VOL. 148
No. 3742

NATURE

SATURDAY
JULY 19, 1941

ANGLO-AMERICAN COLLABORATION

IN a speech read on his behalf on December 11, Lord Lothian affirmed his belief that the only nucleus round which a stable, peaceful, democratic world could be built after this War was the possession by the United States and Great Britain of air-power, sea-power and key positions superior to those of any possible totalitarian rival. Peace and order always depend on the existence of an overwhelming power behind just law, and more and more people have come to the conclusion that all real hope depends on some form of co-operation between the United States and the British Commonwealth of Nations.

Without some such general realization and indeed actual co-operation, it is almost inconceivable that the British Ambassador in Washington could address the people of the United States so directly, however careful he might be, like Lord Lothian, to state the essential facts and to emphasize the responsibility of his hearers to decide for themselves. The events of the last six months have abundantly justified such frankness and demonstrated the recognition by the two peoples of their common danger and their solidarity in defence of the ideals and heritage which they share. Anglo-American co-operation has become a reality and a dominant factor in the war itself and in the peace and reconstruction to follow. The questions at issue are now those of the extent and form which such co-operation will take.

With the growing scale of America's contribution in the material sphere, there has been a notable contribution in the moral sphere. It is no disparagement of the speeches of Mr. Churchill, of Lord Halifax or of Mr. Eden to say that the major contributions in the statement of the moral issues of the War and its social, economic and spiritual objectives have latterly come from the American side. That might well be expected, but the warmth and sincerity with which they have been welcomed indicates how fully they are shared in Great Britain and how wide and firm is the foundation upon which practical measures of co-operation can be based.

Nor should it be imagined that this affinity of ideals and purpose is limited to leaders. The American Press affords decisive evidence that President Roosevelt, Mr. J. G. Winant and Mr. Wilkie are speaking for, as well as to, their countrymen. American periodicals such as *Fortune* leave their readers in no doubt as to the consequences which flow from the Lease-Lend Act. The probability of a direct collision with Germany is recognized, as well as the opportunity which the acceptance of that challenge would afford the United States to make the international view effective. The decision to fight for international

democracy would indeed not only be a decision to fight for a world in which there was still room for American ideals. It would also be the opportunity to build a new era in which the dualism which has hitherto characterized American foreign relations could be transcended.

Mr. Streit's new book "Union Now with Britain"* bears striking testimony to the startling transformation of American opinion and policy from the consistently isolationist attitude which characterized it during 1919–39. Written as it is primarily and essentially for Americans, it is this changed outlook, sensed or implied rather than directly described, which is the most striking feature of the book in contrast with "Union Now", overshadowing the fact that the intervening two years have witnessed the passage, one by one, under the Nazi heel, of eight of the fifteen democracies for the federation of which he pleaded in "Union Now". The successive fall of these democracies before the same tactics, has brought home to the United States not merely the fuller realization of the ideals and trust for safeguarding man's heritage of freedom which she shares with Great Britain, but also the clear understanding that the choice for her also is between standing now by Britain's side or fighting later and alone in a totalitarian world.

Ostensibly Mr. Streit's new book is concerned with the organization of co-operation, with the development of the most effective machinery for harnessing the resources of the United States and the six democracies of the British Empire to their common task. Fundamentally the book is vibrant with the moral conviction and ideals which have given such force to President Roosevelt's and Mr. J. G. Winant's speeches. The spirit and conviction on which his views are based are irresistible. No nation can live to itself alone. Each nation must give, and he calls on Americans to give fully and with open hands the best they have.

It is on this basis that Mr. Streit pleads for a union of the United States with the six democracies of the British Empire—the United Kingdom, Australia, Canada, Eire, New Zealand and the Union of South Africa—on the lines of the American federal system but with modifications which introduce something of the British parliamentary and Cabinet systems, and starting with a limited union. The working out of a broader and permanent union would be left until later, but the provisional union is intended and planned to be the nucleus of a world federal union to which each western European democracy would be admitted as soon as it is no longer occupied by the forces of dictatorship. Beyond that, the admission of such peoples as the Germans themselves is contemplated when, by ending autocracy at home, they have proved their devotion to democratic principles and their capacity to practise them.

Mr. Streit writes persuasively of the capacity of such a union to win the war as well as to win the peace. From the outset the Union would be prepared to negotiate armistice and peace terms with any Government attacking any territory of the Union on conditions of no indemnities, no reparations, occupations or annexations, and of arbitration of disputes on details. Such an announcement could be used to undermine the totalitarian regimes, encourage revolt and distrust among them and promote the downfall of dictatorship.

Writing eagerly with the moving quality of vivid talk, Mr. Streit rapidly outlines a union programme and discusses alternatives to such a policy. For what he has to say of Anglo-American co-operation there can only be the most cordial assent, and the basic proposal of the creation of a community of principles is inescapable. It is indeed implicit in such speeches as those of Mr. J. G. Winant's to the English-Speaking Union, with its insistence that the common ideals of the English-speaking peoples of this world are not ideals from which other peoples are excluded, on the drawing together of the English-speaking peoples in a struggle to preserve not only their common heritage but also the common ideals of civilized men everywhere, and its firm declaration that this is not Britain's fight alone. The ultimate stakes, the four freedoms of which President Roosevelt has spoken, are the foundation of their common effort, and that the time of action, the hour of decision, has arrived for all who love freedom can no longer be denied.

While the gap between political realities and the vision of Mr. Streit's "Union Now" has been greatly narrowed in the last two years, his argument is less conclusive as to the form which the organization of co-operation should take. It may be possible to demonstrate that had the union existed, the democracies included in Mr. Streit's earlier union would not have fallen. There is, however, no evidence that, even if made earlier and accepted, the offer of union which Great Britain made to France would have averted the fall of France. Federal union alone between Great Britain and France could scarcely have eliminated in time those weaknesses which led to the fall of France, though it might have ensured that the French fleet and French colonies continued the struggle.

On the other hand, as *Fortune* points out, the Lend-Lease Act really constitutes the first crude step in union. By its terms Great Britain and the United States pool such matters as military equipment, production, specification and design, hitherto strictly national. Moreover, the same pool is

* Union Now with Britain. By Clarence K. Streit. Pp. 286. (London: Jonathan Cape, Ltd., 1941.) 7*s*. 6*d*. net.

offered and made available to any other country that will take the side of democracy by standing up against Germany. This has been done, however, on the basis of friendship and engagement in a common venture, and that of itself may suggest that, as alternative to federal union, the British Commonwealth of Nations, united by common conventions and understandings about the position and the action of its members, not by virtue of common federal institutions, at least deserves consideration.

It is a mistake to insist too crudely that the choice is between federal union or a formal alliance, as Mr. Streit does, and to reject the latter as bad. It is at least possible that there is a third way, tentative and difficult, but in the end surer and wiser—the experimental way of finding and working out our common understandings and forging the appropriate instruments to serve common purposes. Already we have seen the chastening of nationalism in the British Commonwealth. Given the dynamic outlook and readiness to face change and try new methods, the consciousness of common ideals and traditions which lend Mr. Streit his own inspiration, the same spirit which has worked out effectively the relations between the United Kingdom and the Dominions may work no less harmoniously and effectively between the United States and the British Empire.

To that task must be addressed not idealism alone but also the dispassionate spirit of scientific inquiry, ever advancing step by step as new experiments in co-operation are tried. To such experiments the moral appeal and the rapidly developing world situation give urgency, but it is only on the basis of ascertained facts that Great Britain and the United States can discharge adequately their inescapable responsibilities in peace or in war for the defence of freedom and their common heritage. Whether the first or final stage be union, partnership in some more or less organized form will be required to resolve the conflict between nationalism and trade, industry and culture, and make possible a reconstruction of the world on principles which transcend the national sovereignty that has plunged it into chaos. In such a partnership Great Britain and the United States may well once more attest the truth of Lowell's prophetic words of February 1861, and their manhood make a greater opportunity out of the great danger which they at present share.

FACT AND TRUTH

FROM time to time there flare up echoes of the old controversy between science and religion; not, be it noted in any official form in the sense that leaders of either party take part, but individuals of deep convictions suddenly produce attacks, occasionally in print, which one had hoped were disposed of half a century ago. The fact that such attacks still occur is a reflection on men of science themselves, indicating that they have not yet succeeded in spreading the message of science so widely as they should have done; though it may be in part due to singular obtuseness on the part of their hearers.

The ill-informed have in recent months frequently blamed science for the misuse that has been made of its gifts to mankind, for the developments of the means of waging modern warfare. With that aspect we have often dealt, and we need not go over the ground again. A particularly subtle form of attack on science, however, is to take the line that the facts of science actually have the impermanence of matter, which changes and fades continually, and to contrast them with the truths of religion, which are permanent. Science being based on facts, and the facts relating to it mainly on matter, the argument is, on the face of it, worth examination.

The Oxford Dictionary gives a long definition of *fact*—"thing assumed as basis for inference"; "thing certainly known to have occurred or be true". *True* is defined there as "in accordance with fact". How do these definitions fit in with the outlook of the man of science?

There can be surely no question that the now vast body of scientific workers regard their observations as facts, and also they have a high moral sense of obligation for their pronouncements. As the result of carefully devised experiment, results are obtained which become a basis for inference. These are published for criticism by fellow workers, and if no flaws or omissions are found in the experimental work, they are accepted as facts and form the basis of theories—even of rival theories, a choice between which is only possible when further facts are available. Theories must be altered to fit facts; facts can never be adjusted to fit theories.

In more leisurely days, when a research was published after completion of the work, both facts and theories had been frequently tested during a year or more of investigation, and the final conclusions had a high degree of permanence. When work, however, such as that carried out in the Cavendish Laboratory, is of the greatest international interest, it is desirable to make the

results of the experiments known immediately, it being well understood by colleagues that additional work is in hand. In consequence, there has been a certain amount of correction and withdrawal—what some laymen have called impermanence of facts. This might perhaps have been avoided if publication had been withheld for two or three years, and only the final story told. But the loss would have far outweighed the gain ; the individual laboratories would not have been aware of what the others were doing, which experiments to repeat critically, which further developments to pursue or leave to another laboratory. Quick publication has enormously accelerated the rate of progress ; the withdrawal of a few errors has been a low price to pay.

Critics unfriendly to science say we 'assert' : surely we have a right to do so. The orderly structure of chemistry, based on facts, has enabled us to prophecy with accuracy the existence as well as the chemical and physical properties of undiscovered elements. These were verified when the advancement in experimental technique made the discovery of a new element possible. It is true that the scheme of the elements as originally devised has been proved incomplete ; for example, it made no provision for the group of rare gases, present in the air around us, discovered by Rayleigh and Ramsay : this is because for a long time the facts indicating their existence had been overlooked. But the fact—a minute difference in density between samples of nitrogen of different origin—once established, it was followed up until the reason for the difference was shown to be the presence in traces of another gas with very negative properties. Such facts have no impermanence, no relation to doctrinal system.

Another example may be quoted. The organic chemist had used facts to build up a molecular architecture, often of amazing complexity, for carbon compounds, including the natural substances of plants and animals. The chemist was convinced as to the accuracy of this architecture, for he had tested it in so many ways ; but it was none the less satisfactory to have these structures confirmed when the Braggs, father and son, developed the technique of X-ray analysis. This, at first confirmatory, has now gone past what the chemist can do, and has established new facts so that we can picture the structure of starch and cellulose, hair and horn.

These are permanent facts, always being added to. The first theories are tentative ; new facts strengthen or alter them, but they are always in a state of flux, for theories cannot be permanent though they may endure for a decade or many.

We cannot view the facts of science as impermanent. Doctrinal truths are in quite a different category ; their discussion is an individual matter, and no part of our task.

A PHILOSOPHY OF PAIN AND FEAR

Fears may be Liars

By Prof. John A. Ryle. Pp. 96. (London : George Allen and Unwin, Ltd., 1941.) 3*s*. 6*d*. net.

PROF. RYLE's book has, he tells us, been written both for believers and unbelievers to hearten and console men and women in times of trial and trouble. He assures them that pain and fear are natural phenomena ; that there is no evidence that they are punishments for our misdeeds ; that on the contrary they are conditions not only of the survival but also of the advance of life—without them, it seems, the higher species could not have evolved—and that, so far from being shelved and shunned and enveloped in an atmosphere of mystery, they should be subjected to study and research which show them to be not so very dreadful after all.

Take death, for example. Religion, Prof. Ryle points out, has made death more formidable than it is, terrifying men with the fears of hell and bribing them with the dubious joys of heaven. In fact every death is the beginning of a "peaceful, dreamless night", a nothingness in which we cease to be. Prof. Ryle infers this view of death from the closeness of the mind-body relation. Sensations, emotions, feelings of pain and pleasure are all dependent on the integrity of the nervous system ; at death the nervous system disintegrates and our sensational and emotional life, therefore, comes to an end. Possibly ; possibly not ! The question whether death is the end raises an immense variety of issues and can be approached from a multitude of angles. Of these issues, those that fall within the province of physiology are a small minority ; of these angles, that of the medical man only one. For my part, I should have thought that the agnosticism of Socrates' argument—we do wrong to fear death, not because we know that nothing happens after it, but because we do not know whether what happens after (if anything) is better or worse than what happens to us when we are alive ; it might just as well be better—was at once more prudent and less dogmatic.

Prof. Ryle proceeds to consider the possibility that it is not death but dying that men fear—death, as a wit remarked, would be all very well, were it not for the dying. But a little research shows that in the great majority of deaths, dying is a comparatively painless process, since coma or shock or hæmorrhage dims consciousness "with a dreaminess or delirium as effective as the precious gifts of the hypodermic needle" and dims, therefore, the consciousness of pain.

But it seems to me that it is not of death nor even of dying that most people are to-day afraid, but of disablement and pain—the being blinded, burnt, infected; the losing of a limb; the being tied for the rest of one's life to a broken and pain-engendering body. This increased sensibility to pain and disablement, this comparative indifference to death is, I suspect, a characteristic of civilized men and women. This is curious, since, as Prof. Ryle frequently observes, there have never been so many devices for the removal of pain; but it is not, I suggest, regrettable. It is a symptom of our demand for life at a higher level than that which sufficed our ancestors (a demand which for some of us has in part and on occasion been realized), a level which is incompatible with disablement or prolonged pain. It is not life *tout court* that we want, but life which can be lived out to the full scope and limit of our faculties. If we cannot have life at this freedom and of this intensity—and we cannot, if we are in continual and recurrent pain—many of us would sooner be without it altogether. I venture to make this point since it enables me to say why I find Prof. Ryle's apologia for pain unconvincing. It is grounded in the demonstration that pain is necessary for survival. If the broken leg did not heal, we should walk on it; if the inflamed tooth did not pain, we should bite on it and so on. In short, "if Nature, or God, had not invented pain, man could not have survived at all". Necessary for survival, pain is also useful for diagnosis. Hence we are bidden not to question Nature's foresight in announcing the presence of disease or "injury by pain".

I find this argument unconvincing. I do not know who or what Nature is, but either She or It has a purpose, or not. If She or It has no purpose, there is nothing and nobody to question. If, however, purpose is to be postulated, it seems to be simpler to go all the way with the religious hypothesis and postulate a Person who conceives the purpose and plans the world which is to fulfil it, in which case the phenomenon of pain assumes a different complexion and requires a different mode of treatment, revealing itself as a particular aspect of the moral problem of evil. Prof. Ryle is precluded from taking this line by his avowed rationalism. But, as a rationalist, what title has he to suppose that Nature or the universe takes any interest in us, benevolent or otherwise, that it *wishes* us to survive and has hit upon pain as a device for enabling us to do so? And why this insistence upon the importance of survival, on life at any cost and on any terms? Even if a man's life were abruptly terminated by accident or maltreatment which, owing to the absence of pain he failed to avoid, when, if he had been sensitive to pain he might have avoided it, why should it be assumed that his life was not worth while, more worth while, perhaps, than a life which was prolonged through pain and in pain? Why not in fact a short life and a painless one?

Prof. Ryle has some interesting things to tell us of fear (also diagnosed as performing a biological function in prompting defensive activity leading to survival) and of pain arising from his recent experiences in attending victims of air raids. The pains of even the worst hit victims are not, it appears, as bad as the layman would be led to suppose, for out of a convoy of twenty or thirty sufferers only two were heard by Prof. Ryle to groan. I am glad to hear it. But I cannot rid myself of the suspicion of occasional special pleading. Prof. Ryle is so determined to make the best of things that he never sees a cloud without looking for, and inevitably finding, the silver lining, with the result that when he means to be consoling, he too often succeeds in being merely complacent.

