding to nearly the same solar longitude, and indicating a recurrence after an interval of one or more solar rotation periods of 27·3 days.

Maunder's diagram, however, has no necessary connexion with the sun; it forms what I have called a *time-pattern*, in which successive horizontal lines represent merely successive intervals of 27·3 days. Maunder adopted the 27·3 day interval because it is the mean rotation period of sunspots; but he recognized that if a sequence of storms occurred at a slightly different interval, this would be clearly shown by a slight displacement of their successive 'lines' to the right or to the left. In his diagram the sequences of storm lines are rarely so clear cut as to show whether the usual interval is 27·3 days, or half a day more or less than this. The identification of the mean recurrence interval with the solar rotation period is an independent step which, though highly probable, is a speculation rather than, like the recurrence interval itself, an established fact.

Chree's 27-Day Pulse Diagram

Chree applied his superposed epoch method to this question, using as the selected epochs days of

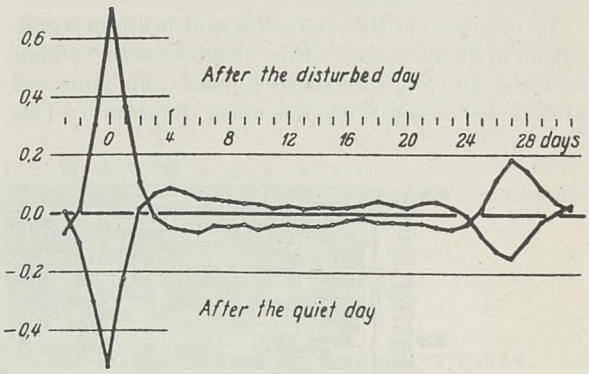

Fig. 3*a*.

AVERAGE CHANGE IN THE DAILY MAGNETIC CHARACTER-FIGURES, INDICATED BY THE DEVIATIONS FROM THE MEAN, FROM FOUR DAYS BEFORE UNTIL 31 DAYS AFTER A SET OF DISTURBED OR A SET OF QUIET DAYS, 1906–24. After Chree and Stagg.

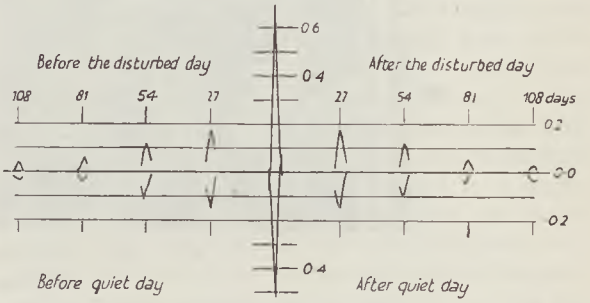

Fig. 3*b*.

AVERAGE CHANGE IN THE DAILY MAGNETIC CHARACTER-FIGURES, INDICATED BY THE DEVIATIONS FROM THE MEAN, FOR GROUPS OF DAYS AROUND A SET OF DISTURBED OR A SET OF QUIET DAYS (CENTRE), AND AROUND EPOCHS 1, 2, 3, 4 SOLAR ROTATIONS (OF 27 DAYS EACH) BEFORE AND AFTER. After Chree and Stagg.

either disturbed or quiet geomagnetic conditions. The daily data averaged for these days, and for the preceding and following days, were purely magnetic, namely the character figures internationally assigned as an index of each Greenwich day's geomagnetic activity. Some of his results are illustrated in Fig. 3 (*a*, *b*); the upper and lower parts of Fig. 3*a* refer respectively to the averages when the selected epochs are disturbed or calm. There are naturally peaks (positive or negative) for the selected days; there are also peaks 27 days

afterwards. This demonstrates the recurrence tendency and gives an indication of the recurrence interval, while involving absolutely no preconceived notion as to its length or significance.

Later Chree showed that there are corresponding peaks, of diminishing height (or depth) at about 54 and 81 days after the selected disturbed (or quiet) days, and also at similar intervals before them (Fig. 3*b*, where the averages for the days not near the peaks are not shown).

In my opinion this beautiful and brilliant application of his method is Chree's highest achievement and best gift to geomagnetic science ; his fame will always be linked with his pulse diagrams. This graphic product of his genius fitly finds a place on the Chree Medal.

Within the last two years Chree's method of superposed epochs has found useful applications to the time relationships of cosmic ray data, both as regards interrelationships with geomagnetic activity, and as regards the 27-day recurrence tendency in cosmic ray measures alone.

Time-patterns

Chree examined in great detail the significance of the recurrence pulses in his diagrams, to see, for example, whether they were due to the recurrence of a few notable days of the selected character, or merely to the occurrence of that character to a more moderate degree in a large proportion of days around the recurrence epoch.

In the course of such detailed investigation undertaken by Chree later, in conjunction with Stagg, differences were found between the pulse recurrences in 1920–21 and 1922–23. To examine these in more detail, they constructed two 27-day time-patterns, on which the international daily magnetic character figures were arranged in successive 27-day rows ; these figures were entered only for specially quiet or specially disturbed days, so that most of the 'pattern' was blank (as in Fig. 2) ; it showed the recurrence tendency in the same manner as in Fig. 2, by the grouping of disturbed or quiet days along the same verticals.

This diagram by Chree and Stagg forms a transitional stage between Maunder's diagram and later time-patterns constructed by Bartels. Maunder's diagram, despite its solar 'dress', was a true time-pattern, each row representing 27·3 days ; it showed the occurrence of outstanding magnetic disturbance, beginning and ending at different Greenwich times, and of varying duration ; the greater portion of the diagram was empty. The Chree–Stagg time-pattern was also mainly empty ; it showed specially quiet as well as specially disturbed periods ; but these were taken in units of the Greenwich day, and the horizontal range of

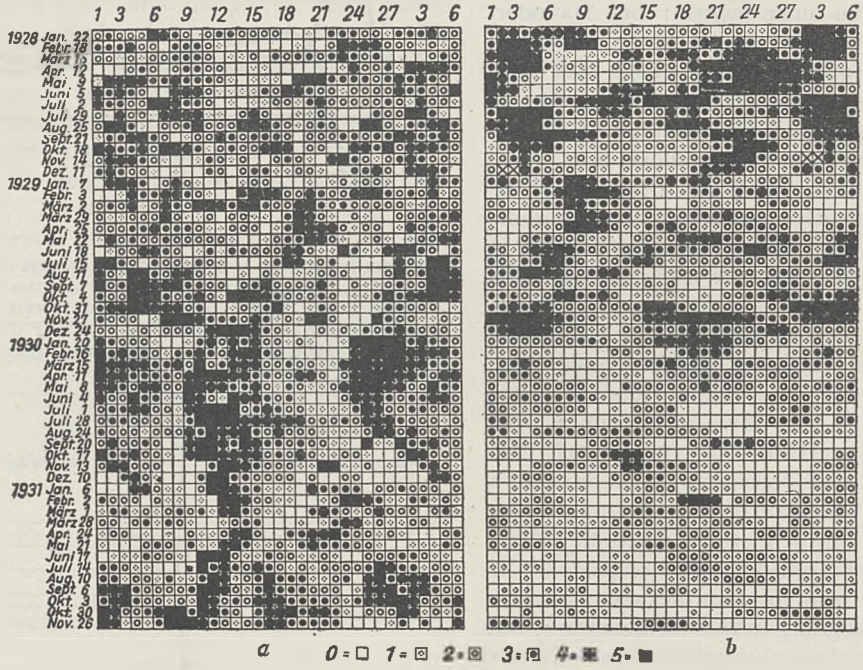

Fig. 4.

Time-patterns, for successive rows of 27 days, illustrating the 27-day recurrence tendency for the daily magnetic activity (left, *a*) and the daily sunspottedness (right, *b*). The date for the first day in each row is indicated at the left. After J. Bartels.

the diagram is 27 days (this does not prevent the diagram from showing a recurrence interval differing from 27 days; recurrences with a different interval would be shown by a slope of the sequences in successive rows).

Bartels by successive stages brought the 27-day time-pattern to perfection (1) by including all days, and (2) by indicating their magnetic character by a greater or less proportion of black (representing magnetic activity) in the square corresponding to each day. The result is shown in Fig. 4 (left); such a diagram represents an extraordinary concentration of knowledge, derived from magnetic observatories all over the world, over a period of nearly four years. The recurrence tendency is clearly shown by the 'columnar' distribution of the blackest and lightest parts of the diagram, though at least one recurrence sequence (near the end of 1930) is notably sloping, implying a recurrence interval of more than 28 days.

Bartels also applied his method to construct a time-pattern of solar activity, based on the daily *sunspot* number, as shown in Fig. 4 (right). The comparative study of the two diagrams for the same period is of great interest. The decline from the maximum (1928) of the sunspot cycle is much more strongly manifested by sunspots than by magnetic disturbance, and even in periods when both the sun and magnetic disturbance were active, their time-patterns are often very different. This shows that sunspots are often not a good index of the agencies on the sun that cause geomagnetic disturbance.

I feel confident that not only the method of superposed epochs, but also the study of time-patterns, has much still to contribute to geophysics and cosmical physics.

THE STUDY OF ENERGY-LEVELS IN BIOCHEMISTRY*

By Prof. A. Szent-Györgyi,
University of Szeged, Hungary

THE atom consists of a nucleus surrounded by a system of electrons. By sharing one or more electrons, atoms can join to form molecules. In such a molecule, as a rule, every electron belongs to one or two atoms. This is our idea of a single small molecule, and this picture has hitherto unconsciously governed our thinking in biochemistry.

The study of crystals and metals, however, has revealed the existence of a different state of matter. If a great number of atoms be arranged with regularity in close proximity, as for example, in a crystal lattice, the terms of the single valency electrons may fuse into common bands. The electrons in this band cease to belong to one or two atoms only, and belong to the whole system.

These bands or energy-levels are separated from possibly higher levels by forbidden zones. Under ordinary conditions all electrons are within the lowest band. If this lowest band contains the maximum number of electrons ($2n$, if the number of atoms is n), as is the case with insulators, the electrons will be unable to transport energy. If, however, one of these electrons is raised by the absorption of energy to a higher level, and comes to be in what we call an excited state, where it will move and transport its energy freely, it will be impossible to say which is the atom to which the excited electron belongs, and the whole system can be looked upon as activated. By falling back to the lower level the electron will give off its excess energy and perform work in a place more or less distant from that of the absorption of energy. This is the case with certain phosphors, as has been shown recently by N. Riehl[1]. Here, as for example in zinc sulphide, the electron, raised to a higher level by a collision with an α-particle, can travel relatively long distances and will fall back to a lower level, giving up its energy where it meets a copper atom present as an impurity. Thus the absorption and emission of energy will proceed independently at different places.

The problem is whether this state of matter, that is, common energy-levels, exists also in living systems. If it does, it cannot fail to influence profoundly our biological thinking and open new approaches to research and understanding. Protein molecules are systems built up of a great number of atoms, closely packed with great regularity. So theoretically the possibility exists that within these molecules analogous conditions prevail to those in crystals.

The first indication of the existence of such common energy-levels was given by the study of photosynthesis. Emerson and Arnold[2] found that 2,500 chlorophyll molecules form one functional unit. Warburg and Negelein[3] showed that four quanta are necessary for the reduction of one

* Substance of the Korányi Memorial Lecture, given in Budapest on March 21, 1941.

carbon dioxide molecule. There are observations to indicate that these four quanta must reach the carbon dioxide molecule simultaneously. Gaffron and Wohl[4] calculated how many chlorophyll molecules must interact to absorb four quanta simultaneously at the weakest optimal illumination. Their calculation showed that only one thousand molecules are capable of doing this. These observations indicate that the electrons, raised to a higher energy-level by the absorbed light, can move and transport their energy freely through the system of chlorophyll molecules.

Kubowitz and Haas[5] have measured the inactivation spectrum of urease, and P. Jordan[6] has pointed out that their results are in agreement with the idea that common energy-levels exist within this protein molecule. At present, K. Laki and M. Gerendás are engaged in my laboratory in the study of the inactivation spectrum of fumarase, crystallized by Laki. Their results also indicate that the energy absorbed may leave the place of its absorption and cause a break of links at a different place, thus travelling to some distance through the molecule. (If common energy-levels are present in native protein molecules, this cannot fail to contribute to the stability of the molecule and influence its immunological behaviour.)

The more interesting question, however, is not whether common energy-levels exist within one molecule ; but whether protein molecules can join into more extended systems with common energy-levels. It would be difficult to picture such a continuum built up of globular protein molecules, and protein molecules have hitherto, with rare exceptions, been found to be globular. However, last year Banga and I[7] found that the proteins building up the solid structure of the cell are fibrous, and that these fibrous molecules, as shown by their strong thixotropy, are interconnected by intermolecular forces. Chloroplasts also contain fibrous proteins.

This finding allows us to suppose tentatively that a greater number of molecules may join to form such energy continua, along which energy, namely, excited electrons, may travel a certain distance. The study of gene mutation, induced by X-rays and ultra-violet light, also indicates such a possibility.

It cannot be expected that any single observation will definitely solve this problem. Only the accumulation of a great mass of data will answer these questions. But even at this early stage we are justified in reconsidering the biological problems in the light of these possibilities.

My own biochemical research of two decades has yielded one or another insignificant result—the isolation of this or that—but whenever I was faced with a fundamental problem, I failed. When these problems are reconsidered in the light of common energy-levels an easy explanation offers itself. I will enumerate a few of these problems, starting with one which arose lately in collaboration with Banga[7].

The contractile element in muscle is myosine, a protein built up of fibrous molecules. These molecules are arranged in small, primitive bundles. A great number of such primitive bundles forms one microscopic fibril. The energy of muscular contraction is derived from the splitting of adenosine triphosphate. The adenosinetriphosphatase activity is bound up with myosine, but our measurements indicate that only a very small fraction of myosine molecules can be endowed with such activity. The problem is, how the energy liberated by a molecule can be communicated to a great number of similar molecules. The common energy-levels give an easy answer.

Another problem that troubled me for many years was why the enzymes involved in oxidation and fermentation can be separated so sharply into soluble and insoluble ones. The enzymes involved in lactic fermentation of muscle are soluble, while the enzymes involved in oxidation are insoluble, that is, bound to the insoluble fibrous proteins of the cell. This difference can be explained if we suppose that the latter are part of a system with common energy-levels. In lactic fermentation no such common levels are necessary, for the single enzymes do not interact but react in series with soluble molecules.

Still another problem, closely connected with the former, is how the enzymes of oxidation interact. In part of the oxidation system electrons wander directly from enzyme to enzyme. The enzymes, being insoluble, have no free molecular motion and must be arranged so that their small reactive groups are at atomic distances. It is possible to arrange two large protein molecules in such a way, but it is geometrically impossible so to arrange a whole series. Even if we could devise such an arrangement, it would still be incomprehensible how the energy liberated by the passing of an electron from one substance to the other, for example, from one iron atom to the other, could do anything useful. All this can be understood if we suppose that the single catalysts are connected with different, distinct energy-levels and that the electrons do not pass directly from one substance to the other but travel within the corresponding energy band, and can fall to a lower level and give off energy only at a place where they can do work (for example, a synthesis) analogous to the zinc sulphide phosphors of Riehl. If the cell and with it the energy-levels are disturbed in some way, we can expect the electrons to fall freely to lower levels at any place. This might explain why cata-

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Applications are invited for the post of ASSISTANT LECTURER in MATHEMATICS. Duties to commence September 29, 1941. Stipend £300 per annum. Qualifications in Pure Mathematics essential.—Applications, not later than Friday, August 23, to the Registrar, The University, Manchester, 13, from whom further particulars may be obtained.

UNIVERSITY COLLEGE OF SWANSEA

(A Constituent College of the University of Wales)

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Metallurgy

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Assistant Professor: R. Higgins, Ph.D. (Glasgow).

Lecturer: R. Griffiths, M.Sc. (Wales).

Assistant Lecturer: T. H. Wilkinson, Ph.D., B.Eng. (Liverpool).

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Lecturer in Electrical Engineering: R. G. Isaacs, M.Sc. (Bristol), B.Sc. (Lond.), A.M.I.E.E.

Lecturer in Civil Engineering: A. A. Fordham, Ph.D. (Lond.), A.M.Inst.C.E., M.I.Struct.E.

Lecturer: J. Selwyn Caswell, M.Sc. (Wales), A.M.I.Mech.E., A.M.Inst.C.E.

Assistant Lecturer: W. E. J. Farvis, B.Sc. (Bristol).

The College offers a number of exceptional advantages to students who aim at entering upon professional careers in Metallurgy or in Engineering. It is situated in the heart of an industrial area which includes a large number of works of very varied character, and presents an unrivalled variety of metallurgical practice. The Manufacturers of the district, who contribute largely to the support of the College, give the Staff and Students of the Applied Science Departments every access to the Works, and the Managers, Engineers, and Technical Officials co-operate with the Staff of the College in making visits to Works of practical educational value to the students.

Courses of study are provided (1) for the B.Sc. Degree of the University of Wales in (*a*) Metallurgy; (*b*) Metallurgical Engineering; (*c*) Civil Engineering; (*d*) Mechanical Engineering; (*e*) Electrical Engineering; and (2) for Diplomas of the College in (*a*) Metallurgy; (*b*) Civil Engineering; (*c*) Mechanical Engineering; (*d*) Electrical Engineering.

Persons who are not desirous of studying for Degrees or Diplomas may attend selected College classes provided they satisfy the authorities of the College that they are qualified to benefit by such classes.

Entrance Scholarships will be offered for competition in April, 1942.

Particulars concerning admission to the College, and of the Entrance Scholarships, may be obtained from the undersigned.

EDWIN DREW, Registrar.

Singleton Park,
Swansea.

SUDAN MEDICAL SERVICE

Applications are invited for the post of junior British LABORATORY ASSISTANT, male, unmarried, in the Stack Medical Research Laboratories, Khartoum.

The salary commences at £E.324 or £E.360 (£E.1=£1 0s. 6d.) according to age and qualifications, rising by 2-3 yearly increments to £E.780 after 18 or 20 years depending on the initial rate. The appointment carries prospects of pensionable service afer 5 years' service. A free passage to the Sudan will be provided.

Candidates should be between 22 and 30 years of age and should hold the Laboratory Assistants' Diploma of Bacteriological Technique, and preferably have some experience in clinical pathology.

Application forms may be obtained from the Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. Envelopes should be marked "Laboratory Assistant".

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DEPARTMENT OF GEOGRAPHY

Applications are invited for the post of Temporary Assistant on the teaching staff of the Geography Department. Salary £250 to £300, according to qualifications and experience. Further particulars may be had from The Registrar, The University, Leeds, 2, who will receive applications for the appointment on or before August 20.

MARX HOUSE SCIENCE FACULTY
is holding a
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on
ENGELS' "DIALECTICS OF NATURE" and "ORIGIN OF THE FAMILY, PRIVATE PROPERTY AND THE STATE"
at the
CAXTON HALL
Caxton Street, Westminster, on August 16th and 17th, 1941

This Symposium offers a unique opportunity of discussing problems of modern science and philosophy in the light of Marxist theory. Contributors to the discussions include: R. P. ARNOT, Prof. BERNAL, C. P. DUTT, Prof. HALDANE, Prof. LEVY, Prof. THOMSON.

Admission to all sessions: 5s. (Single session, 1s. 3d.). For tickets and details apply to: The Secretary, Faculty of Science, MARX HOUSE, 37a Clerkenwell Green, London, E.C.1.

Public Lecture, Sunday, 7 p.m., by R. P. ARNOT on:
DIALECTICAL AND HISTORICAL MATERIALISM

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS.

bolic processes prevail over anabolic ones in damaged tissues (and cancer ?), why certain oxidations (catecholoxidase) are activated by damage, why chloroplasts do not build up carbohydrates, and why viruses do not multiply outside the cell.

One of my difficulties with protein chemistry was that I could not imagine how such a protein molecule can 'live'. Even the most involved protein structural formula looks 'stupid', if I may say so. If the atomic structure is only the backbone underlying the common energy-levels, the thing becomes more likely. It is equally difficult to understand the great biological activity of certain molecules. R. Kuhn, F. Moewus and D. Jerchel[8], have shown lately that one single crocin molecule is capable of inducing a sexual change in a whole alga. If the cell forms an energy continuum, any substance, approaching at any point, can upset the whole system, making, so to say, a hole in the continuum.

Then we do not know what a 'cell' really means, or why the kidney, for example, is subdivided into such units. Possibly the cell wall is the border line of the common energy-levels.

Biochemistry is, at present, in a peculiar state. By means of our active substances we can produce the most astounding biological reactions, but we fail wherever a real explanation of molecular mechanisms is wanted. It looks as if some basic fact about life were still missing, without which any real understanding is impossible. It may be that the knowledge of common energy-levels will start a new period in biochemistry, taking this science into the realm of quantum mechanics.