C. E. M. JOAD.

INSECTS AND PLANT DISEASES

Insect Transmission of Plant Diseases

By Prof. Julian Gilbert Leach. (McGraw-Hill Publications in the Agricultural Sciences.) Pp. xviii+615. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 42*s*.

IN 1801 it was shown for the first time that bacteria could cause plant disease, and this was only eleven years before the first scientific demonstration of a virus. The discovery that insects were concerned in the transmission of plant disease was made in 1901 when Takami showed that 'dwarf' or 'stunt' of rice was associated with a certain species of leaf-hopper, and at about the same time it was shown that insects could transmit diseases of man and other animals. As early as 1878 Manson had shown that mosquitoes were the

vectors of *Filaria bancrofti*, the nematode causing elephantiasis, and it was Manson, convinced of the importance of mosquitoes as vectors of disease, who stimulated and encouraged Ross in his studies on the transmission of malaria by mosquitoes. The importance of insects in the transmission of the diseases of man has led an increasingly large number of investigators into this field of research. These investigators are trained in the fundamentals of both entomology and medical science. The author of this book pleads for a similar training in the essentials of entomology and botany for potential workers in the field of insect-borne diseases of plants.

Diseases of plants and animals which are associated with insects and allied arthropods fall into a series beginning with that type of disorder which is not due to an agent multiplying within the host, but which is caused by the systemic distribution of a toxin injected by the insect or allied vector. In the plant world there are several examples of this type of disease, such as 'wilt' of pine-apples arising from a diffusible secretion incapable of reproduction injected by a species of mealy bug, and 'psyllid yellows', a disorder of a similar type caused by the potato psylla. This latter disease has all the appearances of a systemic virus disease except that it cannot be transmitted to other healthy potato plants and is not perpetuated by the tuber. A possible parallel in animals is tick paralysis, a condition due to the injection of a toxin by the dog tick. Next in the series come the virus diseases proper, in which an actual disease agent with tremendous powers of self-increase is concerned. In plants this type of disease is in particularly close association with insects and the number of insect-transmitted viruses is very large, curly-top of sugar beet and leaf-roll of potato being cases in point. There are also insect-transmitted viruses affecting man, yellow fever by the mosquito, for example.

The next type of disease is that due to the Rickettsiæ ; these are extremely minute agents on the border-line of microscopical visibility which may perhaps be regarded as intermediate between the viruses and the bacteria since they have some characteristics of both. There are many rickettsia diseases of man and animals, the two best known being typhus and its milder cousin, trench fever, both of which are transmitted by the louse. Here also there seems to be a very close association between the disease agent and insects, and Zinsser has suggested that rickettsiæ were originally harmless parasites or symbionts in insects and that the pathogenic forms have developed from these. At all events there occur structures in the cells of many insects which resemble these agents and while no rickettsia diseases of plants are as yet known, similar structures can be demonstrated in phytophagous insects. This makes plain the importance of Chapter iii on insects and their symbionts, which otherwise might have seemed redundant. It is of interest to note in passing that the rickettsiæ of typhus fever become rapidly fatal to the louse itself which suggests that the association between the two is not complete and is of comparatively recent origin. Next in the list of insect-transmitted diseases are those due to undoubted organisms, bacteria, fungi and protozoa. So far as plants are concerned some of all three of these types of organisms are pathogenic and are transmitted by insects. The author himself has done valuable work on the bacterial disease of potato known as 'blackleg' and has shown the connexion between the causal organism and the dipterous maggot which transmits it. One of the most outstanding examples of an insect-transmitted fungus disease known to us is the so-called Dutch elm disease which is spread by the bark beetle, *Scolytus scolytus* Fabr. Examples of plant diseases caused by protozoa which are insect borne are not numerous, though flagellates which pass part of their life in hemipterous insects and part in laticiferous plants are well known.

Prof. Leach deals at length with all the foregoing types of insect-transmitted diseases and gives many examples of each. He devotes two chapters to plant viruses and their insect vectors and gives a comprehensive and up-to-date account of these. In addition to chapters on the actual diseases and the relationships of the transmitting insects, there is a great deal of valuable information on the fundamentals of the general problem. Thus Chapter xii deals with the anatomy and physiology of plants in relation to infection and insect vectors ; Chapter xiii describes the anatomy and physiology of insects in relation to the transmission of plant diseases, while Chapter xv describes the feeding and breeding of insects from the same viewpoint. The author casts his net widely, but does so deliberately in furtherance of his plea that investigators in the field of insect-transmitted plant diseases should, like the medical entomologist, be trained in the fundamentals of both the subjects involved.

Prof. Leach is to be heartily congratulated on having brought together in a very readable form such a mass of useful information. There is very little to find fault with in this book, though the reviewer does not quite agree with the statement (p. 278) that "there are very few, if any, true virus diseases [of plants] that are not to some extent transmitted by insects". On the contrary, there are several undoubted viruses which apparently have no connexion with insects ; such are the viruses of tomato bushy stunt, tobacco necrosis and potato paracrinkle and, in the reviewer's opinion,

tobacco mosaic virus also. Furthermore, there are about forty virus diseases which spread by unknown means, though no doubt insect vectors for some of these will eventually be found. Probably also the entomologist will not accept the classification of the Homoptera and the Hemiptera into two separate orders (p. 284).

The book is extremely well produced, and the illustrations are excellent. There are carefully selected references at the end of each chapter, and at the end of the book is an appendix giving many salient facts in tabular form. The price is rather high for the average student.

KENNETH M. SMITH.

ULTRA-LIGHT ALLOYS

The Technology of Magnesium and its Alloys
A translation from the German by the Technical Staffs of F. A. Hughes and Co. Ltd., and Magnesium Elektron, Ltd., of "Magnesium und seine Legierungen", compiled by Dr. Adolf Beck. Pp. xxiv+512. (Swinton, near Manchester: F. A. Hughes and Co. Ltd., 1940.) 30*s*. net.

THE great majority of the technically useful metals crystallize in the cubic system. There are, however, two important ones which have a hexagonal lattice, zinc and magnesium. Though neither of these has a history going back into the distant past, that of magnesium is much the shorter, the metal having been first isolated in 1808. This was about fifteen years before aluminium was isolated, but for various reasons the development of the latter was more rapid; and while aluminium had definitely established its place as an important industrial metal by about 1890, magnesium was only becoming a serious competitor in the neighbourhood of 1910.

The War of 1914–18 saw a great development in the uses of light metals, and the majority of the aluminium alloys at present in use were evolved during that period. Whether new magnesium alloys will be similarly developed during the present conflict remains to be seen; but there can be no doubt that an enormous increase in production must have taken place both in Great Britain and in Germany. This will be obvious to anyone who has been in the neighbourhood of a shower of incendiary bombs.

Many books have been written on aluminium, but apart from a small monograph published in 1937 by H.M. Stationery Office, the volume under review is the first which deals solely with magnesium and its alloys—the 'ultra-light alloys' as the French call them to distinguish them from the 'light alloys' of aluminium. The very marked effect of the anisotropic character imparted to the metal by its hexagonal lattice, and the great influence which this lattice has on the properties of the material, both in mono- and polycrystalline forms, is very well brought out in the early chapters of the book. Indeed these chapters, dealing with the crystallography, metallography and physical properties of magnesium and its alloys, are probably the best. The one dealing with mechanical properties is very full of specific information, but is, nevertheless, scrappy, as it deals almost entirely with the alloys developed by the German firm with which the authors of the original book were connected—alloys which are, admittedly, the chief ones in use. The translators have had to re-write the first chapter on "Raw Materials" as in the original it presented a view of the situation which was completely biased in favour of Germany, and they have also added many valuable footnotes which help to correct the impression, undoubtedly given by the German edition, that no work has been done on magnesium alloys outside the Reich. The remaining chapters contain much that is of great value to the user of the alloys, whether he is engaged in forming the material into the desired shapes by casting, extruding, machining, etc., or in using the formed shapes in engineering construction.

It is almost certain that a new edition of this most valuable book will be called for some time, if only because of the progress in the subject that will undoubtedly be made during the War. When this is being written the following suggestions may possibly be of assistance. On p. 39 occurs the sentence "some alloys may be etched-down instead of polished". Apart from the ugly construction, the term "etched-down" is not a recognized one, and if it must be used it should be explained. On p. 61 the name Grime is spelled Grimme. On the same page reference is made to the work of Pusîn and Micîc. The authors, in the original paper, called themselves Pušin and Micić. The obvious misprints on pp. 119 and 144 would doubtless be corrected in the new edition. The definition of 'creep' on p. 198 appears very arbitrary and the omission of any reference to general corrosion on p. 273 should be rectified. Table 56 (p. 285) is not at all clear. Probably "pure Mg" should refer to test-piece No. 1 only. A more general point is the conversion of metric units into British ones. Is it necessary, or even advisable to do so, particularly in cases where material has been made to a definite

simple size expressed in centimetres or tested under a load expressed in simple integers when metric units are used? For example, on p. 159 reference is made to alloys which were submitted to five different stresses of 0, 3·2, 6·3, 9·5 and 12·7 tons per square inch. One naturally wonders why these strange loads were chosen, until one realizes that the stresses actually applied were almost certainly 0, 5, 10, 15 and 20 kgm. per sq. mm. Finally, but this time a really big request, could not Chapter v ("Mechanical Properties") be re-written on quite a different basis?

Reference has been made above to a new edition. Until this appears this handsome and useful volume is sure to be in constant use by the large number of people who are now so closely connected with ultra-light alloys.

JOHN L. HAUGHTON.

SPECTROSCOPIC METHODS OF ANALYSIS

The Spectrochemical Analysis of Metals and Alloys

By F. Twyman. Pp. viii+355. (London: Charles Griffin and Co., Ltd., 1941.) 21*s*. net.

MORE than a century has elapsed since Fox Talbot laid the foundations of chemical analysis with the spectroscope by his observation that lithia and strontia could be distinguished by optical analysis of their flame spectra. This original idea has proved so fertile that there are now few elements traces of which cannot be identified by their spectra. It is appropriate that Talbot, a notable pioneer in photography, should have initiated a technique which owes so much to the photographic plate. Indeed the development of spectroscopy and its widespread use in present-day industry would not have been possible without the photographic recording medium. Perhaps it is almost equally true that this expansion would not have occurred without the modern spectrograph with its twin virtues of optical excellence and simplicity of operation. Mr. Twyman's contributions to the design and production of such instruments are outstanding and none will question his authority to write a book on spectrochemical methods, more especially as he has maintained close contact with spectroscopists and their technique for more than forty years.

'Spectrochemical analysis' is a compound term which the author adopts in preference to alternatives, such as the ambiguous 'spectrum analysis'. It includes any method of determining the elemental constituents of a substance from its spectrum. The book begins with an excellent historical survey and an elementary account of atomic spectrum theory. Subsequent chapters on instruments and accessories include a very thorough treatment of the microphotometer, an instrument which is of considerable importance for the measurement of line densities on the spectrogram. The major part of the book deals with the quantitative determination of impurities and alloying constituents in metallic samples, but there is a single chapter devoted to analytical techniques for miscellaneous materials including solutions and gases.

It is shown that quantitative analyses can be made swiftly and to sufficient accuracy for a high proportion of metallurgical requirements such as the sorting of scrap, control of alloy compositions, and the checking of purity. The author claims that a minor constituent can be determined to an accuracy of between 2 and 7 per cent, provided certain conditions are fulfilled. Extensive accounts are given of the various techniques in use for the analysis of aluminium and ferrous alloys. Methods are also described for brasses and bronzes, precious metals, lead, magnesium and zinc alloys, and indeed for most of the common metals and alloy groups. The relative scope and merits of alternative methods are carefully assessed, and often their respective advantages have been combined in a standard technique used in the author's laboratory. Practical aspects such as mode of exciting the spectrum, electrode shape and pre-sparking time are treated fully, and in many instances suitable spectral lines for intensity measurement are listed. One slight inconsistency has been noted. Reference is made to the detection of as little as 0·001 per cent of tellurium in a copper globule arc; this conforms to the reviewer's own experience. Yet twice in the earlier chapters it is indicated that tellurium is not excited in the arc.

References and quotations are abundant throughout the book. The majority of the quotations are usefully included, but a few of them are perhaps too lengthy and are not accompanied by sufficient critical comment for the reader's guidance. The illustrations are adequate, except for a complete absence of photographs of modern apparatus, possibly in view of the author's expressed intention of avoiding reference to the firm with which he is associated. The book is suitably indexed and a bibliography is included, which increases its value

as a work of reference. Units and definitions are also given in an appendix, and it is gratifying to see the logical notation for millimicrons, mμ, used instead of the incorrect μμ.

All those engaged on spectrochemical analysis and especially metallurgists will be stimulated by reading Mr. Twyman's up-to-date account of other workers' methods, and they could usefully retain the book for permanent reference. There must also be many responsible for industrial processes who would discover in the method valuable applications to their own problems. The reviewer has not observed any important typographical errors and the quality of binding is well up to the peace time standard associated with the publishers.

L. A. THOMAS.

EPIDEMIOLOGY FOR THE MILLION

Plague on Us

By Geddes Smith. Pp. viii+365+10 plates. (New York: The Commonwealth Fund; London: Oxford University Press, 1941.) 16*s*. net.

THERE are few subjects which tempt 'experts' to write popular books so much as epidemiology; but it would be hard to name a single volume in English which has secured and maintained popularity. At first sight this seems odd; all men are interested in health and disease, the dramatic value of great epidemics is intense and the detective side of epidemiological investigation should appeal to the large reading public which reveres Dr. Thorndyke, Mr. Reginald Fortune and Lord Peter Wimsey. There are many reasons for the lack of success. The possession of a medical qualification, even clinical eminence, does not ensure expert knowledge of epidemiology, while professional *esprit de corps* and an urge to improve the occasion lead to a propagandist treatment. On the other hand, real 'experts' like Creighton (who also had the gift of literary style), *will* hunt hares of their own raising, and the rule Creighton adopted, namely, that whatever was believed by the majority of his medical contemporaries must be wrong, is quite as misleading as simple faith in the infallibility of 'doctors'. Finally, the subject-matter is so vast that an attempt to cover the whole field is threatened on one side by dullness and on the other by sciolism.

Now, when many thousands of men and women are doomed to die of epidemic diseases directly or indirectly due to war, a new appeal to the interest of the many in disease is timely. Dr. Geddes Smith devotes his first chapter to brief but dramatic accounts of great epidemics, or incidents in great epidemics, of the past. To the English reader it is both instructive and interesting that here and in other parts of the book examples are so far as possible drawn from American experience. We tend to be too insular in our epidemiological teaching, and to forget that American epidemiological records cover a much wider field than our own. There follows an excellent account of epidemiological doctrines from the time of Hippocrates to our own days. The next chapter is mainly concerned with the individual biology of infection, the reactions of host and parasite, but the herd aspects as elucidated by Topley, Webster and their respective colleagues are carefully explained, and, in the following chapter, the herd aspects are fully discussed. The next chapter, on defences, necessarily follows beaten tracks, but is refreshingly free from professional dogmatism and overstatement. The following chapter, "Detective Work", tempts me to break the Tenth Commandment; the "Case of the Methodist Ladies" or the "Case of the Sleepy Lobsters" read to schoolboys might do much to awake interest in hygiene. The last chapter, "Unfinished Business", is concerned with the unsolved problems of epidemiology—certainly not less important than those solved. As the author remarks in an epilogue, "The diseases stopped in their tracks by the use of vaccines or antisera are few, and those still unpreventable by such means are many."

In any book covering so wide a field, any specialist will find statements with which he does not agree. The natural predilection of a cobbler for leather inclines me to regret that rather more emphasis has not been put on the importance of the pioneer work of Graunt, Petty and Halley in deflecting interest from speculative opinion to measurable fact. The work of Louis, mentioned in the footnote on p. 55, was directed to show the value of statistical methods in *clinical* research, and, unfortunately, had little effect in Europe. I should have welcomed a critical survey of American developments in this field, particularly as Raymond Pearl and his pupils did much to arouse interest in the analysis of hospital data. But these are matters of secondary importance, and perhaps of little interest to the million. Taken as a whole, this seems to me the best book I have read on the subject, and should do much to raise the level of epidemiological discussion, not only in general, but also in professional circles.

MAJOR GREENWOOD.