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[2] Emerson, R., and Arnold, W., *J. Gen. Physiol.*, **16**, 191 (1930).
[3] Warburg, O., and Negelein, E., *Naturwiss.*, **13**, 985 (1925).
[4] Gaffron, H., and Wohl, K., *Naturwiss.*, **24**, 81 (1936).
[5] Kubowitz, F., and Haas, E., *Biochem. Z.*, **257**, 337 (1933).
[6] Jordan, P., *Naturwiss.*, **42**, 693 (1938).
[7] Banga, J., and Szent-Györgyi, *Science*, **92**, 514 (1940); *Enzymologia*, **9**, 111 (1940).
[8] Kuhn, R., Moewus, F., and Jerchel, D., *Ber. Chem. Ges.*, **71**, 1541 (1938).

OBITUARIES

Sir David Wilson Barker

SIR DAVID WILSON BARKER, whose death occurred on June 15, was born on October 1, 1858. He was educated in the training-ship H.M.S. *Worcester*, and on leaving in 1873 joined the Blackwall Line and served in sailing-ships of that company for eight years, rising to the rank of chief mate of the *Superb*. Afterwards he joined the Silvertown Telegraph Works Co., and in 1885 was given command of the cable ship *Dacia*, an appointment which he held with that of cable engineer until August 1892.

Captain Barker will best be remembered as captain superintendent of the training-ship H.M.S. *Worcester*, an appointment which he held with much distinction during 1892–1919.

He was a born seaman and natural scientist—he took a very great interest in meteorology and natural history and made a particular study of sea birds and their habits; he was also an enthusiastic photographer and took up colour photography with some success in its early stages of development.

He was much sought after by various societies and associations on whose committees he served; of these may be mentioned the Royal Geographical Society, the Royal Meteorological Society, of which he was president during 1903–5, and the Challenger Society; he was vice-president International Pollok Prize Committee for Saving Life at Sea, 1901, chairman of British Section of Marseilles International Fisheries Exhibition, 1906. In spite of his busy life he also found time to contribute many papers to the Press on subjects connected with the sea. His numerous activities and the services rendered the country in the training of young officers brought its reward when on retiring from official life in 1919 he received the honour of knighthood.

After his retirement, Sir David continued his active life, lecturing and writing and interesting himself in anything connected with the sea; he was one of the vice-presidents of the London Scout Association and at one time commissioner of Sea Scouts for London. In 1922 he undertook a special mission to Gambia at the request of the Colonial Office to advise on the reorganization of the Gambia Marine.

Many old Worcesters and others will regret his passing and will remember with gratitude his helpful advice and kindly interest—nothing gave him greater pleasure than to meet his "old boys".

Mr. H. W. Hilliar, C.B.E.

THE death occurred at Eltham on July 15 of Mr. H. W. Hilliar, formerly a superintending examiner in the Patent Office. After serving for a time as a chemist at the British Uralite Works near Gravesend, Hilliar (who had taken his B.Sc. at London) entered the Patent Office as an assistant examiner in 1906 at a time when the staff had been greatly enlarged to deal with the newly instituted search for novelty of inventions. By 1914 his work had already received special recognition, and when the War broke out he was lent to the Research Department of the Admiralty, where he conducted important investigations upon the effect of depth charges, for which he was made C.B.E.

Returning to the Patent Office he secured rapid promotion to the grades of examiner (1921), senior examiner (1925) and superintending examiner (1932). During most of his service at the Patent Office he was engaged upon the examination of inventions relating to automatic telephones, of which he had a profound knowledge. He compiled the material for a book on this subject, but his health prevented its completion. He also made a deep study of the case law relating to patents, and in his later years as a hearing officer his judgment both on scientific and legal matters was trusted by all.

Hilliar's first-rate analytical power was combined with great patience, courtesy and charm of character, which endeared him to all who knew him, and his retirement in 1937 owing to ill-health was a great loss to the Patent Office.

We regret to announce the following deaths :

Prof. J. C. Philip, F.R.S., emeritus professor of physical chemistry in the Imperial College of Science and Technology, on August 6, aged sixty-eight.

Prof. A. J. Clark, F.R.S., professor of materia medica in the University of Edinburgh, on July 30, aged fifty-five.

NEWS AND VIEWS

Charles Chree Medal and Address

At the science meeting of the Physical Society on July 25, the Charles Chree Medal and Prize were presented to Prof. Sydney Chapman, who delivered

The Charles Chree Medal

an address, part of which appears on p. 153 of this issue. The circumstances of the foundation were described in the issue of Nature of March 1, p. 261. The Medal, which is a particularly beautiful example of the medallist's art, is the work of the distinguished artist, Mrs. Mary Gillick, and the reverse design most fittingly summarizes and symbolizes the outstanding work of Chree. The Society is to be congratulated on its first award of the Medal.

Prof. Chapman's work for the advancement of the science of geomagnetism is both long and distinguished. It began so far back as 1911, when it fell to his lot, on his appointment as chief assistant at the Royal Observatory, Greenwich, to design new instruments and buildings for magnetic observations. His work on the solar and lunar diurnal variation and on magnetic storms is outstanding, and his investigations of the lunar variation have involved the ordering and discussion of an immense mass of material such as would daunt the courage of all save the boldest and most clear-headed investigator. His analysis, which has been made by the aid of methods largely devised by himself, has resulted in a clear formulation of the effect of the sun and moon on terrestrial magnetism, and in a notable increase in our knowledge of the mechanism of the effect. His work on magnetic storms, which has not yet approached a final phase, is of the first importance. The analysis, which has involved very complicated mathematical theory, has resulted in a theory of storms depending on the emission of particles from the sun.

Great Britain and the U.S.S.R.

In reply to the cable of greetings sent by the Royal Society to the Academy of Sciences of the U.S.S.R. (see Nature, August 2, p. 135), Dr. Otto Schmidt, vice-president of the Academy, has sent the following message : "The Academy of Sciences of the U.S.S.R. sends its warmest greetings to the Royal Society, London. Soviet scientists express feelings of deep admiration and friendship to British colleagues who in war conditions pursue courageously their research work, obtaining world achievements in various fields of science and thus successfully opposing the aim of Fascism to destroy all culture. In the struggle for the happy future of humanity, standing hand in hand against the common foe, men of science of Great Britain and the Soviet Union will contribute with all their forces to the triumph of liberty, culture and science over Hitlerite tyranny and obscurantism."

W. H. Hudson Centenary

The centenary of the birth of the British naturalist, W. H. Hudson, occurred on August 4. Hudson was born at Quilmes, near Buenos Aires, and lived on the pampas for thirty-three years, after which he returned to England, where for years he lived in London in poverty, to such an extent that in 1901 he was granted a civil list pension. This he relinquished, however, when belated success reached him. There is no need to relate the titles of Hudson's well-known works which achieved such outstanding popularity. His bird books are probably the best known. A bird sanctuary, with a decoration by

Epstein which has caused considerable controversy, was placed to his memory in Hyde Park, London, in 1925.

In the presence of the British and United States Ambassadors, a bronze plaque was unveiled on August 3 to the memory of Hudson at Berazategui, in the province of Buenos Aires, to commemorate the centenary of the writer's birth. Dr. Fernando Pozzo, president of the Committee of Homage, announced the foundation of the Association of the Friends of Hudson, the chief objects of which will be to acquire the property of Veinte y Cinco Ombues, in Quilmes, the suburb of Buenos Aires where Hudson was born, and to create there a bird sanctuary and a museum of ornithology.

Feeding-stuffs in War-time

THE present position and prospects of home-produced feeding-stuffs in Great Britain have already been reviewed in NATURE (**146**, 251, 362, 712 ; 1941). Supplementing the papers by Dr. Norman Wright, the Imperial Chemical Industries Research Station at Jealott's Hill has published a bulletin (No. 3) on the same subject, which, as it is written largely in non-technical language, will be especially valuable to farmers, and to others who wish to know the facts before they express opinions on Government policy. Much of the bulletin is devoted to the various ways in which concentrated feeding-stuffs hitherto imported can be replaced by home-grown fodders, and the authors set out to show how the entire present deficiencies can be made good by greatly increased cultivation of oats, barley, peas and beans, by better manuring of grass and fodder crops, by making some six million tons of silage, and treating two million tons of straw with caustic soda to make it into a palatable and digestible carbohydrate feed. Incidentally, they remark that a large proportion of the four million acres of grassland ploughed up in the last two years was land in poor condition and low in fertility, and that without the aid of fertilizers the sanguine expectations of many are likely to be disappointed.

The authors may be somewhat unduly optimistic in their estimates of present potentialities, and also in their assertion that "the belief that there must be a considerable reduction in the number of livestock during the war is the policy of the defeatist". In the War of 1914–18, livestock were slaughtered in Germany and in Britain at a time when both countries were 'all out' for victory, and history is now repeating itself. A useful feature of the bulletin is the comparison of conditions in the year 1875—when British agricultural production was at its height—and in 1938, for it gives some indication of present possibilities. It is recalled that about a century and a half ago, Sir John Sinclair, president of the then Board of Agriculture, warned the country against over-reliance on imported feeding-stuffs, stating that "in times of war our great domestic foe will be our grasslands, which are producing in the most favourable cases only one-fortieth of what we are able to produce under high arable cultivation, which are dependent for their boasted livestock production on vast imports of foreign feeding-stuffs and which, in the case of emergency, will prove one of the weakest links in our national defences". The warning, as is well known, has passed unheeded by those responsible for agricultural policy, with the result that in 1941, as in 1917–18, we are hard put to it to feed our stock and people.

Committee on Agricultural Education

MR. R. S. HUDSON, Minister of Agriculture, has announced that, after consultation with the late President of the Board of Education, he has appointed the following committee to examine the present system of agricultural education, and to make recommendations for improving and developing it after the War : Lord Justice Luxmoore (chairman), Mr. H. Beaumont, M.P., Mr. W. J. Cumber, Mr. Ifor L. Evans, Mr. W. M. Goodenough, Dr. T. Loveday, and Mr. J. M. McClean. Mr. A. R. Whyte, of the Ministry of Agriculture, and Mr. Ronald Ede, secretary of the School of Agriculture, Cambridge, will be joint secretaries to the Committee, and Dr. G. K. Sutherland, of the Board of Education, will act as assessor. Mr. Hudson added that the committee would cover the main work of elementary and secondary school education, and the various types of training required in the different categories of education to include farmers, landowners, bailiffs, farm-workers, land agents, teachers, and technical advisers.

Uses of Wood in Warfare

WOOD wins wars, despite the apparent primacy of metals. This was the subject of an address by Mr. G. W. Trayer of the U.S. Forest Service on June 25 at the midsummer meeting of the American Association for the Advancement of Science. Wood has the further advantage over metals that it can be grown as a renewable crop if good forestry practice is observed, whereas metals are definitely limited and exhaustible resources. Even in aeroplanes, where aluminium and magnesium have replaced the spruce and fabric of the earlier machines, wood is being used again. Plastic-bonded plywood is coming to the rescue of an industry affected by a shortage of light metals. Smaller aeroplanes of this revolutionary new construction, with laminated wooden propellers, have been proved entirely practicable for training purposes.