An Introduction to the Practice of Organic Chemistry in the Laboratory

By Prof. Homer Adkins, Prof. S. M. McElwain and Prof. M. W. Klein. (International Chemical Series.) Third Edition. Pp. ix+294. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 17*s.* 6*d.*

IN this introduction to the study of organic chemistry, an attempt is made to interest the student in the general principles underlying the experimental work involved in the preparation of fifty carefully chosen compounds by devoting the greater part of the work to the discussion of such general reactions as oxidations and reductions, esterifications and hydrolysis, halogenation, nitration and sulphonation, diazotization, intra-molecular rearrangements and special reactions including some modern work, and inserting cross-references to the relevant paragraphs to these discussions in the directions for procedure. Relatively little attention is given to qualitative and quantitative analysis, but a few physico-chemical topics such as those involved in the distillation of azeotropic and other mixtures and in extractions with solvents are discussed.

Rules are given for the proper use of note-books, and, since equations and formulæ are deliberately omitted from the experimental directions, the student is expected to make a careful study of each experiment by reference to text-books and to the discussions before beginning the work. At a later stage he is expected to undertake problems involving the use of the library, and a very welcome feature of the book is a chapter devoted to the use of the literature. Some experiments suitable for senior students are included, with references to original memoirs and to standard works of reference. One or two misprints have been noticed and also several mistakes in structural formulæ, but apart from these minor defects the book is likely to stimulate the interest of the novice in organic chemistry.

The Scientific Photographer

By Dr. A. S. C. Lawrence. Pp. x+180+5 plates. (Cambridge: At the University Press, 1941.) 18*s.* net.

IN the preface the author puts in a plea for the more frequent use of photography in the laboratory for the making of permanent records of apparatus and experiments, and for the more extensive use of the lantern slide and cine film for teaching and demonstration purposes. This book is written primarily for the scientific worker who wishes to make use of photography either to augment his own research records or to illustrate his published work; but it is also directed to the serious amateur photographer who, however skilled he may have become by experience, can only benefit by a knowledge of the fundamental principles of photography.

The physicist may find some sections elementary, and in one or two places statements may be found that will scarcely satisfy him. For example, one finds it recorded that the brightness range obtainable in a transparency is greater than that in a print because "the amount of light passing through the high-lights [of the transparency] may be increased at will by increasing the power of the light source".

The book is easy to read and well illustrated, and a great deal has been condensed into its pages. In attempting to cover such a wide field some subjects have inevitably received brief treatment, but the book provides a good groundwork for the thoughtful reader and should give the scientific worker all the information he requires to carry out any normal photographic operations.

Differential and Integral Calculus

By Prof. Ross R. Middlemiss. Pp. x+416. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 17*s.* 6*d.*

THE author of this useful volume touches a vital spot when he says that "while in a first course many students acquire some facility in manipulating calculus symbols, very few obtain a real understanding of the fundamental ideas of the subject". The text has therefore been prepared in order to present the principles and processes of the calculus with special clarity and simplicity without sacrificing accuracy, and there is no doubt that the author has carried out his aim with skill and thoroughness.

Of the twenty-eight chapters, the first thirteen are devoted to functions and their graphs, limits and derivatives. Integration, as the inverse problem of differentiation, then follows and covers the standard forms with many well-chosen practical illustrative examples. The succeeding chapters deal with Duhamel's principle, mean value theorems, centroids, moments of inertia, centres of pressure, partial derivatives, multiple integrals, series, expansion and elementary differential equations. At the end of the text, a handy table of integrals is provided, for reference, together with tables of logarithms, common and Napierian, trigonometric functions, powers, roots, exponential and hyperbolic functions. Large numbers of exercises, with answers, are supplied, which are both interesting and instructive. The text is excellently printed and well illustrated by clear diagrams and isometric drawings. No student who conscientiously works through the course should have any difficulty in reaching a full understanding of the basic principles of the calculus.

Les Chaleurs spécifiques

Par Prof. Edmond Brun. (Collection Armand Colin: Section de physique, No. 224.) Pp. 224. (Paris: Armand Colin, 1940.) 15 francs.

SOME of the books of this series on physical subjects have justly attained an importance out of all proportion to their size. The present volume definitely belongs to this category, for it gives a most admirable survey of the whole field, experimental and theoretical, of specific heat measurements. It is very clearly written, and, as an example, one may mention that a chapter of some twenty-five pages on specific heat anomalies in solids is remarkable for a concise non-mathematical account of order–disorder transformations in metals and alloys. Most students will find it an excellent guide to the study of specific heats.

L. F. B.

FOOD PRODUCTION BY FISH AND OYSTER FARMING

By Dr. F. Gross,
Department of Zoology, University of Edinburgh

History

FISH culture experiments with marine fishes have been made in the past along two lines: (1) Eggs of cod, plaice, turbot and sole have been hatched in hatcheries and the larvæ, prior to the complete absorption of yolk, returned to the sea. In a series of such experiments undertaken by Dannevig for the Scottish Fishery Board, the larvæ were transported to Loch Fyne and released there. (2) Young plaice have been transferred from crowded inshore grounds to richer feeding grounds which were hitherto sparsely populated by plaice.

Hatching operations were undertaken on a large scale in the United States, Norway, Scotland and the Isle of Man, and many millions of larvæ were liberated each year. The results have been much disputed and the statistical data are rather scarce. Fulton[1], discussing the Loch Fyne experiments, came to the conclusion that the liberation of 142,880,000 fry of plaice led to a substantial increase of the plaice population. During the period 1896–1901 when the fry were transferred to Loch Fyne, the average number of young plaice taken with a push net at various points of the Loch was 87·7 per hour, whereas in the second period (1903–1908) when no plaice fry were added, the average number taken per hour was 39·7, or less than half.

The transplantation of young plaice from Danish and Dutch coasts to the Dogger Bank[2,3] in the years 1904–1908 was followed by a remarkable growth of the fishes. The average initial size of the fish transplanted was about 8·75 in.; the average length of the plaice recaptured one year after liberation was 14 in., an increase of 5·25 in. Had they remained on the inshore grounds from which they were taken the annual growth would have been only 2 in. The average growth in weight of the transplanted fish was even more striking, amounting to 382 per cent of the original weight. Similar fish on the inshore grounds only increased their weight by 100 per cent in a year. It is important that, though the growth of the transplanted fish took place most rapidly in the summer months, a certain amount of growth did take place even in winter, when growth on the inshore grounds practically ceases.

Since 1908 the Danes have been transplanting 1–3 millions of plaice annually to the Inner Limfjord. The growth of the transplanted fishes, measuring 16·3–19·1 cm. in length, was very rapid. During one growth period, from April until November, it amounted to 8–13 cm., so that in the autumn most of the transplanted fish weighed about 375 gm. as against an average weight of about 57 gm. on liberation. These figures are taken from Blegvad's report[4] which also summarizes the results of the large Danish experimental transplantation of North Sea plaice to the Belt Sea in 1928–1933. The transplanted fishes showed an increase of 10–12 cm. in length, and 120–490 gm. in weight during the first growth period, which is nearly twice the growth of the local Belt Sea fish. A calculation relating to the transplanted fish of the year 1931 gives the total value of the fish recaptured as amounting to 120,000 Kr., while the actual cost of the transplantation is put at about 40,000 Kr.

Marine Food Resources in War-time

In view of the present difficult food position it would seem desirable to inquire into the possibilities of utilizing to a greater extent the food resources of the sea. For obvious reasons the activity of fishermen is greatly restricted in war-time, the supply of fish is relatively small and the price of this valuable food high. Could we look to an extended practice of fish culture for an increase of the supply of fish? There is no doubt that in areas of water under proper control the culture of freshwater fishes has proved highly profitable. In 1915 Allen[5] compared the yield of organic substance derived from a given area of fresh water, sea water and land, and his figures may be quoted here:

Continental carp pond:	95	lb.	of	fish	per	acre	per	year
Enclosed harbour:	89	,,	,,	,,	,,	,,	,,	,,
Cultivated land:	73	,,	,,	beef	,,	,,	,,	,,
Fish from the North Sea:	15	,,	,,	fish	,,	,,	,,	,,

Allen then remarked: "The extension of fish culture to marine fishes, which are much more delicate and difficult to rear than those which live in fresh water, is by no means an easy matter, and much further knowledge will be necessary before successful results can be obtained."

Since the time when the various hatcheries began their operations, our knowledge of the sea and of life in the sea, of the life-histories of marine organisms and the conditions governing their growth has been greatly increased, and a new attempt at the culture of marine fishes would be justified. To succeed in such an attempt marine biologists will have to take counsel of the fresh-water farmer. The large crop taken from a carp pond was the outcome of the application of two sound and simple agricultural principles: (*a*) an area of land can support a larger population of plants if the soil is properly manured; and (*b*) if a herd of animals is to be maintained on a piece of land that does not fully provide all the food required by the animals, the diet must be supplemented by some extra feeding-stuff. True to these principles the carp ponds receive a copious supply of stable manure drained direct into the pond, and fish meal is added to supplement the food provided by the intensive growth of the vegetation and the fauna of the pond as a result of the manuring.

The marine hatcheries which have returned to the sea millions of fish fry in a most helpless and delicate stage have, in a way, attempted to get something for nothing. They expected a richer harvest merely by increasing the number of seeds sown. It is true that the protection afforded during their embryonic development and part of their larval life may result in the survival of a number of larvæ liberated. But this number cannot be substantial; there is no food for a surplus population of larvæ belonging to an indigenous species. As it takes roughly six million eggs to give two turbot a chance of reaching maturity, it is probable that the release into the sea of the larvæ will also result in the destruction of the vast majority owing to the severe competition under natural conditions.

The liberation of large numbers of larvæ in Loch Fyne was a hazard. As it turned out, the experiment was successful to a degree, leading to a certain increase of the plaice population. It was a hazardous undertaking as, so far as I know, no survey of the plankton and the bottom fauna on which the plaice depend for food had been made prior to the 'planting' of the larvæ. Loch Fyne had a plaice population of its own which naturally did its best to grow in numbers. As no steps had been taken to increase the food supply for the greatly increased larval population, only a mere fraction of the 142,000,000 fry was given a chance to survive.

It is common knowledge that animal life in the sea depends to a large extent on the phytoplankton for its supply of organic food, and it seems obvious that the bulk of animals maintained is roughly proportional to the bulk of the vegetation on which they directly or indirectly graze. It is significant that Allen, in the address referred to, said that his work on the artificial culture of plankton diatoms was commenced "largely with a view to obtaining information about some of the fundamental problems upon which any scientific practice of fish culture would need to be based". Further work has brought a fuller understanding of the different factors favouring and limiting the growth of phytoplankton in the sea.

Cultures of quite a number of species of plankton diatoms and autotrophic flagellates can be maintained in the laboratory throughout the year [6,7], each subculture reaching a density of population many times greater than in the sea. During the spring outburst the number of diatom cells may reach a maximum of about 50,000 per litre in the sea[8]. In Loch Striven as many as 25,000,000 cells per litre are present for a short period during the spring increase[9]. In a culture, 500,000,000 cells per litre may be reared at all seasons, provided the culture medium is properly enriched with nutrients required for their growth, namely nitrate, phosphate and soil extract, containing substances the action of which, though not yet fully understood, is highly beneficial for the growth of marine organisms.

Attempts to culture plankton organisms on a larger scale in the 'plankton shaft' of the Oceanographic Institute in Göteborg gave encouraging results[10,11]. In spite of the detrimental effect of convection currents, by which large numbers of diatoms were carried to the cooling pipes and immobilized there, the phytoplankton reached a population density larger than in the sea during the spring increase, namely, 660,000 diatom cells and many more autotrophic nannoplankton flagellates per litre. In a separate experiment, the density of the zooplankton population, consisting chiefly of copepods, that could be supported in the plankton shaft for more than three weeks was at least of the same order of magnitude as that occurring in the sea. Had it not been for some technical faults of the shaft it would probably have been considerably larger, particularly if diatoms as well as flagellates had been provided as food for the copepods.

We may now make certain proposals regarding the methods for the future culturing of marine fishes and oysters. It is essential that areas of water be chosen which can be to some extent controlled, that is, manured and stocked, if necessary, with organisms forming the food chain on which the fishes depend. Only artificial ponds, harbours and lochs connected with the sea by a mouth sufficiently narrow to prevent a rapid mixing of the water with the sea outside could be used for the purposes outlined below, and only

those fishes which show little tendency towards migration before maturity, for example, dab, plaice, turbot, sole and flounder, could be thus 'farmed'.

(1) Fattening of Small Flat Fishes

It would be relatively easy to collect large numbers of flat fishes below marketable size, say 5 in., and transplant them into the chosen area which, analogous to the carp pond, would provide the conditions for rapid growth. The water would be manured with nitrate and phosphate, which, as we know, represent two of those 'limiting factors' that control the seasonal waxing and waning of the phytoplankton population. Other substances which are present in the sea in small exhaustible quantities and are required by the micro-vegetation would be provided by slow-acting fish meal manure and farmyard manure, if available, and by soil drained into the water. Thus the conditions would be created for a rich and prolonged production of phytoplankton. We cannot predict what kinds of organisms would respond best to the conditions provided; but there are probably few, if any, kinds that would not be utilized either as larval food or as food of the bottom fauna.

The great bulk of planktonic forms, and also the sedentary polychætes and lamellibranchs which form the chief items of the diet of flat fishes, are particle feeders, and are not very particular as to the kind of autotrophic organisms they filter into their digestive system. *Calanus finmarchicus*, for example, can utilize quite a range of organisms, from the most minute flagellates (2μ in length) to relatively large diatoms such as *Ditylum Brightwelli* reaching a size of 80μ by 100μ [12]. On the other hand, detritus should be a good source of food supply for the bottom fauna from whatever kind of phytoplankton it may have originated.

We may assume that under such conditions the local population of bivalves and polychætes would thrive and increase. If necessary, the stock could be augmented by the transplantation of large numbers of molluscs and polychætes from the sea-shore, and thus an ample food supply provided for a large fish population all the year round. The conditions for the growth of the fishes would then be at least as favourable as on the Dogger Bank or in the Limfjord, and the rate of their growth at least as high. That would mean that transplanted fishes of 120 gm. should reach marketable size—1 lb. in weight—in one year or even less. An annual increase in weight of 400 per cent may well be expected in view of Ben Dawes's investigations on the growth and maintenance of plaice[13] in which increases in weight of fishes ranging from 340 to 580 per cent and more were obtained during a period of 175 days.

(2) Rearing of Flat Fishes

It was realized by Dannevig[14] that the advantage of fish culture would be much greater if the protection given to the eggs by the hatcheries during the embryonic development could be extended through the period of post-larval development until the time the flat fish lives on the bottom. The hatcheries did not rear the larvæ beyond the stage of yolk absorption because of the 'critical period', that is, one of very high death-rate, following that stage.

However, Dannevig was able to rear a small number of plaice without very much trouble, and a few specimens reached an average size of 3·25 in. in about nine months. Preliminary experiments with eggs of plaice, undertaken recently by me in collaboration with Mr. J. Raymont, show that after the absorption of the yolk the larvæ fed very actively on diatoms for about a week, and the death-rate during this period is negligible. In these experiments the stage after the complete absorption of the yolk was 'critical' and this only because the next link in the food chain, namely, crustacean or mollusc larvæ, could not then be provided. Rollefsen[15] reports in a preliminary communication that artificially hatched plaice and flounder fry could be successfully reared up to the bottom stage on a large scale by feeding with nauplii of Artemia. In our experiments the plaice larvæ did not take to feeding on Artemia nauplii, possibly because of their relatively large size* and attempts will be made in future experiments to bridge over the gap with small harpacticoids and cyclopoids which, like Artemia, are being cultured on a large scale in this Department.

Dannevig was probably justified in arguing that as rearing on a small scale is possible, it would be easier to rear larval fish in a large enclosure. "The success of such an experiment would mean that such valuable fishes as the sole and turbot could be protected in captivity throughout the time of the early development while the enormous destruction takes place in the sea."

However, even when planted out or kept on in enclosures after metamorphosis, great destruction would take place among the flat fishes, chiefly by cannibalism, and the growth of the fish would be very slow, unless the natural food supply of the area was increased. Growth depends on the

* The stock used for our cultures originated from an Italian polyploid parthenogenetic race[16].

density of the stock; great density entails less food per fish and therefore slower growth. If, however, the rearing of the larvæ were done in enclosures farmed in the proper manner, one might expect survival and rapid growth of a large proportion of small fishes, which after two years' intensive feeding might reach marketable size.

(3) Oyster Culture

Recent experiments by Cole[17] in Conway and by Bruce, Knight and Parke[18] in Port Erin, show that by employing the culture methods for phytoplankton organisms, developed by me some years ago in Plymouth, and by feeding oyster larvæ with some of my cultures of minute flagellates a large settlement of oyster larvæ can be obtained. The procedure adopted in Conway is to let the larvæ settle on tiles placed in tanks and to transplant them afterwards to cages planted in the Menai Straits where growth takes place at a very satisfactory rate.

It is suggested that this work be extended by transplanting the settled spat to enclosed areas of water with a larger food supply than is available under natural conditions. The method may be further modified by allowing the larvæ to settle on pieces of rope and either to attach the ropes to poles stuck in shallow parts of the enclosure, as has been the practice of some oyster breeders in France and Yugoslavia, or to suspend the ropes on rafts floating at the surface.

These three types of experiments, quite apart from their economic potentialities, should yield results of great scientific interest. They would give us the first indications of the reaction of a large, but relatively isolated marine community to environmental changes brought about purposely by man; they would show how the intricate network of factors responsible for such phenomena as the seasonal sequence of plant and animal associations, their growth and decline, and the competition among the various species, would alter in quality and intensity under the impact of an 'agricultural' improvement of their ecological realm.

As to the localities where such experiments could be undertaken, their choice will depend largely on the scale on which they are to be attempted. I have consulted Mr. Elmhirst, Dr. Marshall and Dr. Orr of the Marine Station in Millport on this point and have discussed the whole scheme with them, receiving much encouragement from them. There are quite a number of lochs in Scotland which might be very suitable for pisciculture. Some lochs would probably require the damming up of their sea entrances, while, on the other hand, others could be farmed without damming.

To test the validity of the methods outlined above a preliminary investigation would seem desirable. For this purpose Loch Sween is perhaps suited best owing to the existence of three or more basins with entrances only 4–10 yards in width, which could be easily dammed up and used for the fattening and rearing of fishes and oysters. Dr. Orr informed me that the sand there, although muddier than in the open Clyde area, is probably quite suitable for young plaice. There are very numerous lug-worm casts, and mussels and cockles are abundant. In the branch of the loch called Linne Mhurich there are numerous shells of large oysters and Dr. Orr was told that there were still some oysters lifted each year in this branch. It therefore would be highly suitable for oyster culture.

Should the preliminary experiment prove successful, fish and oyster farming could be developed on a sufficiently large basis to add considerably to Great Britain's home-grown food supply. However, at present, the problem is to find the means for financing the preliminary experiments. A rough estimate made with the kind help of Prof. J. Ritchie puts the expenditure at about £3,000 for damming, compensation to owners, catching and transportation of young fish, etc. On the other hand at least 120,000 young fish would be transplanted for fattening, weighing approximately $\frac{1}{4}$ lb. each. A catch of 60,000 fish of 1 lb. at 1*s*. per lb. after one year would repay expenditure, of which the biggest items (damming and compensation) would not recur in the following year. Admittedly no such experiments have been made so far, and there is a certain risk that the project might not be altogether profitable as a commercial undertaking. This much can however be said: we have sufficient experience—from transplantations and culture experiments in particular—to plan it with a reasonably good chance of success.

[1] Fulton, T. W., Twenty-sixth Ann. Rep. Fish. Board Scotl. (1909).
[2] Garstang, W., Mar. Biol. Ass. Internat. Rept. I [Cd. 2670] (1905).
[3] Borley, J. O., *ibid.*, Rept. IV [Cd. 6125] (1912).
[4] Blegvad, H., *J. du Conseil*, **8**, 161 (1933).
[5] Allen, E. J., *J. Mar. Biol. Ass.*, **11**, 380 (1917).
[6] Gross, F., *ibid.*, **21**, 753 (1937).
[7] Gross, F., *Phil. Trans. Roy. Soc.*, B, **228**, 1–47 (1937).
[8] Harvey, H. W., Cooper, L. H. N., Lebour, M. V., and Russell, F. S., *J. Mar. Biol. Ass.*, **20**, 407 (1935).
[9] Marshall, S. M., and Orr, A. P., *ibid.*, **16**, 853 (1930).
[10] Pettersson, H., Gross, F., and Koczy, F., NATURE, **144**, 332 (1939).
[11] Pettersson, H., Gross, F., and Koczy, F., Goteborg's Kungl. Vetensk.- och Vitterh. Samh. Handl., **6**, No. 13 (1939).
[12] Raymont, J. E. G., and Gross, F., in preparation.
[13] Ben Dawes, *J. Mar. Biol. Ass.*, **17**, 877 (1931).
[14] Dannevig, H., Fifteenth Ann. Rep. Fish. Board Scotl. 176 (1897).
[15] Rollefsen, G., *Rapp. Proc. Verb. des Réunions*, **109**, 3, 133 (1939).
[16] Gross, F., *Naturwiss.*, **20**, 51 (1932).
[17] Cole, H. A., Min. Agric. Fisheries Inv., Sec. II, **15**, No. 4 (1936).
[18] Bruce, J. R., Knight, M., and Parke, M. W., *J. Mar. Biol. Ass.*, **42**, 337 (1940).

UNIVERSITY COLLEGE OF SWANSEA

(A Constituent College of the University of Wales)

Principal: C. A. EDWARDS, D.Sc., F.R.S.

The twenty-second Session will open on October 1, 1941.

Courses of study are provided for:

(*a*) Degrees of the University of Wales in Arts, in Pure Science and in Applied Science (Metallurgy, Engineering and Metallurgical Engineering);

(*b*) Diplomas of the College in Metallurgy and in Engineering;

(*c*) The training of teachers for elementary and secondary schools;

(*d*) The first medical examination of the University of Wales.

College courses in Pure Science are recognized by a number of medical licensing bodies as constituting a first year of medical study.

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

The College maintains a Hall of Residence for women students.

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.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

UNIVERSITY OF BIRMINGHAM

APPOINTMENT OF LECTURER IN DEPARTMENT OF CHEMISTRY

Applications are invited for the post of lecturer in Chemistry (Grade IIa). Commencing Stipend £500-£600 per annum.

Duties to begin October 1, 1941.

It is desirable that candidates should be specially qualified in, and have had experience in teaching, inorganic Chemistry.

Three copies of application and the names of two Referees must be sent, on or before July 31, to the undersigned, from whom further particulars may be obtained.

C. G. BURTON,
Secretary.

The University,
Edmund Street,
Birmingham, 3.
July, 1941.

BIRKBECK COLLEGE
(UNIVERSITY OF LONDON)

Autumn Term begins on Saturday, September 6

Applications for admission from men and women who desire to read at the week-ends for degrees in the Faculties of Arts and Science or for the Diploma in Geography should be addressed to The Clerk, Birckbeck College, E.C.4.

UNIVERSITY COLLEGE OF NORTH WALES

(A Constituent College of the University of Wales)

SCHOOL OF AGRICULTURE

Applications are invited for the post of TEMPORARY LECTURER IN AGRICULTURAL BOTANY. The duties of the post include in-College teaching and advisory work in the four counties of North Wales. So far as can be seen at present, the appointment will be for the duration of the war. Salary £500 per annum, with travelling expenses and subsistence allowances. Conditions of appointment will be forwarded on request.

Applications will be received up to August 2, and should be addressed, Secretary, School of Agriculture, University College of North Wales, Bangor, Caernarvonshire.

July 8, 1941.

HEAD LABORATORY ASSISTANT (man or woman) FOR CHEMISTRY DEPARTMENT OF THE

LONDON (ROYAL FREE HOSPITAL) SCHOOL of MEDICINE for WOMEN

(now at Exeter)—required from September, 1941

Good experience essential. Salary £4 5s. per week, rising by annual increments of 5s. per week to a maximum of £5, together with a temporary war allowance. Incorporated in the Federated Superannuation System for Universities.

Applications, giving particulars of age, qualifications, experience, etc., should be sent to the undersigned as soon as possible.

NANCIE MOLLER,
Warden and Secretary.

Thomas Hall, Cowley Road, Exeter.
July, 1941.

Required, Pulfrich photometer ("Stupho") new or secondhand, in perfect condition. Offers should be accompanied by full details of instrument and equipment, serial number and price asked. Also required offers of spare parts for above instrument.—Apply Box No. 795, T. G. SCOTT & SON, LTD., Three Gables, London Road, Merstham, Surrey.

Wanted, 1940 Periodicals, single copies, J. Amer. Chem. Soc., Nov. and Dec.; Chem. Abs. Nov. 20; Ind. Eng. Chem. (Ind. Edn.) April and Nov.; Ind. Eng. Chem. (News Edn.) Nov. 10 and 25. Librarian, 48, Tewin Road, Welwyn Garden City, Herts.

Beilsteins Handbuch; Ber. d. deutschen chem. Gesellsch.; Chemisches Centralblatt; American Chem. Soc. Jnl.; Amer. Chemical Abstracts; Kunststoffe; Mellor's Treatise; Complete sets or runs wanted by THE MUSEUM BOOK STORE LTD., 45, Museum Street, London, W.C.1.

Microscopes, second-hand, a large selection of instruments in perfect condition; 3d. stamp for list.—Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

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

ABSORPTION SPECTRA OF HÆMOGLOBIN IN SOLUTION AND IN RED BLOOD CORPUSCLES

By Prof. D. Keilin, F.R.S., and Dr. E. F. Hartree
Molteno Institute, University of Cambridge

IN 1877 and 1879 Hoppe-Seyler[1,2] put forward the theory that the hæmoglobin within the red blood corpuscles is not identical with that which appears in solution after lysis of the corpuscles. He even proposed for the intracorpuscular states of the pigments in arteries and veins the names 'arterin' and 'phlebin', reserving the names oxyhæmoglobin and hæmoglobin for the corresponding pigments in solution. However, the numerous arguments brought forward by him in support of this theory were soon invalidated by other workers, who found an easy explanation of all his observations without postulating the above theory[3]. Hoppe-Seyler's theory was soon abandoned, and considered until recently as of purely historical interest. It was, however, recently revived in a slightly different form with fresh evidence in support of it.

It is well known, since the classical work of Soret, that the absorption spectra of hæmoglobin and all its derivatives down to the porphyrin show, in addition to the absorption bands in the visible region, a strong and sharp band near the violet end of the spectrum between 405 mμ and 430 mμ. This band, which is much stronger than the other bands of these pigments, is known as the Soret band or γ-band. It is absent in all derivatives with an open pyrrol chain such as bile pigments or even compounds like verdohæmochromogen with an open tetrapyrrolic chain maintained in ring form by the central iron atom[4].

It was shown recently by Macallum and Bradley[5] (1930) and Adams, Bradley and Macallum[6] that the γ-band is absent in oxyhæmoglobin of intact corpuscles although it appears at once on hæmolysis. This observation seems to suggest that there must be some physical or chemical difference between hæmoglobin inside and outside red blood corpuscles. The problem was reinvestigated by Adams[7], who made an attempt to determine the nature of intracorpuscular hæmoglobin which could account for the disappearance of the γ-band. The main conclusion of his study is that within the corpuscle hæmoglobin is not free but forms with the 'stromatin' of the corpuscle a compound devoid of band γ. This compound appears to be very labile and rapidly dissociates, even on ordinary lysis, liberating the hæmoglobin which shows the normal band γ. This view is based on experiments *in vitro* which seem to show that hæmoglobin, when mixed with a solution of stromatin, brought to *p*H 9·7 and warmed for about 1hr. at 37° C., gradually loses its absorption band γ. It cannot be disputed that the problem as to the state of hæmoglobin within the corpuscles is of great physiological and biochemical interest. It is therefore a matter for some surprise that this phenomenon of obliteration of the γ-band discovered in 1930 has not stimulated more work in other laboratories. We should like to mention that although a quartz spectrograph as was used by the above workers is the best instrument for the quantitative study of this problem, the main optical phenomena can be observed and studied by means of much simpler spectroscopic apparatus more easily accessible to less specialized laboratories. We shall briefly describe the three spectroscopic methods used by us.

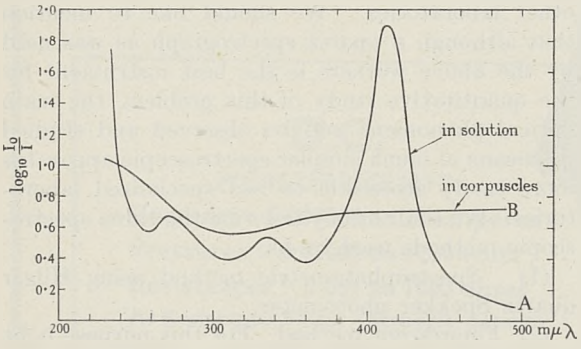
(1) Spectrophotometric method using Hilger quartz Spekker photometer.

(2) Fluorescent method. For this purpose light from 500 c.p. Pointolite lamp is focused on the slit of an ordinary constant deviation spectroscope. The eye-piece of the latter is removed and the emergent spectrum focused by means of lenses on to a glass cell (2 mm. thick) containing a fluorescent solution such as (*a*) 1 per cent solution of 3 : 6-dihydroxyphthalonitrile in 70 per cent alcohol and 0·2 per cent sodium carbonate, or (*b*) 1 per cent solution of 7-aminoquinaldine, in 70 per cent alcohol containing 0·1 per cent sulphuric acid. Using glass throughout, the spectrum extended down to about 360 mμ. The cells containing the absorbing solutions are placed between the spectroscope and the fluorescent cell.

Replacing the Pointolite by a mercury-vapour lamp enabled the apparatus to be calibrated. The drum of the spectroscope was set at 435·8 mμ and a pointer attached to the fluorescent screen to mark the position of the corresponding emission band. The wave-length of the absorption bands could then be determined by bringing them to the position marked by the pointer and reading the drum.

(3) The third method, which is the direct spectroscopic observation of the γ-band, is possible only for CO-hæmoglobin and desoxygenated hæmoglobin, the γ-bands of which are at 420 mμ and 430 mμ respectively. These two bands can easily

be observed with an ordinary microspectroscope ocular attached to a microscope and a strong light passing through a suitable filter such as copper sulphate solution combined with either a solution of ammoniacal copper sulphate or a Wratten filter *D*. This method, owing to its simplicity, was finally adopted for rapid spectroscopic examinations of hæmoglobin in red blood corpuscles and in solution. For this purpose 2 ml. of a dilute suspension of washed blood corpuscle in isotonic saline is placed in a Thunberg tube, and 0·2 ml. of a dilute solution of saponin is put into its hollow stopper. The tube is either evacuated and filled with carbon monoxide or boiled in a vacuum until the oxyhæmoglobin becomes completely desoxygenated. The content of the tube is then examined spectroscopically in a strong beam of



Absorption spectra of oxyhæmoglobin in solution and in corpuscles using Spekker U.V. photometer.

Curve A, 1 part washed blood cells in 2,500 parts water. Water in compensating cell.

Curve B, 1 part washed blood cells laked in 2,500 parts normal saline. Compensating cell contains a suspension of yeast in saline of approximately equal turbidity. The yeast suspension was matched nephelometrically in red light with the corpuscle suspension.

The values of the absorption coefficient are not absolute but are the readings obtained directly from the photographic plate using 20 mm. cells.

light passing through the coloured filters. Neither CO-hæmoglobin nor reduced hæmoglobin show any indication of the band γ before laking. On mixing the contents of the tube and the stopper the corpuscles are laked and the CO- or reduced hæmoglobin passes into solution.

Spectroscopic examination of the solution now reveals a very strong γ-band lying at 420 mμ or 430 mμ respectively. Similar results were obtained in experiments carried out by the first two methods. The second method, although comparatively simple and not requiring expensive instruments, enables the direct observation of the bands to be carried out much farther into the short wave end of the spectrum, which makes possible the study of all derivatives of hæmoglobin. The first method has the advantages of being quantitative and giving a permanent record of the experiment (see accompanying graph).

While reduced, oxygenated and carbon monoxide hæmoglobin are easily obtained within intact corpuscles, their conversion into methæmoglobin requires somewhat more complicated manipulations. The method adopted was as follows: 20 ml. corpuscles in saline are shaken with 20 ml. 1·06 per cent sodium nitrite in a 200 ml. centrifuge tube. After 5 minutes the tube is filled with 0·9 per cent sodium chloride, well mixed and centrifuged. The residue is then washed three times with normal saline. The methæmoglobin in the corpuscles can easily be transformed into the acid form by suspending them in 0·154 *M* KH_2PO_4.

All these experiments confirm and extend the results obtained by previous workers[6], namely that the very strong Soret or γ-band in the absorption spectrum of Hb, O_2Hb, COHb or metHb in solutions is scarcely perceptible or completely invisible in these pigments within the intact corpuscles.

We have also attempted to repeat the experiments to which we have previously referred and which according to Adams seem to prove the formation of a compound between hæmoglobin and stromatin.