A modern army's needs for wood are almost beyond counting. They range all the way from lumber for barracks and heavy timber for bridges to wooden poles for holding up camouflage nets and wooden crates for the safe transport of ammunition. Chemical uses for wood are important in warfare. Wood pulp can supply cellulose for nitrating into explosives quite as good as that derived from cotton linters. Black powder, still used to a limited extent in modern war, contains charcoal as an essential ingredient. More important, compressed wood charcoal is now replacing coconut-shell charcoal in the canisters of gas masks.

A Major Cause of Hay-fever

EXTRACTION from ragweed pollen of a colourless, nitrogen-containing chemical believed to be one of the major causes of hay-fever was announced by Prof. Harold A. Abramson and Dr. D. H. Moore of the Columbia University School of Medicine and Dr. H. H. Gettner of Mount Sinai Hospital, at the Wilder D. Bancroft Colloid Symposium held at Cornell University under the auspices of the National Research Council and the American Chemical Society on June 20. The molecular weight of the chemical was found to be "surprisingly low—only 5,000". This small size is significant, it appears, from the explanation that in order to produce hay-fever, pollen must not only be blown into the nose and eyes, but also the molecules causing the symptoms must pass through the mucous membranes into the deeper tissues beneath. "Our study indicates that the ease with which allergic individuals will become sensitized to the contents of pollen grains may depend to a great extent upon the small size of the allergenic molecules which have now been isolated and studied quantitatively by electrophoresis, by ultracentrifugation, and by diffusion experiments for the first time".

Industrial Research Bureau, India

THE report of the Industrial Research Bureau of the Government of India for the year 1939–40 (Delhi: Manager of Publications. 1*s.* 9*d.*) refers to the reorganization entailed by the decision to curtail severely plans for expanding the staff of the Bureau and the Government Test House. The Industrial Research Bureau and Research Branch of the Government Test House have now been merged by the formation of the Board of Scientific and Industrial Research and the office of the Director of Scientific and Industrial Research, the first director being Sir Shanti Swarup Bhatnagar. The report on the work of the Industrial Research Council refers to investigations carried out on oils and soaps as well as on the development of the glass industry, and particularly to progress made in the designing and installation of improved glass-melting furnaces. Progress has been made in the survey of deposits of glass-making materials as well as in the survey of the oil-seeds crushing industry.

In regard to the co-ordination of the universities and research institutions in India with the development and extension of industrial research, attempts are being made to obtain the co-operation of the universities in preparing the combined list of industrial researches completed, in progress and proposed to be undertaken in Government laboratories, universities and research institutions in India. Publication of an annual combined list is contemplated. The report on the work of the Industrial Research Bureau also refers to the co-ordination of universities and research institutions. The number of laboratories in India capable of undertaking industrial research work is limited, and after considerable attention had been given to the matter it has been decided to provide funds to be allocated to selected institutions for the payment of grants to workers engaged in research falling within the programmes to be arranged on the recommendations of the Board of Scientific and Industrial Research.

The Indian Lac Research Institute has continued its work on the development of moulding powder compositions containing a considerable percentage of shellac. The Research Branch of the Government Test House has continued its investigations on paints, particularly on accelerated weathering, paint formulæ, fungus growth on paints, and the physical properties of paint films. Work on the factors affecting the properties of dry cells has been continued during the year and some correlation established between the chemical constitution and electrical performance of ores. An automatic cooking machine for dry cells has been designed and constructed in the laboratory. Work on vegetable oils as lubricants has indicated that phenyl-α-naphthylamine, as.-diphenyl-hydrazine, *p*-toluidine and phloroglucinol are the most effective stabilizers for castor oil and rape-seed oil in the presence of iron. A number of blends were prepared for engine tests, and details of these trials are included. Other work has covered the use of vegetable oils as Diesel fuels, building materials, particularly the use of Surkhi as pozzolana.

Trees of the Past

A SHORT interpretation of the fossil herbaria of the rocks by the late Sir Albert Seward (*J. Roy. Hort. Soc.*, **66**, Pt. 6, June, 1941) provides a useful epitome of palæobotanical knowledge. The paper deals particularly with trees, and the story commences with *Cercidiphyllum japonicum*, an Eocene fossil species which is still indigenous in China and Japan. Cretaceous strata brought the first geological appearance of the genus Magnolia. Tulip-tree, plane, hazel and oak are present-day trees with stratigraphical antiquity. The maidenhair tree, *Ginkgo biloba*, is one of a group of plants which flourished in the Jurassic and Triassic periods. It is curious that many trees which now only appear in China and Japan were inhabitants of Europe and North America in earlier geological time; west and east seem to have changed places. The Norfolk Island pine, *Araucaria excelsa*, also had a divergent distribution in the past, for fossil leaves, cone scales and seeds were discovered in 1931 from Tertiary sediments in the Kerguelen Archipelago, where now is found only a scanty flora of flowering plants, ferns, mosses and lichens, but no trees.

Wild Flower Society

THE 264th issue of the Wild Flower Society Magazine is an enlarged double one covering January–June 1941, an evidence of the Society's decision to carry on during war-time. Many contributors stress the danger of the Women's Institutes' Herb Scheme exterminating rare British plants unless the Government-encouraged collection of wild drug plants is botanically supervised. The chief paper in the issue is the first supplement to Green's "Flora of Liverpool"

which Mr. Eric Hardy has drawn up for the Merseyside Naturalists' Association. Covering botanical vice-counties 58 and 59, it adds new records of a number of plants. The increase of a hermaphrodite form of *Bryonia dioica* on the Lancashire dunes, a new unnamed Œnothera hybrid and the extinction of *Rumex cuneifolius* (first recorded in Britain from west Cheshire, 1913) are also noted.

Biological Investigations at Palao

THE first part of the second volume of the "Studies of the Palao Biological Station" contains seven reports relating to corals, detailed descriptions of four species of Pheretima (Oligochæta) and an examination by Y. Haneda of the luminescence of shore fishes of the genus Leiognathus. In these latter the luminous body is in the form of a ring surrounding the œsophagus where it enters the body cavity. The light in the eleven species examined passes through the muscles, which are milky white and translucent. The gland has two openings from the œsophagus. Through these, luminous cocci enter and settle down, the response to outer stimuli being rapid.

Three reports deal with the biochemistry of corals, and Motoda compares the conditions in the open sea with those in the lagoon; these are preliminary reports. Motoda also studies the growth-rate of a massive coral (Goniastrea) by the multiplication of its polyps. It is a coral of the reef flat and thus subjected to tidal waters, which are studied in respect to temperature, salinity, oxygen content, *p*H and exposure to air. The oxygen production by ten polyps under varied conditions of light and depth, this due to their symbiotic algæ, gives 0·22–0·14 per hour at a depth of 6 cm. in clear weather, while under thick clouds 0·08 c.c. is consumed. Direct exposure to the sun's rays in air is successfully resisted for two hours, but nearly all polyps are killed after six hours. The growth-rate decreases with age, but most colonies died before the second count. It had previously been suggested that this decrease is correlated with reproductive activities, but this is not considered. Finally, Abe's work on Fungia is interesting as dealing with the effect of sediments.

School Hygiene in São Paulo

THE School Health Service of São Paulo, Brazil, claims to be one of the oldest, if not the oldest, child welfare institution. By a decree of December 28, 1938, the service has been reorganized, with the enlargement of existing facilities and the creation of other services including those of mental hygiene and child guidance clinic, allergy clinic, endocrinology and nutrition clinic, dermatology and syphilis clinic, educational puericulture for students of normal and professional schools, X-ray and laboratory services, etc. During the first half of 1939 the Service, which is under the Department of Education, attended 94,108 children, made 2,286 health examinations at headquarters and 42 at home, 1,426 vaccinations at headquarters, attended 39,144 children in the Largo de Arouche School Polytechnic, 4,216 in the eye service, 5,369 in the otorhinolaryngology service, 388 in the dermatology and syphilis clinic and 3,819 in the X-ray clinic. In the School Groups, 26,276 children were examined.

Vital Statistics in New Zealand

ACCORDING to the annual report of the Royal New Zealand Society for the Health of Women and Children founded by the late Sir Truby King, the birth-rate of the Dominion in 1939 (excluding Maoris) was 18·73 per 1,000, the highest recorded since 1930. The maternal mortality-rate, excluding septic abortion, was 2·95, and the infantile mortality-rate 3·14 per 1,000 births, almost the lowest ever recorded. The death-rate during the first month of life was 21·8, an improvement on the figure for recent years. The Society has six infants' hospitals in various parts of New Zealand, and the 138 Plunket nurses in its service saw 22,000 new cases during the most recent year and paid 170,000 visits to homes.

The National Trust

THE report of the National Trust for the year 1940–41 shows the unique position attained by this society devoted to the preservation of places of historic interest or natural beauty. Not only are bequests of land coming to the Trust upon an increasing scale, but the recent Country Houses Scheme has received important support in the transfer of the beautiful Blickling Hall, Norfolk, and its large estate, to the control of the National Trust. In the terms of Lord Lothian's will the freehold is vested in the Trust on the condition of preserving the amenities, and with the request that in the choice of tenant preference shall be given to descendants of the donor, subject to facilities for the access of the public. Death duties on large estates are now on such a destructive scale that the preservation of England's noble mansions, their period furniture, and surrounding parks can only be ensured by their transfer to a permanent society such as the National Trust.

Fire Risks in Railway Trains

THE report which Colonel A. C. Trench has presented to the Ministry of War Transport on the fire in which six schoolboys lost their lives and which destroyed three coaches of an express train on the L. and N.E. Railway on April 28 should not disturb faith in the general safety of railway travel in Great Britain. It is unfortunate, as is pointed out in *Engineering* of July 11, that, in the interests of economy, the reports of inquiries into the causes of railway accidents are no longer being published and circulated in the usual manner. This is doubly regrettable, for the account of the tests carried out by Colonel Trench, in spite of war conditions, is good evidence of the morale of the country.

The train in question was travelling at about 55 miles an hour when the fire began; it was stopped in about a mile and a quarter, by which time the fire had taken a firm hold on one coach. Colonel Trench refers in his conclusions to the locking of doors of unoccupied vans and of gangway and corridor doors. He also suggests that the wadding

and the outer rexine covering on the backs of the railway seats, where the fire in this case began, might be omitted. It is evident that the main lessons of this fire require to be studied by the travelling public in general rather than by the railway companies or their employees. The carelessness habitually displayed by many passengers in the disposal of matches and cigarette ends is quite inexcusable; nevertheless, the provision of more and larger 'ash trays' might be considered.