For this purpose stromatin was prepared by two methods, that of Jorpes[8] and a somewhat simpler method which we have previously used for the purification of hæmoglobin[9]. According to this latter method 300 ml. of fresh horse blood corpuscles are cooled to 0°C. and laked with 90 ml. of cold distilled water and 90 ml. of cold pure ether. The mixture is shaken for five minutes, mixed with 30 gm. sodium chloride and centrifuged. The centrifuge tube contains two distinct layers, a thick almost solid layer of red stroma on the top and a clear, strong solution of hæmoglobin underneath. The centrifuge tube is slightly tilted, so that the clear hæmoglobin solution can be sucked off. The stroma are mixed with ice-cold water, thoroughly shaken, and centrifuged. This manipulation is repeated several times until most of the hæmoglobin is washed out.

Numerous attempts to combine hæmoglobin with stromatin, carried out under different conditions including those described by Adams, failed, however, to reveal any evidence for the existence of such a compound.

In all our experiments the γ-band of hæmoglobin remained strong and clearly visible, which is not surprising considering that this band belongs to all hæmoglobin derivatives containing a closed tetrapyrrolic ring. In fact it is present in porphyrin, hæmatin, hæmochromogen, parahæmatin, hæmoglobin, O_2Hb, COHb, metHb

and the compounds of the latter with H_2S, H_2O_2, NaN_3, NaF and NO.

In other words, even if the existence of the supposed hæmoglobin-stromatin compound is accepted, it could scarcely be expected that the absorption spectrum of such a compound would be devoid of the γ-band.

The absence of the γ-band in the suspension of intact red blood corpuscles, while it is present in a suspension of oxyhæmoglobin crystals or in an amorphous precipitate of hæmoglobin, excludes any simple optical explanation of this phenomenon.

Attempts were made to imitate a suspension of corpuscles by suspending droplets of concentrated oxyhæmoglobin solution in oil. For this purpose 0·1 c.c. of strong oxyhæmoglobin solution (containing 0·3 mgm. Fe per ml.) is shaken with 50 c.c. medicinal paraffin containing 0·02 per cent sulphonated castor oil. The mixture forms a permanent suspension of very fine droplets of hæmoglobin solution varying from 7μ to 14μ in diameter. Spectroscopic examination of this suspension shows that while the strength of the bands α and β is at least 80 per cent of that of the original solution, the band γ is completely invisible. A suspension in pure castor oil has similar properties. On centrifuging the suspension with a little water, about 75 per cent of unmodified hæmoglobin can be recovered. On the other hand, if oil droplets are dispersed in a dilute solution of hæmoglobin, all absorption bands of the emulsion are of the same intensity as the corresponding bands in the solution of hæmoglobin of similar concentration. That the depression of the band γ of hæmoglobin dispersed in oils is not due to the effect of the dispersion on the protein is shown by the fact that a similar disappearance of the band in the violet can be noted in a solution of acid porphyrin dispersed in castor oil.

All these experiments clearly show that the failure to observe the band γ of hæmoglobin when this pigment is within red blood corpuscles must be due to a purely optical phenomenon brought into play by the properties of surfaces separating hæmoglobin from the surrounding medium. At present we are unable to offer a simple optical explanation of the mechanism of this phenomenon either in the suspension of the red corpuscles or in the emulsions of oxyhæmoglobin in oils.

[1] Hoppe-Seyler, *Physiologische Chemie*, **1**, 381 (1877) (according to Gamgee).
[2] Hoppe-Seyler, *Z. physiol. Chem.*, **13**, 477 (1879).
[3] Gamgee, A., in Schäfer's "Textbook of Physiology", p. 185 (London, 1898).
[4] Holden, H. F., and Lemberg, R., *Austral. J. Exper. Biol. and Med. Sci.*, **17**, 133 (1939).
[5] Macallum, A. B., and Bradley, R. C., *Science*, **71**, 341 (1930).
[6] Adams, G. A., Bradley, R. C., and Macallum, A. B., *Biochem. J.* **28**, 482 (1934).
[7] Adams, G. A., *Biochem. J.*, **32**, 646 (1938).
[8] Jorpes, E., *Biochem. J.*, **26**, 1488 (1932).
[9] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **117**, 1 (1935).

OBITUARIES

Prof. R. Robison, F.R.S.

THE Lister Institute has sustained a severe loss to its active strength by the sudden death on June 18 of the head of its Biochemical Department, Prof. Robert Robison. He was in his fifty-eighth year. On the previous day he was at work as usual in the Institute and was looking forward eagerly to spending a brief respite from duty at his home in Putney and tending his beautiful garden. Thus has been cut short a career of strenuous endeavour and high accomplishment in biochemistry, which is the poorer for his loss.

In 1913 Robison was appointed second research assistant to Arthur Harden in succession to W. J. Young, who had migrated to Australia and is now professor of biochemistry in the University of Melbourne. He came with the strongest credentials to his chemical training and research experience acquired at the University Colleges of Nottingham and Galway and the University of Leipzig. The War of 1914–18, during which he served in Italy and the Middle East as a captain, R.A.M.C., engaged in sanitary duties, broke the progress of his early researches at the Lister Institute; but one piece of work which Harden and he published in 1914 and which bore the title "On a New Phosphoric Ester Obtained with the Aid of Yeast Juice" was destined to presage the field of study to which, in post-war years, Robison was to devote his whole energies and which in one extension or another held his interest to the end.

It was not until 1921 that Robison was able to return to the subject of his life work, for in the immediate post-war years he had helped Harden with his investigation of the antiscorbutic properties of fruit juices and had collaborated with C. J. Martin in a valuable study of the minimum nitrogen expenditure of man and the biological value of proteins for human nutrition, a study which involved for both the strictest regimen of prescribed and uninteresting diets over considerable periods. In 1922 appeared Robison's report of the separation and purification of the hexosemonophosphoric ester, which he and Harden had found among the fermentation products of sugar by yeast juice, and it was followed in 1923 by the first of what was to prove a lengthy series of papers devoted to the carbohydrate-phosphoric esters and their physiological roles. In this first

paper he tells us how the appearance of a calcium phosphate precipitate in the hydrolysis by enzymes of the hexosemonophosphoric ester suggested to him the possibility that some enzyme might be found in the growing bones of animals which could effect the deposition of calcium phosphate and so lead to bone formation. Such an enzyme Robison found in the hypertrophic ossifying cartilage of young rats and rabbits, and so began that series of studies on the significance of the hexosephosphoric esters in ossification and in metabolism generally which, with the help of a succession of collaborators including H. D. Kay, K. M. Soames, M. Martland, Morna Macleod, E. J. King, Honor Fell, A. H. Rosenheim, M. G. Macfarlane and W. T. J. Morgan, he devoted the twenty years of life that remained to him.

In 1930 Robison was elected fellow of the Royal Society, and in 1931 he was invited to deliver the Herter Lectures in New York on the subject of his work. In January 1931 he became head of the Biochemical Department on Harden's retirement, and about the same time the University of London conferred upon him the title of professor of biochemistry. In 1933 the Royal College of Physicians honoured him by the award of the Baly Medal, a tribute he greatly valued.

Than Robison there was never a more conscientious head of a research department. Helpfulness was his keynote and an insistence at all costs on honest and accurate performance. No pains were spared, sometimes unfortunately at the cost of a constitution that was never too robust, to make the sojourn of workers in his department, whether native or foreign, both pleasant and profitable. To offices that outside bodies called upon him to perform —and they were many—he gave ever the most serious attention, and indeed his presence where chemists and biochemists foregather will be greatly missed, for he was a man of wide and cultured outlook and strongly held convictions. He leaves a widow and a married daughter, trained in her father's science, and to them we would offer our sincere sympathy.

J. C. G. LEDINGHAM.

Sir Edward Blunt, K.C.I.E., O.B.E.

SIR EDWARD BLUNT, whose death occurred on May 29, was born in 1877, educated at Marlborough and at Corpus Christi College, Oxford, and entered the Indian Civil Service in 1901. He was superintendent of Census Operations in the United Provinces of Agra and Oudh for the census of 1911. It was in that capacity, when Sir Edward Gait was census commissioner for India, that Blunt undertook the study of caste and the social structure of Hinduism, the results of which appeared in his census report published in 1912. It contains a critical examination of Hinduism as observed by him in the United Provinces, and the subject of caste, though treated there in a separate chapter, is primarily approached from its aspect as an essential element of Hinduism, which "depends a great deal more on whom one marries and what one eats and drinks, than on what one believes". The tenets of Hindu sects are also examined, and it is interesting to observe that the *Arya Samaj* is treated as a different religious unit from Hinduism proper. In 1891 the *Arya Samaj* had demanded separate classification, but the po ition had so far changed by 1911 that to meet various objections Blunt then classified them as *Hindu Arya*, though as an entity independent of *Hindu Brahmanic*. This arrangement had to be altered in subsequent censuses, which included the *Arya Samaj* as a mere subhead of the Hindu total.

Blunt treats caste as the result of a cross-division of guilds on a class system based on colour, on which as involving hypergamy he lays particular stress. The origin and nature of sub-castes he also dealt with, aptly illustrating the position by the Laungbarsa sub-caste of the Dhanuk caste, which in one place is strictly endogamous, in another in the same district strictly exogamous, and in yet a third exogamous as regards one other sub-caste of Dhanuk but endogamous as regards all others. Further, wherever it is exogamous it sometimes only gives girls to, sometimes only takes them from, the same sub-caste of Dhanuk. In investigating civil conditions, Blunt contributed much information on survivals of the levirate in various castes of the United Provinces, as well as comprehensive lists of the terms of relationship and a brief but very useful examination of Hindu exogamy in general.

"The Caste System of Northern India", published in 1931, covers a good deal of the same ground as the Census Report, though there is much added material such as the important chapter on "Caste and Islam". The book, however, is in one respect out of date for a book of 1931 in that it retains Risley's dogma of the civilized Aryan invader and the primitive savage Dravidian. It seems now much more probable, in view of subsequent researches, that the Dravidian-speaking population was more advanced in the apparatus of civilized life than were the Rigvedic invaders, and that the stories of contest between the enlightened invader and the black and noseless Dasyu were derived from the traditional inheritance of pre-Rigvedic inhabitants. Moreover, Stanley Rice's cogent correlation of caste with taboo suggests a much earlier origin for that system than Blunt envisages, though he specifically avoided dogmatizing. Sir Edward Blunt's researches, however, though they may not embody the latest ideas as to the origins of caste, have provided us with one of the best of the very few recent books which describe the facts of caste, and with much valuable material for its understanding; on the score of this he has earned a definite and important position among the distinguished students of that unique phenomenon.

J. H. HUTTON.

We regret to announce the following deaths:

Sir Arthur Evans, F.R.S., honorary keeper of the Ashmolean Museum in the University of Oxford, the leading British authority in the classical archæological studies, on July 11, aged ninety (see also NATURE of July 12, p. 46).

Sir William Willcox, medical adviser to the Home Office since 1919, on July 8.

NEWS AND VIEWS

Soviet Men of Science and the War

FOR the second time in twenty-five years the whole world is plunged into war; and already it has brought death to hundreds of thousands and disaster and unhappiness to millions. Prof. P. Kapitza, in a broadcast from Moscow on July 6, said that he was speaking in particular to British men of science and intellectuals and he reminded them that he had worked for some time in Cambridge under Lord Rutherford where he made numerous friends and carried away many pleasant memories. He wished to discuss the relations of the War to science and culture. The attitude of Fascism to science is that of a woodcutter who uses his axe to disable people instead of to cut wood. It is actuated by nonsensical theories leading to the desire for a dominant race. This is the opposite to the outlook of the Soviet Union, which is working for race equality and for the use of science and cultural achievement for the raising of the standard of living and the advancement of knowledge. In keeping with this the whole population shows the greatest interest in science. People in Great Britain often ask what is the attitude of the Soviet Union towards the man of science in his work. He could say that he and his colleagues are encouraged, as in England, to carry out what work they wish.

The Soviet people show great interest in British science and literature. Works by Shakespeare, Bernard Shaw and Priestley are performed, and Dickens and Stevenson, to name but a few classical British authors, are widely read; and now in the War all Soviet scientific workers are giving every support possible to the struggle of the people to preserve their country and those things which are so dear to them, as well as to liberate the enslaved peoples of Europe. With the British Empire and the United States they have a common enemy, Fascism, and he appealed to British men of science and intellectuals to collaborate with their Soviet colleagues with whom they have so many ideals in common.

New Building for the Soviet Academy of Sciences

BEFORE the outbreak of hostilities, the main building of the new home of the Academy of Sciences of the U.S.S.R. had been started on the Krimsky Embankment of the Moscow River. The building was designed by the Soviet architect, Prof. A. V. Shchusev, who recently stated that this would be one of the largest buildings in the Soviet capital—755 ft. long, 328 ft. wide and 131¼ ft. high. The new building will house the presidium of the Academy, twelve institutes, a library with a depository for four million books, and two exhibition halls. One of the features of the building is a round conference hall, 118 ft. in diameter, with comfortable seating accommodation for a thousand persons. Connected with each of the two exhibition halls will be a semi-circular auditorium seating a hundred and fifty persons and specially fitted for demonstration lectures.

Each of the twelve institutes to be housed in the new building will have a meeting hall, a hall with cinema apparatus, laboratories and reception rooms. If circumstances permit, the major part of the construction work will be completed by 1943, when the presidium and the institutes of the Academy will begin moving into their new quarters. Alongside the main building will be erected a large depository for fifteen million volumes, and two museums—the History of the Earth and the History of Animal Life.

Large Aircraft for the R.A.F.

IT has recently been revealed that twenty Boeing "Flying Fortresses" (B-17.C.type), all of which have been flown across the Atlantic, are now in service with the Royal Air Force. The official R.A.F. title for these will be "Fortress 1". Further supplies of an improved design (B-17.E.) are under construction in the United States. These bombers, the largest at present in service, have a span of 104 ft. and a length of 68 ft. They are equipped with four engines of 1,200 h.p. each, supercharged, can maintain a speed of 305 miles an hour at an altitude of 25,000 ft., and have a ceiling of 36,000 ft. With speeds and heights of this order they can put up a reasonable defence against enemy fighters, and the problem of providing them with fighter escorts is simplified as their performance is comparable to that of their protectors. Particular attention has been paid to protective armament, the wide angle of fire over which the machine guns can traverse giving almost complete cover in any direction.

The load carried by these machines is 5,000 lb. over a range of 2,000 miles. This enables very large individual bombs to be carried, that are considered to be necessary for the destruction of certain types of targets not always susceptible to the effect of a similar total weight of smaller bombs, carried in a number of machines of less capacity. Also there is the tactical advantage of the relatively smaller requirement in trained personnel needed for the one large machine. The Minister of Aircraft Production, Lieut.-Colonel Moore-Brabazon, recently announced in Parliament that although these machines were the biggest in the world at the time they were made, we have now under construction "three types bigger than anything in America".

The Iraq Meteorological Service

THE fourth annual report of the Director of the Meteorological Service of the Government of Iraq, for the year ending March 31, 1940, deals with a period during which a variety of causes operated to increase the difficulties in the way of the orderly

development of this infant service (Government of Iraq: Ministry of Defence: Meteorological Service. Annual Report of the Director, No. 4: Year ending 31st March 1940. Pp. 30. Baghdad: Government Press, 1940). Measures taken in previous years to provide the most efficient service of information about the existing and anticipated weather on the various air routes of civil aviation "blossomed and bore fruit towards the end of the year", to quote the report, an achievement which practically coincided in time with a reduced demand for such information resulting from reduced civil aviation on account of the War. In addition there were the minor disturbances of continuity arising from the transfer of the service from the administrative control of the Officer Commanding the Royal Iraq Air Force to the Director of Civil Aviation and from a change of directorship, although the latter did not occur until the fourth day of the last month of the period covered by the report, when Mr. J. S. Farquharson relieved Mr. J. Durward, the first full-time director.

But the greatest obstacle to progress in national meteorological organization remained, as in previous years, that of getting suitably educated staff of the right calibre willing to take up the openings that become available in the expansion of such a youthful service. A consequence of this was that several of the observatories were maintained single-handed without a day's respite—no mean achievement when the climate of Iraq is taken into consideration. The calling up for military service of some of the trained staff was a contributory cause of this state of affairs. As regards the work of the Service, the report shows that a large part of this consisted in the carrying out, in spite of the obstacles just referred to, of a fixed scheme of distribution of information for the benefit of aviation, and supplying answers to various climatological inquiries. In addition, the first three of a series of non-routine publications described as "Occasional Publications" were completed. Of these the first and third dealt with climatological statistics —principally monthly mean temperature and rainfall—while the second was concerned with administrative regulations.

Expansion of Electrical Industries in Canada

MR. JOHN R. READ, president of the Canadian Westinghouse Co., Ltd., gave an interesting broadcast in Canada on the vital part being played by the Canadian electrical industries in the war effort (Bull. Hydro-Electric Power Commission of Ontario). He stated that the Canadian worker has more electrical energy to call upon than anyone else in the world except the Norwegian. More than 80 per cent of the power used for all purposes in Canada is electric power, and to-day the electrical plants of the Dominion can produce some nine million h.p., more than five times the amount of electric power which was available for the service of Canadian industry during the War of 1914–18.

Enormous supplies of power and power equipment are required in the manufacture of explosives. Because Canada has the power available, a total of 106 million dollars is being expended in creating great chemical and munitions plants in various parts of the country. A large new aluminium plant is now being constructed in Canada, representing an investment of about fifty million dollars, and capable of producing when completed enough aluminium a year for the construction of about fifty thousand military aeroplanes. This will be an installation of 700,000 h.p.

It is much the same story with respect to all those other metals vital in war—gold, copper, nickel, lead and zinc. Almost one tenth of all the electric power used in Canada is employed by the mining industry. Ample power supplies have made it possible for the mines to increase their production to meet war needs. One of the very striking differences between the present War and that of 1914–18 relates to communications. Since 1918, the whole new world of radio has emerged, and radio equipment makes possible the constant co-ordination of military action. Radio is also a vital link in the national life. Already scientific men of the industry have moved far in the fields of television, facsimile transmission, electron optics and extremely high frequencies. More than 60,000 Canadians are engaged in the electrical industry. Their wages and salaries amount to more than one hundred and ten million dollars a year. The electrical industry of Canada well realizes the task which war imposes, the duty which it owes to democracy, to Canada, and to the ideals of its founders.

The Gas Industry in War-time

THE seventy-eighth general meeting of the Institution of Gas Engineers was held in London on June 11 under the presidency of Mr. George Dixon of Nottingham. At the luncheon Mr. Oliver Lyttelton, then president of the Board of Trade, and Sir Peter Bennett, of the Ministry of Aircraft Production, spoke in complimentary terms of the resilience of the industry and its valuable services under present war conditions. The technical business consisted in the discussion of a symposium in "The Gas Industry, 1941 and After"—nine short papers on topics of current interest and importance. These revealed a strong movement for reorganization and administrative concentration of the industry which it is felt consists of an excessive number of producing and distributing units. The number of standards of calorific value is excessive, with consequent undue multiplication in patterns of appliance and their cost. The success of grouping small undertakings and the establishment of 'gas grids' in promoting the freer use of public gas supply was taken as an example to follow. There are obstacles to reorganization in an old industry consisting of numerous and sometimes small local units. If, however, desirable changes are not undertaken spontaneously, it was suggested that they might be enforced by national action to meet urgent and national needs. Coal carbonization industries with their production of liquid fuel may, under post-war economic conditions, acquire a new and greater importance.

Road and Rail Transport in India

AN article by C. N. R. Rau in *Current Science* of March on "The Co-ordination of Road and Rail Transport" reviews recent experience of transport in the Empire both before and during the War, with special reference to India, and endeavours to indicate basic principles of service which should determine both the choice and organization of transport. Discussing the handicaps under which rail transport generally labours, Mr. Rau considers that the plea for a 'square deal' for the railways is well founded. He suggests that investigation is still required to determine how far co-ordination of inland transport can meet the recognized ideals of service, whether in the transport of goods or passengers, or from the point of view of operating efficiency and safety, and indicates that both road and railway transport services might explore the field of public relations much more thoroughly. Emphasizing the importance of co-ordination, once it is clear as to the types of traffic best suited for one form or other of transport, he suggests that legislative or Government control, without nationalization, could with a judicious road policy, so shape the transport system of India that the two methods would work as complementary units, each performing the work best suited to itself and rendering the best service to the community.

The value of agreements between the two systems, of mutual recognition, and the organization of road transport with reference to railway stations, for example, by the use of railway stations as bus termini, the interavailability of tickets, publicity of one service on the other, the application of "undue preference" and "common carrier" clauses to both systems, are among concrete suggestions advanced for the promotion of efficient transport in India, as well as consideration of the establishment of an organization under joint auspices, entrusted with the task of collecting, analysing and collating all relevant information in regard to problems of common interest. Road operating statistics should be published on the same lines as railway statistics, and the State should insist on the organization of road haulage on the lines adopted by the railways, so that the two systems can negotiate on an equal footing and share the benefits of any co-ordination schemes.

Diesel-Electric Tube Locomotive

THE London Passenger Transport Board is utilizing parts of old railway coaches from the "Central Line" of the underground system for building at its Acton works Diesel locomotives for hauling ballast and maintenance trains, or for emergency use in the 'tubes'. These duties are at present performed by tank-type steam locomotives. It is arranged to collect current from the live 600-volt track rail, or be propelled by its self-contained generating set as circumstances may require, and it is capable of hauling a 600-ton train on the level or one of 300 tons up a 1 in 34 gradient. The length of the vehicle is 57 ft., its width 8 ft. 2 in., its height 9 ft. 5 in., and the tare weight in running order is 62 tons 12 cwt. According to the *Electrical Review* of May 16, only the oil engine and generator with some switchgear had to be purchased in fabricating the train. The passenger compartments of two old driving cars were cut off, leaving the equipment compartments with motors and driver's cabs; these were joined together. The locomotive can be controlled from either end. Its engine is of the Petter 'superscavenge' airless injection, two-stroke cycle, cold starting type. The six cylinders develop 506 b.h.p. at 675 r.p.m. The engine is started by means of compressed air at 350 lb. per sq. in. The generator, which was made by the Brush Electrical Engineering Co. Ltd., is a level-compounded shunt machine with a continuous rating of 750 amp. at 450 v. The traction equipment consists of two series-parallel sets with automatic relay controlling notching.

Control of Pig Raising

C. P. MCMEEKAN has furnished what, in view of the present food situation, should prove a valuable analysis of the growth and development of the pig with special reference to carcass quality characters. The five parts (*J. Agri. Sci.*, **30**, 1940; **31**, 1941) with their appendixes have been conveniently issued together. The aim of the work is to provide a base from which to control the raising of pigs as meat-producing animals. It is, therefore, particularly concerned with the effects of nutrition upon not only the growth and size of the pig as a whole but also upon the quality of the meat produced. The author admits that the term 'meat quality' is not possible of exact definition in a form capable of universal application, but some approximation can be made thereto. Of course it will vary with the use to which the meat is to be put and also with the local tastes and requirements. The bulk of the memoir is naturally concerned with the statement of a number of experiments and an analysis of their results, but general ideas are not overlooked and the work concludes with a review of the main principles that emerge and their wider application even to human beings.

British Natural History

DESPITE the increasing difficulties and demands upon the spare-time, amateur as well as professional, natural history continues in Great Britain. The summer *Bulletin of the British Empire Naturalists' Association* records the continuance of branch activities at Bournemouth, Merseyside, Derbyshire, North Cotswold, London, Manchester and Lancaster; in fact only two branches have closed since the outbreak of war. 1941 field records include the first definite nesting of the fulmar on St. Bee's Cliff, Cumberland; Bewick's swans and a green sandpiper on spring passage in Lancashire; a fire-crest at Stanmore, Middlesex, on April 6; siskins at Farnham, Surrey, April 30, and a bird migration survey over twelve counties. The 1940 edition of the Burton-on-Trent Natural History and Archæological Society records has appeared and directs attention to the opportunity for studying the changes the war-time felling of woods will have upon bird, plant and insect life.

The Merseyside Naturalists' Association is shortly publishing its new book on the birds of west Lancashire and west Cheshire; the Blackburn Naturalists' Field Club reported a record attendance, averaging two hundred, at its indoor evening meetings last winter, and the recent summer meeting of the North-East Lancashire Naturalists' Union at Darwen was very well attended. The Thunder Census Organization is carrying on its work and has just issued its fifth annual report from Langley Terrace, Oakes, Huddersfield, and particulars of trees struck by lightning are being collected. The Liverpool Botanical Society is continuing its field work for the publication of its "Flora of South Lancashire" and the North of England Zoological Society, Chester, has made its monthly journal the organ for reporting the activities of other zoological collections since the *Animal and Zoo Magazine* of the London Society suspended publication, and London, Dudley and Maidstone Zoos contribute to the June issue.

Medicine in Saint-Simon's "Mémoires"

IN a recent paper on this subject (*Proc. Roy. Soc. Med.*, **34**, Sect. Hist. Med. 31; 1941) Dr. J. D. Rolleston claims that this work, which covered twenty-one years of the reign of Louis XIV and eight years of the Regency, contained many passages of medical interest, though they had received little attention from medical historians. They could be classified under the headings of prevalent diseases, portraits of contemporary doctors and miscellaneous topics. Small-pox was by far the most frequent of all the diseases mentioned by Saint-Simon, and its prevalence among royal personages and courtiers was a striking proof of the efficacy of Jenner's discovery, as since that time the disease was almost unknown among the upper classes in whom conscientious objectors were rare. Among chronic infections described in the "Mémoires" syphilis undoubtedly held the first place and claimed several courtiers of both sexes among its victims. Many cases of lung disease, probably of a tuberculous nature, are also mentioned. As might be expected owing to their indulgence in highly nitrogenous diet, large consumption of alcohol and lack of exercise, a great number of courtiers as well as Louis XIV suffered from gout. Several examples of nervous and mental diseases as well as alcoholism and cancer are also alluded to by Saint-Simon. Of the thirteen surgical operations mentioned five were for stone in the bladder and four for fistula *in ano*, a complaint which, after the operation on Louis XIV, became as fashionable as appendicitis did more than two centuries later after the operation on Edward VII.

The "Mémoires" also contain brief indications of three diseases—achondroplasia, spondylitis deformans and hæmophilia—long before they were described in scientific medicine. As regards his attitude towards the medical profession, Saint-Simon, like many other distinguished laymen before and since his time, did not appear to have a liking for doctors, as is shown by the frequency with which he declared that they had not understood the nature of the disease which they were treating. On the other hand, he was unsparing in his eulogies of individual doctors, such as Fagon, Louis XIV's physician, Mareschal, his surgeon, and Hyghens, the king of Spain's physician who attended Saint-Simon during his attack of small-pox. The miscellaneous topics of medical interest mentioned in the "Mémoires" include longevity, sexology, spas, poisoning, post mortem examinations and the illnesses of Louis XIV.

History of Endocrinology

IN a recent paper on this subject read before the Section of the History of Medicine of the Royal Society of Medicine (*Proc. Roy. Soc. Med.*, **34**, 303; 1941) Dr. A. P. Cawadias said that three periods could be distinguished in the historical development of endocrinology. The first was the descriptive period, the second was one of analytic endocrinology and the third or contemporary period was that of synthetic endocrinology. The first description of endocrine diseases was given long before there was any accurate knowledge of endocrine physiology, being found in the writings of Hippocrates, who studied hypo-orchidism and climacteric hypo-ovarism. Only after some advance was made in the knowledge of glandular physiology, however, were endocrine diseases introduced into nosography. The earliest of these was hypothyroidism, studied by T. Curling in 1850 and later by C. H. Fagge in 1871 and Sir William Gull in 1873. Hypo-adrenalism was described by Addison in 1855, when endocrine nosography first made a real start. A notable advance in the history of endocrine diseases was made by the introduction of endocrinotherapy. This began with Brown-Séquard in 1889, reached a notable peak with the introduction of thyroid organotherapy by G. R. Murray in 1890, and developed intensively in recent years, outstanding events being the introduction of insulinotherapy by Banting in 1921, of the various sex hormones and of cortin.

The Wyperfeld (Mallee) National Park

THE Mallee National Park in Victoria, known as "Wyperfeld", an account of which appeared in NATURE of August 12, 1939, p. 272, has received a substantial addition of 51,840 acres, owing to the far-sighted action of the acting premier of Victoria, Mr. Lind. This makes a total area of 138,700 acres. The land added, known locally as the "Desert", is useless for purposes of production, but contains the mound builder, known as the 'lowan', and is a feeding-ground for birds. The Park is situated in the most arid part of the State with a capricious rainfall of 9 in. and great evaporation. In spite of this dryness it is well stocked with birds of the cockatoo and parrot family, also lowans and emus. It also contains a number of black-faced kangaroo. There is at present only one well in the area, and exactly where these animals get the necessary water is not known. The trough at the well is used by some of the birds and by bees, but so far the kangaroos have not been seen to use it. A somewhat similar problem of water supply can be seen in the Egyptian Desert bordering on the Mediterranean which, whereas it is lifeless in the day-time, is stocked with jerboas and various reptiles at night.

A Matrix Machine

WITH the growing application of matrix algebra, especially in the factorial analysis of psychological data, there is an increasing demand for a machine that will multiply matrices. Such a machine has now been produced in the United States by the International Business Machines Corporation, assisted by a research grant from the Carnegie Foundation, and is described in *Psychometrika* (5, 289; 1940). It uses an electric circuit in which one set of connexions is made by special marks on record sheets, one for each row in the first matrix, and the other set by plug wires corresponding to a column of the second matrix. The product of a matrix with any number of rows and up to 15 columns by a second matrix consisting of a single column is thus found, the results being read off on a meter. If the second matrix has more than one column, one column at a time is dealt with. The machine is in use in the psychological laboratory of Dr. L. L. Thurstone of Chicago, and the results appear to be accurate to two significant figures.

The International Seismological Summary

THE International Seismological Summary for the second quarter of 1934 has just been received. It contains the determinations of 144 epicentres by the workers at Oxford, from all the available evidence sent by seismological observatories throughout the world. Sixty-two of these epicentres are new and eighty-two are repetitions from old epicentres, again showing the tendency of earthquakes to recur. Fifteen of the earthquakes have deeper focus than normal and one on June 29, 1934, at 8h. 25m. 20s. G.M.T., has a calculated focus 0·106 of the earth's radius below normal, which is at a greater depth than that of any earthquake previously treated in the summary. The epicentre of this shock was at 6·1°S., 123·4°E., which is in the Banda Sea close to and immediately east of the town of Baoebaoe in the island of Celebes in the Dutch East Indies. The area is well known to be frequented by deep focus earthquakes. In view of the accuracy with which the epicentre is known, the numerous data have been used to extend a table of corrections which may be applied to epicentral distances to produce agreement between observed and calculated times of the *P* wave.

Society of Chemical Industry

AT the sixtieth annual meeting of the Society of Chemical Industry, held on July 8, Dr. W. Cullen, the well-known consultant in chemical and metallurgical engineering, was elected president in succession to Prof. J. C. Philip, who has occupied the post for two years. According to the Council's report, membership at the end of 1940 stood at 3,920, a decrease of only 77 on the total for the previous year; since then, however, many hundreds of new members have joined the Society, a reflection no doubt of the expanding chemical industry of Great Britain. The Society's Medal, the oldest of its distinction, has been awarded to Sir Robert Pickard, director of research for the British Cotton Industry Research Association at the Shirley Institute, who delivered an address on "The Influence of Science on National Life". The Society is to be congratulated on successfully overcoming the difficulties created by two enforced evacuations by its offices.

Announcements

PROF. F. A. LINDEMANN, who had been created a baron (see NATURE, June 21, p. 772), has taken the title of Baron Cherwell, of Oxford in the County of Oxford.

LORD HORDER has been appointed by the Minister of Food to be his personal adviser on medical aspects of food problems.

THE first Charles Chree Medal and Prize of the Physical Society will be presented to Prof. S. Chapman, professor of mathematics in the Imperial College of Science and Technology, on July 25. Prof. Chapman will deliver an address on (1) Chree and his work on geomagnetism; (2) geomagnetic time relationships; (3) the future of world magnetic surveying.

PROF. J. B. CONANT, president of Harvard University, was elected an honorary fellow of the Royal Society of Edinburgh at a meeting held on July 7. At the same meeting the Gunning Victoria Jubilee Prize for the period 1936–40 was presented to Sir James Irvine for his distinguished contributions to organic chemistry; and the Makdougall-Brisbane Prize for the period 1938–40 to Mrs. E. L. Ince, on behalf of her husband, the late Dr. Edward Lindsay Ince, for his papers on "The Periodic Lamé Functions", published in the *Proceedings* of the Society.

THE Edinburgh Association for Sending Medical Aid to Foreign Countries this year celebrates the centenary of its foundation.