Making Light for To-morrow

THE *Electrician* of July 4 quotes Mr. S. G. Hibben, director of applied lighting to the Westinghouse Lamp Division, as attributing most of the very rapid progress being made in developing illuminants to the influence of the large 'fairs' recently held in the United States. Each exhibition has been identified with some new and often radical means of producing light. The Panama-Pacific Exposition of 1915 ushered in the use of tungsten filament lamps of large wattage for exterior floodlighting, and coloured beams from carbon-arc searchlights. In 1926 the Philadelphia Sesqui-Centennial Exposition presented colour-coated incandescent filament lamps with spirally coiled filaments surrounded by inert nitrogen and argon, in sizes down to and including the commercial 60-w. lamp. High voltage (10,000 volt range) neon and mercury tubing for architectural decoration were also used. The high-intensity mercury vapour lamps were publicly introduced into the United States at the Chicago Century of Progress Exposition in 1933.

Noteworthy above all others, the New York World's Fair of 1939–40 introduced in that country the radically new and efficient fluorescent lamps. In addition, there were also introduced new sizes of mercury vapour lamps for the illumination of foliage, the production of short-wave visible colours for underwater fountain lighting, new projector lamps, and the popularly termed 'black-light' lamps or long-wave ultra-violet illuminants. The latter of these gave a wide variety of fluorescent effects. Whilst attention is naturally focused on the new or unusual illuminants, it has to be remembered that the familiar incandescent lamp is, and for many years to come will be, the basic, most commonly used lamp for work requiring light primarily. More precise manufacturing methods and lower costs now give the purchaser two and a half times as much light for the same money, as compared with 1928.

Seismological Data from India

VALUABLE seismological data is contained in the *Seismological Bulletin* of the Government of India Meteorological Department for the period January–March 1940, published under the direction of Dr. C. W. B. Normand. Interpretations of the seismograms obtained at the observatories at Agra, Bombay, Calcutta, Colombo, Dehra Dun, Hyderabad and Kodaikanal are given in considerable detail, and it is pleasing to note that J. H. Sil at Poona has again collected non-instrumental reports from voluntary observers. At the Upper Air Observatory at Agra, ninety-four earthquakes and tremors were recorded instrumentally during the quarter, and in each case there are given the type of wave with its arrival time, occasionally its period and amplitude, together with the estimated epicentral distance and depth of focus. The deepest focus shock recorded was apparently one approximately 200 km. deep estimated by the Brunner Chart, on March 28, at an estimated epicentral distance of 4,135 km. The other observatory reports are along similar lines. Fifteen earthquakes were recorded by voluntary observers. Three of these reached intensity 7 on the Rossi-Forel scale. These were at Srinagar on January 26, Gauhati on February 13 and Drosh on March 19, the latter also being recorded with lesser intensities at Kabul, Peshawar and Srinagar.

Announcements

THE Bisset-Hawkins Medal of the Royal College of Physicians has been awarded to Sir Frederick Menzies for his work as chief medical officer of the London County Council, and the Baly Medal has been awarded to Prof. Edgar Allen, of Yale University, for his work on œstrogens.

PROF. JEAN PERRIN, formerly professor of physical chemistry in the University of Paris, has been invited to become visiting lecturer at Wilson College, Chambersburg, U.S.A., during the academic year 1941–42.

THE South African Institute for Medical Research in Johannesburg is about to undertake the manufacture of yellow fever vaccine under the directions of Dr. G. M. Findlay of the Wellcome Research Institute of London.

THE American Society for X-Ray and Electron Diffraction, plans for which were announced in *Science* of May 23, starts its existence with a charter membership of 124. The officers elected for 1941 are: *President*, Dr. M. L. Huggins, of the Eastman Kodak Company; *Vice-President*, Prof. B. E. Warren, of the Massachusetts Institute of Technology; *Secretary-Treasurer*, Dr. George Tunell, of the Geophysical Laboratory, Washington, D.C.

THE British Association's Division for the Social and International Relations of Science is arranging a meeting to be held, if circumstances allow, on September 26, 27 and 28. Various subjects under the general heading of "Science and World Order" will be dealt with. The first day's session will take place, by kind permission, in the theatre of the Royal Institution, Albemarle Street, London, and those of the second and third days, it is hoped, at the Rothamsted Experimental Station, Harpenden.

DR. KENNETH M. SMITH writes: "In a recent review entitled 'Insects and Plant Diseases' (NATURE, July 19, p. 65), through an error in proof-reading, it was made to appear that 1801 was the date of the first discovery of bacteria as a cause of plant disease. This should, of course, be 1881, eleven years before the first demonstration of a virus by Iwanowsky in 1892."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Structure of Cobalt

POWDER photographs of hexagonal cobalt do not always have consistently sharp lines, and the variation of sharpness is not explainable by internal strains or by small particles of unusual shapes. This may be seen from the following table of visual estimates of the breadths of the various lines on a photograph taken with nickel $K\alpha$ radiation.

$h\ k\ i\ l$	Description	$h\ k\ i\ l$	Description
$1\ 0\ \bar{1}\ 0$	sharp	$1\ 1\ \bar{2}\ 2$	sharp
$0\ 0\ 0\ 2$	sharp	$2\ 0\ \bar{2}\ 1$	broad
$1\ 0\ \bar{1}\ 1$	broad	$0\ 0\ 0\ 4$	sharp
$1\ 0\ \bar{1}\ 2$	broad	$2\ 0\ \bar{2}\ 2$	very broad
$1\ 1\ \bar{2}\ 0$	sharp	$1\ 0\ \bar{1}\ 4$	very broad—almost invisible
$1\ 0\ \bar{1}\ 3$	very broad		
$2\ 0\ 2\ 0$	sharp	$2\ 0\ \bar{2}\ 3$	very broad

We have examined the problem by means of powder and oscillation photographs and have found that the following theory is capable of explaining the observations.

It is well known that the close-packed structures can be derived from three types of close-packed planes of atoms; the co-ordinates with respect to the two hexagonal axes of the atoms in each plane are:

$$(0, 0) \ldots A\ ;\quad (1/3, 2/3) \ldots B\ ;\quad (2/3, 1/3) \ldots C.$$

In a normal hexagonal structure only two of these types are used, thus: $ABABAB \ldots$, but it is easy to see that faults may arise and that the sequence may change to $CBCBCB \ldots$, or to $ACACAC \ldots$ If such faults occur frequently the structure will be irregular, but certain sets of planes, such as the (000l)'s, will obviously remain perfect. In general, all sets of planes with $(h\text{-}k)/3$ integral will be perfect, and this is in accordance with the observations in the accompanying table.

From the broadening of the lines an estimate of the degree of imperfection can be made, and it was found that in the specimen which was examined the probability of a mistake occurring was as high as 1/10.

The same kind of theory is applicable to other problems, notably the broadening of the superlattice lines in $AuCu_3$ due to the presence of small 'anti-phase domains' in single crystals.

A more detailed account of the work on cobalt will be published elsewhere.

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Wave Form of Atmospherics

SEVERAL investigators[1,2,3] have shown that an atmospheric often has a characteristic 'slow tail' of a few milliseconds' duration, in addition to the customary wave train of a few cycles of frequency about 10^4 cycles per second. The latter has been associated with the return stroke of the lightning discharge, and precision has recently been given[4] to this suggestion by the calculation of the amplitude and duration of one cycle of this wave from the characteristics of the return stroke, the remainder of the wave being presumably due to reflexions from the ionosphere[5].

As to the 'slow tail', Appleton and Chapman[2] have suggested that this is connected in some way with the slow c portion of the lightning discharge. A study of the electrostatic field changes caused by near strokes recorded by these authors[2], however, suggests that the 'slow tail' is the result of the radiation due to the destruction of electric moment during both the a and the c portions of heavy strokes, an explanation which is supported by the occurrence of the high-frequency radiation due to the b portion within the 'slow tail', observed at relatively near distances[1]. The durations involved are obviously of the right order, being in each case a few milliseconds. As to the amplitude, my theory[6] of the increasing corona current as the leader stroke approaches the earth yields, from the relation

$$\varepsilon_r = \frac{1}{c^2 r}\,\frac{d^2M}{dt^2},$$

a final value of the order of 10 or 20 millivolts/metre for the radiation field due to the a portion at 100 km., assuming that the corona current increases as the square of the voltage. During the c portion a charge of the order of 10 coulombs often flows from cloud to earth in a time of the order of 3 milliseconds[4]. If this charge is initially at a height of 2·5 km., and if its electric moment is destroyed exponentially, which the aforementioned records[2] show to be approximately the case, then the above relation yields a crest value for ε_r at 100 km. of the order of 70 mv./m. These values compare well with the observed value of 125 mv./m. at 100 km.[1].

It would thus appear that the 'slow tail' represents the radiation resulting from the destruction of the electric moment during the a and c portions of a lightning stroke.

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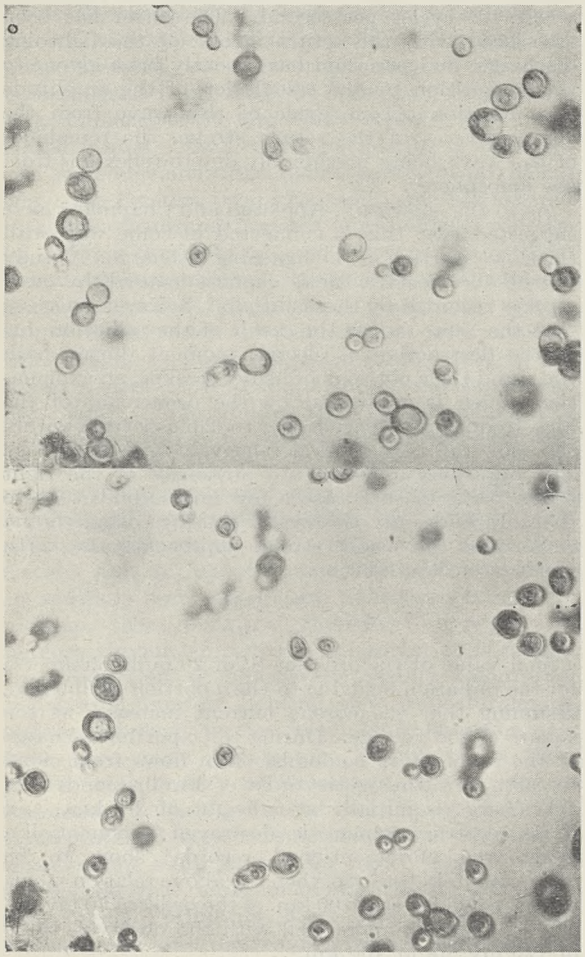
Increased Ultra-violet Absorption of Cells Following Irradiation with Ultra-violet Light*

PREVIOUS investigations[1] have indicated that one of the responses of cells to various injurious agents (for example, lethal ultra-violet light and X-rays) is the release into the intercellular fluids of nucleic acid-like proliferation-promoting factors ('intercellular wound hormones'). Considerable evidence indicates that these active factors are produced in the living cell as a response to injury[2]. The present investigations were aimed at determining by direct observation of living cells whether there is an actual increase in cellular nucleic acids, purines or pyrimidines, during the course of injury. For this purpose, ultra-violet photomicrography was employed, following techniques well established by Caspersson[3].



TWO ULTRA-VIOLET PHOTOMICROGRAPHS OF *S. cerevisiæ* FROM A TYPICAL SERIES, SHOWING INCREASED ABSORPTION OF ULTRA-VIOLET FOLLOWING IRRADIATION WITH SUB-LETHAL DOSES ON THE MICROSCOPE STAGES AT $\lambda = 2800$ A.. ABOVE, BEGINNING OF EXPERIMENT; BELOW, SAME FIELD ½ HR. LATER.

A Zeiss quartz microscope was used, with 2·5-mm. glycerine immersion objective, 10× eyepiece, and quartz double monochromator illuminator. A cadmium spark light source was used for $\lambda = 2800$ A. and a General Electric type *H*-3 high-pressure mercury arc for $\lambda = 2537$ A. A hole cut in the outer glass jacket of the mercury arc permitted passage of the ultra-violet. The organism was *S. cerevisiæ* (Fleischmann bakers' yeast). This was suspended in isotonic salt solution or water, sealed under a quartz coverslip on a quartz slide, and irradiated continuously on the microscope stage with the lethal radiation employed as the microscope illuminant. Photomicrographs were taken at the beginning of the experiment, and at fifteen-minute intervals during the course of irradiation.

The plates showed a progressive increase in the ultra-violet absorption of the cells during irradiation. Since the wave-lengths employed were in the range highly absorbed by purines and pyrimidines[4], one can interpret the results as indicating a production by the injured cells of nucleic acid-like materials. This is consistent with the previous results[2] indicating that proliferation-promoting intercellular hormones are produced in living, injured cells as a response to injury. Two photomicrographs from a typical series are shown in the figure.

In Mitchell's studies of the possible relationship of nucleic acids to the radiosensitivity of tumours, he found an increase in the ultra-violet absorption near 2600 A. of carcinoma tissue and normal epithelium irradiated with X-rays or gamma rays *in vivo* and afterwards examined in section by ultra-violet photomicrography. He interpreted the increased absorption as due to purines or pyrimidines, and not to thymonucleic acid (negative Feulgen reaction). From *in vitro* experiments, he concluded that the effect was not due to direct photochemical changes in the cytoplasm. The supposed purine or pyrimidine nature of the absorbing materials, their apparent production as a result of the effects of lethal agents (X-rays and gamma rays), and their evident formation by living, injured cells rather than as a direct photochemical effect, all suggest that Mitchell was observing the production of the proliferation-promoting factors we have been investigating. If this is true, it points to the advisability of a careful study to determine whether the production of proliferation-promoting factors by injured cells is an initial result of the irradiation of tumours by X-rays and gamma rays. The release of such factors into the tumour mass and surrounding tissues might conceivably play an important part in the variability of the response of tumours to irradiation.

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* Contribution No. 185 from the Department of Biology and Public Health, Massachusetts Institute of Technology.

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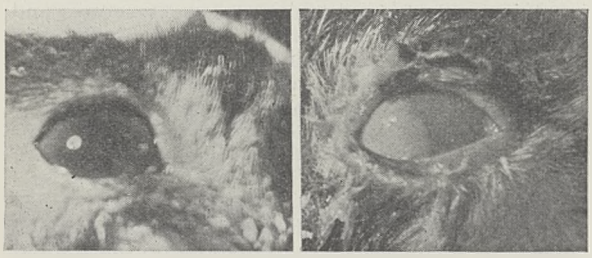
Local Treatment of Experimental Pyocyaneus Ulcers of the Cornea with Albucid Soluble

JOY[1] recently demonstrated that the development of experimentally produced ulcers of the cornea in rabbits could be favourably influenced by the parenteral administration of sodium sulphapyridine. It has also been shown that sulphanilamide penetrates freely through the cornea[2,3].

We have investigated the effect of local application of a water-soluble sulphonamide on experimental ulcers in seventeen rabbits. In each animal a definite area in both eyes was denuded of epithelium by means of a discission needle. Great precautions were taken to ensure that the lesions were equal in both eyes. A 24-hour culture of *B. pyocyaneus* (kindly supplied to us by Dr. Oag, of the Department of Bacteriology of the University of Edinburgh) was then applied to these denuded areas by means of a metal loop; the same strain of *B. pyocyaneus* was used throughout all the experiments.



(*a*) (*b*)

Fig. 1.

SHOWING THE CONDITION OF THE CORNEA IN THE TREATED (*a*) AND CONTROL (*b*) EYES OF A RABBIT ON THE THIRD DAY AFTER THE PRODUCTION OF THE LESION.

Treated eye: cornea healed and showing only a small superficial scar situated at the centre of the cornea immediately adjacent to the light-reflex which is overlying the margin of the pupil. Control eye: severe abscess involving half the cornea.

One hour after the application of the culture several drops of a 30 per cent solution of albucid soluble (which forms a neutral solution) were applied to the cornea of one eye in each animal, the other eye being used as a control and receiving several drops of saline. This treatment was continued four times a day until the lesions were quiescent.

In the majority of the 'control' eyes extensive ulceration occurred and a complete or partial 'ring abscess' developed, the end result being either perforation or gross scarring of the cornea with extensive pannus formation. In some animals, however, the ulceration was limited to the site of scarification, and the resultant scar was very little larger than the original lesion.

In every animal the lesion in the control eye was more severe than that of the treated eye. In eleven animals the difference was very marked (see accompanying illustration), in four animals the difference was less marked, but the treated eye was still definitely better than the control, while in two rabbits the treated eye was only slightly better.

The extent to which ulceration or abscess formation occurred in the cornea is summarized in Table 1.

It is noteworthy that a partial or complete ring abscess developed in twelve of the control and in only three of the treated eyes. Hypopyon was observed in five of the control eyes and in only one of the treated eyes.

TABLE 1.

	No ulceration.	Ulceration present but not extensive.	Extensive ulceration, abscess formation, or necrosis, with or without perforation.
Control eyes	0	4	13
Treated eyes	11	4	2

Conjunctivitis did not play a prominent part in the lesions produced, but again the treated eyes were on the whole very definitely better than the controls, and in no case was the treated eye worse than the control eye of the same animal. The results are shown in Table 2.

TABLE 2

CONJUNCTIVITIS

	Nil	Slight	Moderate	Severe
Control eyes	0	10	6	1
Treated eyes	10	6	0	1

The expenses of this investigation have been defrayed by the W. H. Ross Foundation for the Prevention of Blindness. We are greatly indebted to Mr. Edwards, of Messrs. Schering, London, for the supply of ampoules of 30 per cent solution of albucid soluble.

J. M. ROBSON.
G. I. SCOTT.

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University of Edinburgh.
July 14.

[1] Joy, H. H., *Proc. Soc. Exp. Biol.*, **45**, 709 (1940).
[2] Luo, T. H., and P'an, S. Y., *Chinese Med. J.*, **58**, 167 (1940).
[3] P'an, S. Y., *Proc. Soc. Exp. Biol.*, **46**, 31 (1941).

Sulphanilylbenzamide in the Chemotherapy of Bacillary Dysentery

SULPHANILYLGUANIDINE, first described in 1938[1], was recently introduced by Marshall and his colleagues[2] in the treatment of bacterial infections of the intestinal tract. A subsequent report[3] dealt with the successful trials of this compound in acute bacillary dysentery due to Flexner and Sonne types in children. The use of the drug is based on its potent antibacterial properties, its solubility in water and its poor absorption from the gut. We have re-examined a large number of drugs of the sulphanilamide and sulphone classes having similar characteristics and have found two soluble compounds, 4: 4′-*bis*-γ-phenyl-*n*-propylaminodiphenylsulphone tetrasodium sulphonate and sulphanilylbenzamide to be more effective *in vitro* than sulphanilylguanidine. However, when these compounds were incorporated in the diet of mice, only sulphanilylbenzamide was as efficient as sulphanilylguanidine in its antibacterial action on the coliform organisms of the gut. When fed to rabbits by stomach tube, sulphanilylbenzamide is poorly absorbed, but it is absorbed to the extent of one and a half times that of sulphanilylguanidine.

Our *in vitro* tests compared the antibacterial activity of constant drug concentrations in a stock broth against graded inocula of selected intestinal

pathogens. The range used included strains of Sonne, Flexner, Newcastle, Shiga, coli, typhoid and cholera. We have always found Sonne strains to be the most resistant to sulphanilylguanidine and Shiga and typhoid strains somewhat resistant, while sulphanilylbenzamide has proved highly potent in all types. The mouse test referred to above is one suggested by Marshall[2]. It is based on the reduction in the concentration of the lactose-fermenting organisms in the fresh stools of mice fed on a diet containing 2 per cent of the drugs. Fresh fæces are made into an emulsion containing approximately 50 mgm. in 5 ml. of broth and graded dilutions made on desoxycholate agar plates. The lactose-fermenting organisms are counted after twenty-four hours. Under these conditions sulphanilylbenzamide is as efficient as sulphanilylguanidine.

Whether the promising *in vitro* results, especially against Sonne, Shiga and typhoid types, are reproducible in man will in turn depend on whether the more rapid absorption of sulphanilylbenzamide from the gut is significant. Arrangements for such a clinical trial are being made.

It is hoped to publish a detailed account of this work elsewhere.

We have to thank Mr. T. Dewing of the Wellcome Chemical Works, Dartford, for kindly supplying sulphanilylbenzamide and Mr. W. H. Gray of the Wellcome Chemical Research Laboratories for kindly supplying 4 : 4′-*bis*-γ-phenyl-*n*-propylaminodiphenylsulphone tetrasodium sulphonate.

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Wellcome Physiological Research Laboratories,
Beckenham, Kent.
July 18.

[1] Buttle, Dewing, Foster, Gray, Smith, and Stephenson, *Biochem. J.*, **32**, 1101 (1938).
[2] Marshall, Bratton, White, and Litchfield, *Bull. Johns Hopkins Hosp.*, **67**, 163 (1940).
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Latero-sensory Canals and Dermal Bones

J. A. MOY-THOMAS[1] has recently made important observations on the developmental relationship between the frontal bones and the supraorbital latero-sensory canal in Salmo, and clearly considers that his experiments go far to destroy the whole basis of the homologization of dermal bones in fishes by reference to the latero-sensory system. His results are quite in harmony with, for example, Kindred's embryological study of Amiurus[2], and no doubt somewhat similar conditions occur widely in teleosts, where the dermal bones of the skull-roof, particularly the frontals, play an important part in the mechanical structure of the cranium.