THE following appointments and promotions in the Colonial Service have recently been made: B. de L. Innis (agricultural superintendent, Gold Coast), assistant botanist, British West Indies, Central Sugar Cane Breeding Station, Barbados; J. T. Purvis (senior assistant livestock officer), agricultural officer, Tanganyika Territory.

To promote the interests of science in the south of the United States, a new Southern Association for the Advancement of Science has been organized. Dr. George D. Palmer of the University of Alabama, who served as president during the organizing period, is now secretary-treasurer. Dr. G. H. Boyd of the University of Georgia is president-elect. In addition to the encouragement of scientific research in general and its application to problems of the South in particular, the declared objectives of the new Association include the setting up of a roster of Southern research talent available not only for specific southern problems but also for possible contributions to national defence.

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.*

Tastes of Oxygen and Nitrogen at High Pressures

WHILST carrying out experiments on behalf of Admiral Sir M. E. Dunbar-Nasmith's Physiological Sub-Committee for saving life from sunken submarines, we and other subjects have had occasion to breathe oxygen, air and other gas mixtures at high pressures.

When oxygen was breathed at 6 atmospheres, several subjects noticed a peculiar taste, which was enhanced at 7 atmospheres. None of them noticed it at 3 atmospheres. The taste is both acid and sweet. Two subjects described it as "like dilute ginger beer", and "like dilute ink with a little sugar". It was felt unevenly, by one subject mainly on the back of the tongue, by another beneath it. In one case it persisted for some minutes after ceasing to breathe oxygen. It may be remarked that although oxygen is a convulsant at such high pressures, it can be breathed with complete safety for long enough to taste it.

In air at 10 atmospheres, and sometimes even at 8 atmospheres, a number of subjects reported a taste which is variously described as harsh, metallic, and indefinable. It is certainly not due to oxygen, and one subject who tasted it regularly in air did not do so when mixtures in which the nitrogen of air had been replaced by helium or hydrogen were breathed at 10 atmospheres. We therefore attribute it to nitrogen.

Not all subjects reported these tastes. This was probably often due to the fact that other sensations were distracting them, and to the narcotic effect of nitrogen at high pressures. However, one subject who was repeatedly on the look-out for both tastes has never tasted nitrogen, and only tasted oxygen very faintly at 7 atmospheres. His sense of taste is, however, poor as a result of cerebral concussion.

We conclude that the taste threshold for oxygen lies below 6 atmospheres and for nitrogen below 8, in about half of the persons tested. So far only one person has reported an abnormal smell, in compressed air, but perhaps oxygen and nitrogen may have smells at still higher pressures.

It is clearly inaccurate to describe a gas as inodorous and tasteless. On the contrary, most or all gases may be expected to display these properties at sufficiently high pressures, just as they liquefy at sufficiently low temperatures. Whether men can survive the pressure under which, say, hydrogen develops a taste or smell is, of course, as yet unknown.

We have to thank the Admiralty and Messrs. Siebe Gorman and Co. for making this research possible.

E. M. CASE.
J. B. S. HALDANE.

187 Westminster Bridge Road,
S.W.1.

Ascorbic Acid and Resistance to Low Oxygen Tension

IN an article published in the *Lancet* of June 28, Stewart, Learmonth and Pollock record experiments which show that the intravenous administration of ascorbic acid prolongs the life of cats after severe hæmorrhage. They suggest that ascorbic acid secures a more adequate supply of oxygen to the tissues.

Experiments which have been carried out in this Institute by Dr. B. G. B. Lucas, in an attempt to make oxygen more available to the tissues of animals subjected to low atmospheric pressures, have yielded similar results. Both methylene blue and ascorbic acid, administered intraperitoneally, have been found to increase the resistance of mice and rats to low oxygen tensions. A mouse, injected with methylene blue or ascorbic acid, may survive a number of consecutive exposures to atmospheric air at a pressure of 120 mm. mercury, while, on each occasion, an untreated companion succumbs.

J. M. PETERSON.

Physiology Institute,
Newport Road,
Cardiff.
July 3.

Pharmacological Classification of Steroid Hormones*

UP to the present, the physiological classification and terminology of steroid hormones was based either on one of their outstanding actions ('œstrogens', 'progestins') or on their source of origin ('corpus luteum hormone', 'adrenal cortical hormone', 'testis hormone'). Such a classification is no longer possible, since we know, for example, that 'testis hormones' may originate in the adrenal cortex and may exert 'œstrogenic' actions. In spite of the considerable overlapping between the physiological actions of the steroid hormones, they can and must be classified into certain groups. It is felt that the best solution of the problem is to *classify the steroid hormone actions according to the degree to which they are able to imitate or substitute for the function of a certain endocrine gland.* Accordingly these groups might be given names reminiscent of the glands and yet indicating that this does not imply that such glands are the only source of the hormone.

Thus progesterone imitates the action of a corpus luteum and œstradiol that of an active follicle even though these hormones may originate from cells other than those of the corpus luteum and the ovarian follicle respectively. The grouping of the steroids into œstrane, androstane and pregnane derivatives is a satisfactory basis for the classification of their

* Abridged.

chemical properties. As a designation for the whole groups of hormones having a structure reminiscent of the sterols, Callow and Young[1] suggested the name of 'steroid' which has generally been accepted. The Greek ending 'oid' derived from εισος meaning form, has often been used in pharmacology to designate compounds similar in their actions to those described by the work preceding this ending (for example, toxoid). Accordingly, the four main types of steroid hormone-like actions might be described as corticoid, luteoid, folliculoid and testoid. Thus without introducing any essentially novel terms, we could classify the steroid hormones into four main pharmacological groups according to the principles mentioned above :

Corticoid = having activity of : cortin, adrenal cortical hormone, principle maintaining life of adrenalectomized animals, etc.

Luteoid = having activity of : progestin, corpus luteum hormone, progesterone, luteine, β-hormone, kythine, luteohormone, corporin, relaxin, mucifying hormone, luteocrinine, etc.

Folliculoid = having activity of : œstrin, œstrogenic hormone, feminine, gynæcogenic hormone, menformon, folliculin, α-hormone, follicular hormone, female hormone, etc.

Testoid = having activity of : androkinin, male hormone, testis hormone, androgenic hormone, etc.

It may incidentally be mentioned that the term 'cortin' has now lost its original meaning as a generic term for adrenal cortical hormone activity since Hartman *et al.*[2] now distinguish between the "vital factor, cortin" and the "sodium factor". This means that desoxycorticosterone acetate is both a 'cortin' and a 'sodium factor', while some of Hartman's cortin preparations are apparently devoid of the latter activity. If this type of subdivision were carried over to the group of the testoids, androsterone would have to be called prevailingly a 'prostate factor' and testosterone a 'seminal vesicle factor'. Subdivision carried to this degree is of no particular value as it eventually leads to the mere statement of single characteristics which can much better be done by the generally accepted practice of merely stating the degree to which the compound has 'metrotropic', 'mammotropic', 'renotropic', pituitary-enlarging, life-maintaining, etc., ability. While the determination of all these activities is evidently of importance, it is felt that for the reasons mentioned above, the single action can be used as a basis for a classification. On the other hand, the classification suggested in this note has none of these deficiencies, and the proposed group names are equally applicable to artificial compounds and true hormones. It is hoped they will prove useful at this time when so much work is done on a multitude of newly synthetized steroid compounds with hormone activity.

Department of Anatomy, HANS SELYE.
McGill University,
Montreal.
June 16.

[1] Callow, R. K., and Young, F. G., *Proc. Roy. Soc.*, A, **157**, 194 (1936).
[2] Hartman, Frank A., Spoor, H. J., and Lewis, L. A., *Science*, **89**, 204 (1939).

Nomenclature of Pituitary Autacoids

THE nomenclature of pituitary autacoids is unsatisfactory, and current terminology with reference to those of the anterior lobe is particularly at fault. The terms thyrotropic and gonadotropic are in general use. These terms are misleading. The Greek word τροπος or τροπη means *a turn, return,* or *turning about* and the verb τρεπω from the same root can be used transitively to signify *direct* or *guide.*

We have long-established precedent for this root in current biological literature. The *phototropic* or *geotropic* behaviour of a plant signifies that it turns towards or away from light or the centre of the earth. The same words have also been used to describe the behaviour of an animal when it moves to or from a source of light or the earth's centre. Students of animal behaviour have very properly recognized that this is inconsistent with scientific usage. Consequently they have substituted *phototaxis* and *geotaxis.*

Dr. A. S. Parkes has suggested the use of the term *gonadotrophic* instead of *gonadotropic*[1]. The meaning of the Greek root of the suffix *trophic* would indicate that the hormone feeds the gonads. This is far from certain and it is possible to choose a more appropriate root which can be applied to all the activities of the pituitary gland. It is certain that there is some physiological connexion or link between the specific activities of the anterior lobe and the thyroid, gonads, etc.

One Greek word which meets our requirements is δεσμος, which means a bond, fetter, or link. This suggests the following terminology for the anterior lobe autacoids :

(1) thyrodesmic (*thyrotropic*)
(2) blastodesmic or *growth-promoting*
(3) oodesmic or *follicle-stimulating* } gonado-
(4) xanthodesmic (*luteinizing*) } desmic
(5) androdesmic or *testicle-stimulating* } gonado-desmic
(6) galactodesmic (*galactogogue*)

One objection to the items of this list is that growth-promoting is sufficiently explicit. For those who prefer native words to international terms, thyroid-stimulating is certainly better than thyrotropic.

Existing terminology of the posterior lobe autacoids is not open to the same objections. The term oxytocic is not inherently inconsistent with established usage of Greek affixes. Still, it is open to the criticism that it contains no familiar root which suggests its meaning. For the English-speaking scientific worker, uterine stimulant is therefore a better term than oxytocic activity. From every point of view Hogben's *melanophore stimulant* is preferable to *chromatropic.* Until it is possible to distinguish between the substances responsible for melanophore stimulation and erythrophore stimulation the adjectives *melanodesmic* and *erythrodesmic* might be appropriately used. *Pressor substance* is sufficiently explicit from the point of view of the English-speaking world and is in accordance with international usage. So also is the term *anti-diuretic.* For those who prefer a uniform nomenclature, I suggest the following :

(1) hæmodesmic (*pressor*)
(2) splanchnodesmic (*oxytocic*)
(3) (*a*) melanodesmic (*b*) erythrodesmic
(4) nephrodesmic
(5) leucodesmic (the at present hypothetical "*W*" substance of Hogben and Slome).

Natural History Department, F. W. LANDGREBE.
University of Aberdeen.
June 23.

[1] NATURE, **141**, 36, 73 (1938).

A Possible New Cure for Acarine Disease of Honeybees

ACARINE disease, sometimes still known as 'Isle of Wight disease', as its name implies is caused by the invasion by the mite *Acarapis woodi* of the thoracic tracheæ of the adult honeybee. Although no longer epidemic, this complaint still causes the complete destruction of many colonies of bees annually and the serious weakening of many others.

To kill the mites inside the tracheæ of an infected bee, some volatile substance which exerts a marked differential toxicity upon the bee and *A. woodi* would appear necessary. Up to the present a small number of substances or mixtures has been found to have properties tending towards the desired objective. These have not, however, been found to be entirely satisfactory. Work has therefore been carried out here during the last two and a half years in an attempt to find a volatile material which kills *A. woodi* in the tracheæ of the honeybee, does not harm the adult bees or their brood, and is simple and cheap to apply. Many substances were tested with varying degrees of success and it has been found that the vapour of terpineol, a heavy faction of crude pine oil, gives the results desired, being highly toxic to *A. woodi* but harmless to bees. In one experiment twenty-five bees which were heavily infected were subjected to the vapour of terpineol for five days and, at the end of this period, all the mites were found to be dead, whereas twenty control bees were all found to contain many live mites.

Experiments are now being conducted to determine a simple and satisfactory method of administering terpineol to a colony of bees.

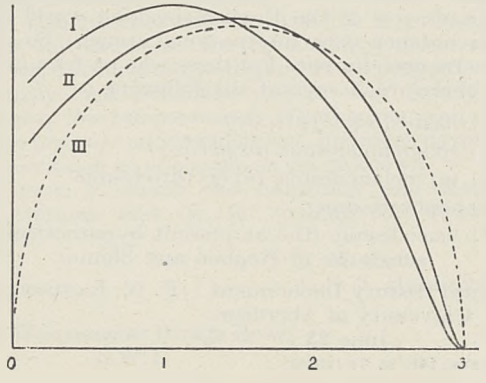
It is hoped that the results obtained with this substance will be published in full in the near future.

C. G. BUTLER.

Bee Department,
Rothamsted Experimental Station,
Harpenden.
June 20.

Production of Electron Pairs

SOME time ago we described a method[1] for calculating rigorously (neglecting screening) the cross-section for production of electron-positron pairs in the field of a nucleus by a beam of γ-rays. This method also gave the energy distribution of the electrons or positrons. Results were given for lead, atomic number $Z = 82$, for γ-rays of energies $h\nu = 5\ mc^2$ and $3\ mc^2$, and were in reasonably good agreement with experiments on pairs produced in thin foils. Calculations have now been made for $Z = 54$, $h\nu = 5\ mc^2$, to enable direct comparison to be made with Wilson chamber experiments on xenon and iodine. The final results contain about 20 per cent of (additive) extrapolated terms and should be accurate to about 10 per cent. The old calculation for lead has been extended and a small error corrected: the revised figures are given below.



The values of σ, the cross-section per atom for absorption by pair production by γ-rays of energy $5\ mc^2$, for atomic numbers 82 and 54 are given in the table, together with the values calculated on the Born approximation[2]. The values of $\bar{E}_+ - \bar{E}_-$ are also given, where $\bar{E}_+$ and $\bar{E}_-$ are the average energies of the positron and electron respectively.

Z	54	82
$\sigma \times 10^{24}$	1·1	3·0
$\sigma \times 10^{24}$ (Born)	1·1	2·5
$(\bar{E}_+ - \bar{E}_-)/mc^2$	0·27	0·51

The energy distribution of the pairs produced by radiation of energy $5\ mc^2$ is shown in the accompanying figure. The abscissæ are electron-energies in units of mc^2 and the scale of the ordinates is arbitrary, the curves being adjusted to have the same area. Curves I, II and III are respectively for $Z = 82$, $Z = 54$ and the Born approximation. Curves I and II theoretically tend to a finite limit for zero energy of the electron, but these values have not been calculated.

J. C. JAEGER.

University of Tasmania,
Hobart.
May 28.

[1] Jaeger and Hulme, *Proc. Roy. Soc.*, A, **153**, 443 (1936). See also NATURE, **137**, 781 (1936).
[2] Bethe and Heitler, *Proc. Roy. Soc.*, A, **146**, 83 (1934).

Thin Glass for Microscope Cover-Slips

MICROSCOPISTS will note with interest and appreciation the recently recorded centenary of the production by Messrs. Chance Brothers of thin glass for microscopic purposes[1].

There is good reason to believe that the production of this glass was due to the insistent and increasing demand by the early members of the Royal Microscopical Society. It is recorded that one of the first things the Council did in 1840 when thin flatted sheets first became available was to consider and standardize the size of the specimen slide at 3 in. × 1 in.—which size has since become universally adopted—and to install a device for the use of members for cutting both slides and cover-glasses from these sheets.

While it would be difficult to produce with certainty the earliest instance of the use of glass in place of talc, there is strong evidence to show that it was used for some ten years before thin flatted sheets became available through the enterprise of Messrs. Chance Brothers.

In 1831 Andrew Ross made the first achromatic objectives on Lister's formula. In 1832 J. T. Cooper suggested the use of Canada balsam as a mounting medium for the preservation of microscopic specimens. Now in both these matters the use of the talc disk would appear to be impracticable; and further, the development and purpose of the correction collar to high-power objectives which Ross brought out in 1837 was to correct the spherical and chromatic

aberrations introduced by the adoption of the cover-glass.

It appears to have been customary in those early days for microscopists to select small fragments of thin glass obtained from large bubbles blown to bursting, and to use the suitable pieces thus obtained for cover-glasses. The helpful warning then given to the members not to use too much pressure in placing the cover-glass over the specimen had an obvious meaning. A few of these early slides are still preserved in the Society's historical collection.

The production in 1840 by Messrs. Chance Brothers of what was then described as thin and very thin flatted sheets was a valued contribution to the study and advancement of scientific microscopy in which Great Britain then led, and continues still to lead, the world. Microscopists everywhere still regard with warm congratulation the long and honourable record of pioneering achievement of this distinguished firm in the production of glass for optical and other scientific purposes.