It is true that some workers have carried the use of the latero-sensory too far, especially where originally enclosed canals show a phylogenetic 'degeneration' to pit-lines, and I have several times[3,4,5,6] noted necessary modifications to some of these rigid schemes. Nevertheless, in certain primitive fossil forms, and in the development of Amia (Pehrson[7]), there is abundant and convincing morphological evidence of a close developmental connexion between certain dermal bones and the latero-sensory system (excluding pit-lines). In the most primitive known Actinopterygii, Crossopterygii and Dipnoi the adult dermal skull-roof consisted of bony plates, occupying the whole thickness of the corium, but having no part in the mechanical construction of the cranium ; somewhat similar conditions still hold in Amia. But in most teleosts (Actinopterygii) and in all but the most primitive tetrapods (from Crossopterygii), several of the dermal bones have new functions as mechanically important cranial elements, and may become deep-seated. It is precisely in these forms that the importance of latero-sensory canals as 'markers' of dermal bones is so greatly reduced. I am therefore unable to accept all Moy-Thomas's conclusions. His experiments should be repeated on Amia before such deductions can be drawn with confidence.

Moy-Thomas's findings are not unexpected. The early Crossopterygii, and probably the earliest tetrapods, are generally considered to show a close relationship between some of the dermal bones and latero-sensory canals ; but in higher tetrapods latero-sensory canals fail to develop, and dermal bones such as the frontals form part of the mechanical structure of the skull. What seems to have been, in primitive forms, a simple 'secondary organizer' relationship involving early formed latero-sensory structures and certain later developed dermal bones, is replaced in tetrapods by apparently more complicated processes, in which the more integrated architecture of the cranium is clearly an important factor. The same may prove to be true of many Teleostei, and it seems likely that a programme of experiments like those of Moy-Thomas, applied to a large series of teleosts and to Amia, Lepidosteus and sturgeons, would provide valuable evidence in the important problem of the changes in organizer-reactions involved in the gradual modification of phylogenetically archaic structures to meet new needs.

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July 16.

[1] NATURE, **147**, 681 (1941).
[2] *Illinois Biol. Monog.*, **5**, No. 1 (1919).
[3] *J. Anat.*, **71**, 362, esp. 378–80.
[4] *Ann. Mag. Nat. Hist.*, [10], **19**, 553, esp. 571–72.
[5] *Geol. Mag.*, **74**, 507, esp. 517–20.
[6] *Geol. Mag.*, **77**, 65, esp. 72–73.
[7] *Acta Zool.*, **3**, 1.

Function of the Ventral Tube in *Onychiurus armatus* (Collembola)

VERY little is known about the function of the ventral tube of Collembola. Until recently it has been regarded as an adhesive organ, but the observations of W. M. Davies[1] suggest that in *Sminthurus viridis* (Linn.) at least, it may be used for cleansing the body and as a means of transferring drops of water from the surface of the body to the mouth where they are then absorbed. In connexion with this, Davies has suggested that 'free water' is essential for the survival of this species, even in a water-saturated atmosphere.

It is interesting, therefore, to record some results obtained with the soil-living Collembola, *Onychiurus armatus* (Tullb) under various culture conditions.

Onychiurus armatus has been maintained on Mucor cultures on agar media in Petri dishes where it moved freely over the vertical and horizontal surfaces without using the ventral tube vesicles. When placed on vital stains in various humidities the stain was

absorbed through the ventral tube, and the lower the humidity the more rapidly was the stain taken up. The distal joints of, in particular, the hind limbs, which were immersed under these conditions, also became stained.

On agar blocks, where only the tips of the legs and the ventral tube vesicles were in continuous contact with the agar surface, in a low humidity the animals survived for a much longer period than when in the same humidity but on a dry surface. The extrusion of the vesicles was only sufficient to reach the surface of the agar and no action of the vesicles comparable with that observed in *Sminthurus viridis* by Davies, has been seen. Puncturing the vesicles had the effect of reducing greatly the length of life except in a saturated atmosphere.

Onychiurus armatus apparently has no mechanism for preventing water loss, and the ventral tube vesicles seem to be the primary water-absorbing organs.

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July 3.

[1] Davies, W. M., *Brit. J. Exp. Biol.*, **6**, No. 1 (1928).

Relative Growth in the Individual

WITH regard to A. E. Needham's communication[1] stressing the desirability of obtaining relative growth data on individuals as distinct from contemporaneous data obtained in populations, we would like to point out that such data relating to guinea pigs were published by us some time ago[2]. We then demonstrated the isometry of teat-length against body-length in the young male guinea pig and the occurrence of 'simple' allometry of the teat under androgenic stimulation. In these experiments data for groups of comparable individuals were averaged.

More recently[3] we have published a preliminary account of teat-growth data obtained on individual goats, showing that in the young female a phase of teat isometry is succeeded by a phase of 'simple' positive allometry; the constant α was found to vary among individuals. A more detailed account of these last observations is in the press[4].

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A. C. BOTTOMLEY.

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in Dairying,
University of Reading.
July 14.

[1] Needham, A. E., NATURE, **148**, 52 (1941).
[2] Bottomley, A. C., and Folley, S. J., *Proc. Roy. Soc., B*, **126**, 224 (1938).
[3] Folley, S. J., and Bottomley, A. C., *J. Physiol.*, **99**, 5 *P* (1941).
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Miocene Deposits in Kenya

IN 1935 I examined the Miocene deposits of Kavirondo, Kenya, but as publication of results (already overdue) seems likely to be further delayed, I should be grateful for an opportunity to summarize the more important results with reference to misconceptions which have arisen about the age of the formation and its fauna.

The deposits are exposed in three main areas: Rusinga, an island on the edge of Lake Victoria, Karungu, originally described by Oswald[1], and Koru, farther east. The rocks are largely volcanic in origin, and in each case are associated with a major volcanic centre. On Rusinga the lower beds are fossiliferous clays with thin sandstones containing a small proportion of tuffaceous material; these are succeeded by tuffs with an intercalation of red clays and thin limestones, and the tuffs overlain in turn by agglomerate and nephelinite lava. The tuffs and agglomerates thicken rapidly towards the south-west, indicating as source the Gwasi volcanic centre of South Kavirondo. Adjacent islands provide confirmatory evidence of this. Karungu lies on the southern fringe of the same volcanic mass, and the fossiliferous beds there are correlated with the lowest beds of Rusinga. Koru shows a succession broadly similar to Rusinga, but red clays with limestones in the middle part provide the main fossiliferous horizon.

Bailey Willis[2] has argued that the Karungu deposits are fluviatile Pliocene, containing occasional derived Miocene fossils, and Broom[3] has recently queried the Miocene age of Proconsul from Koru on systematic grounds. It is therefore necessary to confirm, first, that the fossiliferous part of the formation is definitely lacustrine, secondly, that the fossils are truly autochthonous, being in some cases articulated and in most cases quite unrolled, and thirdly, that Dr. A. T. Hopwood and D. G. MacInnes, who have separately worked on the fauna, are quite satisfied that it is of Lower Miocene date.

Independent evidence indicating considerable age is provided by the later history of the deposits. On Rusinga the beds show strong deformation, including isoclinal folding and thrusting with production of phacoidal structures, which it is exceedingly difficult to explain other than by lateral compression (in this connexion Willis's theory of an expanding disk beneath Lake Victoria as the force which produced the Rift Valleys should be remembered). In particular, it may be emphasized that the phenomena are quite distinct from those of slumping, well-developed in neighbouring Pleistocene beds. Afterwards the deposits were intruded by igneous dykes, and in the west extensively eroded with relation to a base level beneath the present lake before the formation of high-level raised beaches in the Lower and Middle Pleistocene. Between deposition of the fossiliferous beds and the Lower Pleistocene, therefore, accumulation of up to 500 ft. of tuffs and agglomerates, extrusion of lava, disturbance of the beds, dyke intrusion and extensive erosion successively occurred, which supports the palæontological evidence in suggesting a date at least as early as Miocene.

This early disturbance of the African peneplain, previously doubted by some authorities, is further illustrated by the discovery of phonolite-covered Lower Miocene beds in a valley cut in the gneiss of the northern scarp of the Kavirondo Rift, which must, accordingly, be of pre-Miocene age.

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Notts.
July 12.

[1] *Quart. J. Geol. Soc.*, **70**, 128–162 (1914).
[2] "East African Plateaus and Rift Valleys", pp. 148–150 (1936).
[3] NATURE, **148**, 14 (1941).

THE ONTARIO RESEARCH FOUNDATION

THE report of the Ontario Research Foundation for the year 1940 includes the Director's report together with the financial statment and a full list of publications to December 31, 1940. The Director's report refers to the new problems created for those engaged in agriculture, particularly to work concerned with remedying the slow depletion of the soil. The Foundation is studying areas which show evidence of trace-element depletion and also characteristic deficiency diseases, such as boron deficiency in the apple, sugar beet and turnip, copper deficiency in the onion and manganese deficiency in oats. A survey of land values in rural Ontario and their relation to soil, climate and economic factors has been commenced. The work on mastitis in cows has continued throughout the year and evidence has been secured proving that the leucocytes present in milk can destroy the characteristic bacteria which are associated with mastitis. A study of the pathological changes in the udder of the cow caused by tuberculosis and other diseases has been commenced.

In the late autumn the pathological and bacteriological staff were fully occupied in field studies of autopsies and laboratory work arising from a widespread outbreak of a respiratory disease among young pigs. Rapid and successful progress has been made in investigating the life-history of a parasitic fly which attacks and destroys the larvæ of the clothes moth. The research has indicated other problems related to the use of parasites for the destruction of pests and also to the nature of the physiological relation between the host and the parasite.

The work of the Textile Department has continued to expand, and much of its testing work in 1940 was in connexion with fabrics and other materials manufactured for war supplies. Co-operative work with various firms associated with the quality control plan, in which eighteen manufacturers of fabrics and eighty manufacturers of garments are now co-operating, has been concerned particularly with work on the relation between seam construction and serviceability, effects of different finishing processes on the strength of dress fabrics, a comparative study of length of life of wool socks and wool plus rayon socks and the influence of time and other factors on the extensibility of drapery fabrics. Work on the response of silk to water vapour has been extended to cover a number of organic substances such as alcohols, ethers and ketones.

The investigation of the principles of scouring has continued, while in the Division of Engineering and Metallurgy, in addition to important testing work, studies have continued on the resistance of various alloys to abrasion, the malleability of white cast iron in relation to variation in chemical composition and the influence of the cross-sectional area of a test piece on the fatigue strength as measured by the Avery machine.

The Chemistry Division has largely been concerned with analytical work in connexion with specifications, while in the Division of Biochemistry, research in the leather laboratory has been concerned with further improvements in the methods of intermediate alum and chrome re-tannage of heavy leathers. Work has continued on methods for the preparation of organic acids by fermentation as well as the preparation of pure lactic acid for edible and medicinal purposes. Much of the effort of the Biochemistry Division has been given to determinations of vitamins in mill and other food products. The Department is collaborating in the development of rapid cheap and reliable methods for the determination of vitamin B_1, and is already in a position to carry out accurately and economically biological or chemical assays of vitamins A, C, D and B_1 constituents and riboflavin.

USES OF THE 200-IN. TELESCOPE

DR. MAX MASON, chairman of the Observatory Council of the California Institute of Technology, speaking at a meeting in June of the Pacific Division of the American Association for the Advancement of Science and the Astronomical Society of the Pacific, stated that the great 200-inch telescope to be erected on Mt. Palomar is now approaching completion, thirteen years after the late Dr. George Ellery Hale convinced the Rockefeller Boards of the feasibility of such an instrument, and obtained funds for its construction. It will be recalled that Dr. H. Spencer Jones gave some details about this instrument in his Thomas Young Oration before the Physical Society (NATURE, June 14, p. 753).

The disk, about 17 ft. in diameter, originally weighed 21 tons, and during five years' grinding at Pasadena, more than four tons of glass have been removed. The disk is carried by a system of thirty-six levers inserted in the holes of the ribbed back. Both the method of support and the structure of the mirror are new in this instrument. The supporting system must operate so perfectly that no bending of the reflecting surface beyond one or two millionths of an inch will occur as the telescope moves. As the surface of the mirror was brought by polishing close to a spherical form it became clear that the disk, when tipped from the grinding table to a vertical position for optical test, sagged slightly under gravity. This sag has now been eliminated by installing a system of twenty-four squeeze levers, operated by counter weights, distributed around the rim of the glass. The spherical surface required has nearly been reached, after which it will be changed to a paraboloid by deepening the centre concavity five thousandths of an inch.

Dr. Mason stated that it is doubtful whether the new instrument will be useful for photographing moon or planets, due to shakiness of the air, which destroys detail. Instead it will be used to study faint and distant galaxies, and to analyse in high detail light from the stars and planets.

Dr. John Strong, also of the California Institute of Technology, stated that one of the uses of the 200-in.

telescope will be to study planetary radiations. Planets not only reflect visible light which they receive from the sun; they absorb and then re-radiate considerable quantities of solar energy, largely in the form of the invisible infra-red rays. The special instruments and techniques necessary for the analysis of these radiations are being developed by members of the Institute staff. Much of the information necessary for comparison of conditions on the planets with those on the earth can be obtained only by a more careful and exact study of physical processes taking place on the earth's surface and in its atmosphere. Determinations, to an entirely new order of exactness, of the effect of water vapour, carbon dioxide, ozone and the major atmospheric gases on radiation, are on the programme of research. Incidentally, Dr. Strong pointed out, data obtained in these researches will probably be of very considerable value to meteorologists as well as to astronomers.

EQUATORIAL REGIONS OF THE PACIFIC

IN his address on June 18 as president of the Pacific Division of the American Association for the Advancement of Science, Dr. H. U. Sverdrup, director of the Scripps Institution of Oceanography, stated that the Pacific Ocean is two feet higher on the Australasian side than it is on the American.

As a result of this difference in elevation, there is a narrow, relatively swift current flowing eastward along the equator. If it were not for the friction of water against water, it would move at a rate of about seven knots. Its actual rate is one or two knots. This, however, is as rapid as the current in a great many inland rivers.

The pile-up of water against the Pacific's western shore results from the action of the trade winds. Steady winds blowing across the water from the north-east in the northern hemisphere's lower latitudes, and corresponding winds from the south-east in the southern hemisphere, keep two great currents moving steadily westward in the tropical Pacific. Separating them, in the equatorial belt of calms, is the narrow return current, flowing like a river.

This narrow west-to-east equatorial current, however, accounts for only a small part of the water returned across the Pacific. Much larger streams flow away from the equator, to make the return trip at higher latitudes. In the northern hemisphere, the principal returning mass is borne in the Kuroshio or Japan current, which sweeps along the Aleutian chain and turns southward along the North American coast. It is estimated that this current carries more than five thousand times as much water as the Mississippi.

As described by Dr. Sverdrup, the Pacific is a cold monster with a relatively thin, warm skin. Surface temperatures are quite high, reaching as much as 75° F. But this warm surface layer extends downward only a few hundred feet at most. The great bulk of Pacific ocean water, in the depths, is always cold, most of it only a few degrees above freezing-point.

EXTRACTION OF GOLD FROM SEA-WATER

WITH about five million pounds worth of gold dissolved in each cubic mile of sea-water, man has often sought a way of digging out this treasure. Using electrochemical methods, comparable to those used in electroplating, gold has actually been extracted from the ocean, but unfortunately the cost of the process is five times the value of the gold obtained.

Hopes that this may be reduced to the point where gold may be profitably extracted were raised by Dr. Colin G. Fink, of Columbia University, speaking before the Wilder D. Bancroft Colloid Symposium at Cornell University.

In electroplating, the metal in the plating solution is deposited on the cathode, the negative terminal. But when an effort is made to plate the gold out of sea water in this way the metal precipitates out rapidly, and fails to collect in the solid, crystalline form in which it is desired. By using a rapidly spinning cathode in place of the stationary one, it has been found possible to get a distinctly visible gold deposit. It is the cost of providing the spinning cathode that makes the method impracticable commercially.

In his search for the reason why gold fails to deposit on the stationary cathode, Dr. Fink made the discovery that, when gold passes out of or into solution, two distinct steps are involved. Invisible dissolved gold first goes into myriads of minute particles of colloidal gold, and then later into the crystalline form of the metal. The stationary cathode fails because the metal precipitates out in colloidal form and drops away before crystallizing.

Now a problem remains, namely, conversion of the colloidal gold into the metal crystals. Perhaps it can be accomplished with high-voltage electric currents, or with bombardment of electrons. Dr. Fink intends to try these. "In any event," he said, "it is felt that, on the basis of the discovery, we have advanced one step closer to the commercial recovery of gold from sea water."

Apart from this, however, the discovery is of great theoretical significance, and has practical importance as well. For example, it may hasten development of formulæ for the electroplating of metals such as titanium and vanadium. In this way, it may have far-reaching commercial results whether the gold extraction is accomplished or not.

THE WORONORA DAM, SYDNEY

At present four large dams serve the metropolitan area of Sydney with its water supply. The Woronora dam, which is now nearly completed, is in the Upper Nepean catchment, and serves Sydney through a separate pipeline. This will greatly increase the margin of safety against any possible failure of supply to Sydney, which has a population of nearly a million and a half. The dam is a mass concrete structure with a crest length of 1,300 ft. According to the *Commonwealth Engineer* of May 1, it will be 217 ft. high above foundation level and will impound approximately 15,800 million gallons.

After completing the excavation in the river bed, a large number of deep holes were drilled in the floor of the cut-off trench and over the remainder of the foundations. Into these holes liquid cement was pumped to seal up any cracks or fissures in the underlying rock strata. The rock surface was then made spotlessly clean by means of compressed air and water jets, after which concreting was commenced.

The impounding of about 15,800 million gallons of water by the dam across the Woronora River will result in the submergence of one thousand acres of river valley. This area, originally heavily wooded, is being cleared to prevent pollution of the water. Trees are felled, the larger ones broken up by blasting, and the undergrowth is cut down. After a short interval for drying, a running fire is allowed to pass over the area to burn off the small branches and leaves. The remaining timbers are then stacked and burnt.

An inspection gallery runs longitudinally through the dam at a height of 60 ft. above the river bed. An additional gallery is being constructed along the rock foundation to the southern abutment where excavation has revealed very broken strata. The 36-in. outlet pipes at the base of the dam are controlled at the upstream end by timber stopboards, emergency roller gates and penstocks. At the downstream end the outlets are connected to the 48-in. diameter steel delivery main which forms the Woronora pipeline, and are each controlled by a gate valve and a needle valve. A spillway channel, 30 ft. wide at the bottom and with a maximum depth of 150 ft., is being excavated through a spur to provide for the maximum flood discharge of 36,000 cusecs. This channel will be concrete built up to about flood level.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

HEAD OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT—The Principal, Stockport College for Further Education, Stockport (August 15).

LECTURER IN MINING—The Registrar, University College, Nottingham (August 16).

HEADMASTER to re-open British School at Punta Arenas, Chile—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Chile') (August 20).

ENGLISH MASTER for the Grange School, Santiago, Chile—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Santiago') (August 20).

LECTURER IN MECHANICAL ENGINEERING at the School of Mines and Technology, Treforest—The Director of Education, County Hall, Cardiff (August 20).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Manchester 13 (August 22).

LECTURER IN ELECTRICAL ENGINEERING, and LECTURERS IN PHYSICS AND MATHEMATICS—The Registrar, Loughborough College, Loughborough (August 23).

ASSISTANT TO THE CHIEF ENGINEER—The General Manager, Manchester Ship Canal Co., Ship Canal House, Manchester 2 (endorsed 'Personal') (August 25).

DIRECTOR OF EDUCATION—The Town Clerk to the Local Education Committee, Town Hall, St. Helens, Lancs. (August 25).

CHIEF EDUCATION OFFICER—The Education Officer, The Town Hall, Chesterfield (August 26).

TEACHER (MAN OR WOMAN) WITH GOOD QUALIFICATIONS IN BIOLOGY, PHYSICS AND MATHEMATICS—The Headmaster, Dartington Hall, Totnes, Devon.

DIETITIAN—The Food Supervisor, Royal Masonic Hospital, Ravenscourt Park, London, W.6.

LECTURER IN MATHEMATICS—The Principal, Rugby College of Technology and Arts, 61 Clifton Road, Rugby.

MASTER FOR SCIENCE AND ENGINEERING SUBJECTS—The Principal, Sheerness Technical Institute and Junior Technical School, Sheerness

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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Metallurgical Abstracts (General and Non-Ferrous). Vol. 7, 1940. Edited by N. B. Vaughan. Pp. xii+652. (London : Institute of Metals.) [217

University of London. Report of the Principal on the Work of the University during the Year 1940–41. Pp. 6. (London : University of London.) [237

Mines Department. Eighteenth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1939. Pp. 34. (London : H.M. Stationery Office.) 1*s*. net. [237

Annual Report of Gresham's School Natural History Society, 1941. Pp. 60. (Holt : Gresham's School.) [247

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