C. TIERNEY.

Royal Microscopical Society,
B.M.A. House,
Tavistock Square,
London, W.C.1.

NATURE, 147, 803 (1941).

"A School Chemistry"

As the author of "An Introduction to Chemistry", I wish to protest against the review of this book which appeared in NATURE of March 22. The reviewer has devoted so much space to criticisms of controversial or trivial matters that he has failed to emphasize the special features of the book. The general character of several of his remarks can be judged from the following selection, to which I have added some comments.

(1) " . . . phosphorus was discovered by Brand, not Brandt, probably in 1674 not 1669." The implication in the first part of the statement is incorrect; Brand, not Brandt, is given in the text. The reviewer may be correct about the date, but a letter from Brand to Leibniz (G. H. Peters, *Arch. Geschichte Naturw.*, **4**, 206 (1912); **7**, 92 (1916)) indicates the date 1669, and this appears to have been accepted by Mellor, "Thorpe's Dictionary" and the "Encyclopædia Britannica".

(2) "The statement that argon was first called 'aeron' (p. 118) is new to the reviewer, but may be correct." The suggestion in this statement is ungenerous. The author's remark about aeron is substantiated by a letter Rayleigh wrote to Lady Frances Balfour in 1894 (actual quotation, pp. 212–13, "Crucibles", by B. Jaffe).

(3) "The style is generally good, but it is surprising to find on p. 482 the direction to 'tip' a solid into a vessel." The use of the word 'tip' is in accordance with the definition given in the Oxford Dictionary, and the author has been informed by two well-known examiners that they see no reason for criticism on technical grounds.

(4) "Black's date is 1755 not 1775." The correct date of 1755 is given higher up on the same page, indicating that a slip was made in proof-reading. The reviewer might, instead, have pointed out that this section gives a fairly detailed account of Black's masterly researches on the mild and caustic alkalis, and that this is unusual in a School Certificate text-book.

(5) " the definition of a 'pure substance', as given, would include solutions." The author was careful to amplify his definition of a compound (not substance) by stating that it included the law of constant proportions, namely: "a pure compound always contains the same elements in the same proportions by weight." This effectively excludes saturated solutions and eutectics, since their composition varies with temperature and/or pressure.

(6) "Jabir and Geber are confused, as in other places (pp. 257, 310, 344, etc.)." Dr. E. J. Holmyard, an authority on Arabian science, says in "The Great Chemists", p. 11, "The greatest chemist of Islam . . . was Jabir ibn Hayyan, who is more familiar to Western readers under the name of Geber". The "Encyclopædia Britannica" confirms this view, so that there is at least some authority for the author's 'confusion'.

A. C. CAVELL.

Uppingham.

One object of a review is to direct attention to points in a book on which there may be differences of opinion even among experts, and it is generally accepted that such discussion is useful and interesting. Mr. Cavell has raised one or two points which merit further consideration.

(1) In an elementary work, where no authorities are quoted, it is best to follow the modern experts. The date 1674 is now generally accepted for the discovery of phosphorus, as Mr. Cavell now seems to imply, and it is given, for example, in Roscoe and Schorlemmer and in the new edition of Mellor's "Modern Inorganic Chemistry". The matter of the letter of Leibniz is dealt with in special publications. The references to Mellor (presumably the large "Treatise", in which all statements, right and wrong, are quoted), Thorpe's "Dictionary" and the "Encyclopædia" are beside the point. The author of a book is expected to use critical judgment.

(2) As the reviewer stated, the point about the name of argon was new to him but might have escaped his attention. He consulted a pupil of Ramsay's on the matter, but was told that nothing was known of it and that it was improbable. It is interesting to have the source indicated. Whether it is useful to mention it in an elementary book is questionable. The statement in the review is quite unobjectionable and leaves the matter open.

(3) Other examiners object strongly to the use of such words as 'tip' to describe careful quantitative work, and it is specifically condemned in a report of the London Higher School Certificate examiners. Some teachers may encourage such slipshod words but most would, the reviewer thinks, not favour them.

(4) Most authors are grateful when errors of any kind are pointed out.

(5) The reviewer sees no reason to modify what was said under this head and adheres to his opinion.

(6) The statement that the mineral acids were discovered by Jabir is not accepted by the modern authorities on Arabic science, such as Ruska. The statement quoted from Holmyard is perfectly correct but has no real bearing on the matter. The point, which seems to be missed by the author, is the relation between the writings of Jabir (the authenticity of which has also been questioned) and the Latin work which goes under the name of Geber. The information in the book is based on old-fashioned sources and requires correction.

THE REVIEWER.

LIGHT OF THE NIGHT SKY AND TERRESTRIAL MAGNETISM

By D. R. Barber
At Lick Observatory, California

ALTERNATIVE theories[1] that seek to explain the mechanism of the selective emission forming the principal component of the night-sky spectrum postulate solar excitation as the primary cause. On this premise the initial ionization of the gas molecules (O_2, N_2) that are known to exist in the terrestrial high atmosphere is effected either by direct absorption of ultra-violet radiation, or by bombardment with high-speed electrons presumably emitted from the photospheric layers.

Now it is an observed fact that the terrestrial magnetic field is, in part, due to extra-terrestrial influences of solar origin. Hence it appears logical to presume that a significant correlation should exist between the luminous activity of the night sky and solar activity. The magnitude of the latter will be reflected in the perturbations of the magnetic elements, and a measure of this perturbation will yield a reliable index of such activity. S. Chapman[2] has stressed the desirability of investigating the problem experimentally but, hitherto, attempts to reveal a connexion of this nature have not met with conspicuous success. Lord Rayleigh and H. Spencer Jones[3] find some evidence of an enhanced nocturnal luminosity on magnetically disturbed days, but their results are inconclusive.

Systematic observations of the yellow-green (5577 A.) radiation from the night sky obtained at the Lick Observatory, Mount Hamilton, California, which I have made, using a concentric-field visual photometer[4], offer experimental evidence of an intimate connexion between measures of luminous activity and those of magnetic disturbance.

Values of nocturnal luminosity over an area of sky approximately four square degrees in extent at the north celestial pole were obtained during five months in 1940 on nights when excellent photometric conditions prevailed. The observations here referred to

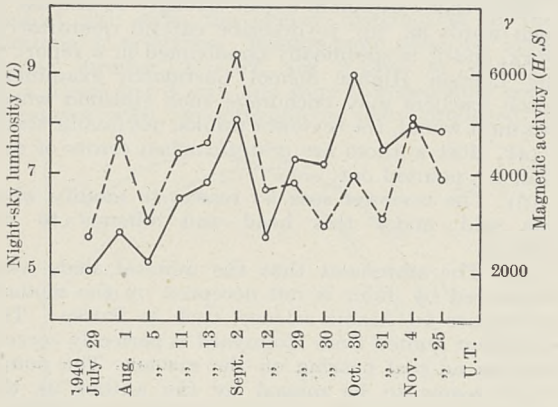


Fig. 1.

COMPARISON BETWEEN NIGHTLY VALUES OF NIGHT-SKY LUMINOSITY AT MOUNT HAMILTON (SOLID LINE) AND MEASURES OF MAGNETIC ACTIVITY AT MOUNT WILSON FOR PRECEDING DAY (BROKEN LINE).

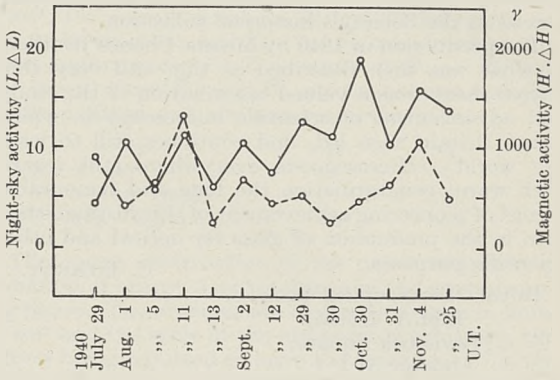


Fig. 2.

COMPARISON BETWEEN NIGHTLY VALUES OF NIGHT-SKY ACTIVITY AT MOUNT HAMILTON (SOLID LINE) AND MEASURES OF CONCURRENT MAGNETIC ACTIVITY AT MOUNT WILSON (BROKEN LINE).

were made at five-minute intervals, and were restricted to those hours of the night when no direct, or scattered moonlight, or twilight was visible above the horizon. The photometric measures were reduced to an arbitrary (linear) scale of luminosity. From these, mean nightly values of the luminosity L, the range of luminosity ΔL, and the luminous 'activity', that is, the product $L.\Delta L$, were computed for each epoch. The complete series of observations was examined in conjunction with the Mount Wilson magnetograph records of horizontal intensity H, which were made available for this purpose by courtesy of the Carnegie Institution of Washington.

The results of the analysis are exhibited graphically in Figs. 1 and 2. The comparative curves of Fig. 1 represent plots of night-sky luminosity L (full line), and magnetic activity (broken line) against epoch of observation. The magnetic activity is expressed here as the arithmetical product of the mean ordinate H', and the diurnal range S, for the twenty-four-hour period *preceding* the nocturnal observations. The correlation coefficients for the paired points from the two curves are + 0·79 for the period July 29 to September 29 U.T., and + 0·31 for all days. It will be noted that there is some divergence of the curves for the later dates: this is primarily responsible for the lower value of the coefficient r derived from the complete series. The reason for this divergence remains a matter for speculation. It may be added that a direct comparison of the nocturnal luminosity curve with that representing a plot of the diurnal variation of H—the amplitude S of which is dependent on the degree of ionization during the hours of insolation—yields also a significant, but slightly lower, positive correlation.

The foregoing comparisons involved measures of magnetic activity over a period of time antecedent to that of the night-sky observations. The paired curves of Fig. 2 exhibit a comparison between the

activity of the night-sky light, as already defined, and the *concurrent* magnetic activity, expressed as the product $H'.\Delta H$, recorded at Mount Wilson 300 miles south-east of Mount Hamilton. Although the correlation between the two curves is less pronounced, and the earlier measures form interlocking points, the point-to-point correspondence is again evident. The coefficients of correlation, referred to the same periods of time as in the previous comparison, are + 0·18 and + 0·11 respectively. The much lower values of r may, in part, be accounted for by the fact that measures of activity involve observation of the rather rapid fluctuations in sky brightness that are likely to be influenced by localized meteorological conditions. Further, the plots of magnetic activity were derived from measures of H obtained at intervals of time comparable with those of the photometric records. In the circumstances a high degree of correlation would appear improbable.

The results of the foregoing comparisons furnish evidence regarding the reality of the suspected connexion between the two geocosmic phenomena under discussion. They indicate that the level of luminosity of the night sky is determined by the degree of solar ionization established during the hours of daylight, and that the relatively frequent, irregular fluctuations of luminosity which are observed to occur during the night can be attributed, in some measure, to the same agency as that responsible for the concomitant magnetic disturbance.

The general nature of this relationship is further corroborated by the close correspondence revealed by comparisons of the seasonal and diurnal trends in nocturnal luminosity with those of magnetic activity. The results of this latter investigation are presented elsewhere[5].

Further research, using a photo-electric technique, which is now in progress, aims at an extension of the comparative analysis to measures of nocturnal radiation in other spectral regions.

[1] Chapman, S., *Phil. Mag.*, **23**, 657 (1937); Dauvillier, A., *Rev. gén. d'élect.*, **31**, 303, 443, 477 (1932).
[2] Chapman, S., NATURE, **121**, 989 (1928).
[3] Lord Rayleigh and Jones, H. S., *Proc. Roy. Soc.* A,, **151**, 22 (1935).
[4] *Pub. Ast. Soc. Pac.*, **52**, 319 (1940).
[5] *Lick Obs. Bull.*, 505 (1941), in the Press.

SPIRITUS VITALIS

DURING the past ten years evidence has been accumulating that the reduction of carbon dioxide, a process widely thought of as unique to green plants, may actually be a characteristic of many and widespread organisms and perhaps indeed of universal distribution in living cells. Much of this evidence has been brought together by J. W. Foster, S. F. Carson and S. Ruben (*Chronica Botanica*, 6, No. 15, 337; 1941) in an instructive article under the above title and with a useful list of key references.

In addition to the well-known cases of chemosynthesis introduced by Winogradski (for example, sulphur bacteria, nitrifying bacteria) it is now recognized that some purple bacteria absorb carbon dioxide in light in the presence of sulphuretted hydrogen (Thiorhodaceæ, differing therefore from sulphur-bacteria in the need for light) or of organic compounds (Athiorhodaceæ). Similarly the organism responsible for methane production reduces carbon dioxide in the presence of hydrogen, propionic bacteria reduce carbon dioxide during the fermentation of glycerol and other substrates, and the anærobic spore former (Clostridium sp.) isolated by Wieringa in 1936 synthesizes acetic acid from carbon dioxide with gaseous hydrogen as the sole reducing agent. There has been sporadic mention of the fact that carbon dioxide is necessary in small amounts for the development of a number of heterotrophic bacteria, for yeast and for other fungi some of which can be stimulated to more rapid growth in the presence of carbon dioxide at concentrations higher than in normal air. Consideration of the facts relating to pigmented cells led van Niel to propose a generalized formula for photosynthesis:

$$2H_2A + CO_2 = (CH_2O) + H_2O + 2A,$$

the hydrogen donor being considered as water in green plants (substantiated by Ruben *et al.* in 1941 using heavy oxygen), sulphuretted hydrogen in green bacteria, sulphuretted hydrogen and other reduced sulphur compounds for purple sulphur bacteria, and an analogous formula would seem to apply to most carbon dioxide reductions by organisms. Thus *B. coli* contains an enzyme 'hydrogenlyase' which catalyses the reaction

$$HCOOH \rightarrow CO_2 + H_2.$$

Another organism catalyses the same reaction but reunites the gases to form methane under the influence of 'hydrogenase'. In this it resembles the classical methane fermentation and here, according to van Niel, the hydrogen comes from any oxidizable organic substrate acting as hydrogen donor, with the general relation

$$4H_2A + CO_2 = 4A + CH_4 + 2H_2O.$$

This and other systems are examined briefly in the review.

In the bulk of these cases the overall metabolism is such that a net uptake of carbon dioxide occurs. The situation in the case of heterotrophic organisms is complicated by the fact that a net *production* occurs. These have now been investigated using radioactive carbon, and a number of tissues and organisms of different physiological types, both plant and animal, are now known to absorb carbon dioxide. It is finally pointed out that the application of this new method to normal photosynthesis in green plants proves carbon dioxide to be absorbed in darkness, and has suggested that the first intermediate in the photosynthetic process is a large molecule (mol. wt. approx. 1,000) with a free $-COOH$ and an $\alpha - OH$. This is conceived as an enzyme or its prosthetic group and suggests that the following reaction occurs:

$$RH + CO_2 \rightarrow RCOOH:$$
$$RCOOH + H_2O + h\nu \rightarrow RCH_2OH + O_2.$$

RCH_2OH adds another carbon dioxide and the process continues until long carbohydrate chains are built up and split off as starch or soluble sugars.

GRASS AS HUMAN FOOD

IN normal agricultural economy the main role of the farm animal is to convert coarse vegetable foodstuffs into palatable and readily digested meat and dairy products. In war-time the value of this function must be reviewed in relation to the exigencies of the shipping situation, and the gain in quality in foodstuffs of animal origin must be balanced against the great loss in quantity which must inevitably occur during the conversion. Some peace-time practices, such as the liberal use of wheat in feeding poultry, are obviously out of place during war-time. It is difficult, however, to forecast what degree of success could be attained in a frontal attack on the position of the farm animal, in which the aim would be to make part of the vast food resources of green pasture directly available for human consumption.

The main objection to the use of grass as a major component of the human diet lies in its high content of cellulose. Since the water content is high, a large bulk would have to be taken to make a significant contribution to the daily calorie requirement, and the undigested residue would prove an intolerable strain on the capabilities of the human intestine. Two distinct possibilities for the use of grass may, however, be recognized. (1) The manufacture of concentrates, free from cellulose, which might be eaten freely as substitutes for meat and cheese. Most of the vitamins would presumably be separated during this procedure, and could be worked up as a by-product. (2) The direct consumption, in salads or otherwise, of small amounts of young tender herbage. This dietary innovation would be valued as a source of vitamins, rather than as a serious contribution to the protein or energy requirements of the body.

In a pamphlet "Eating for Victory", a sequel to "Grass for All", Mr. J. R. B. Branson describes his personal experience of a vegetarian diet containing moderate amounts of fresh or dried grass (Branson's Publications, Headley Mill Farm, Bordon, Hants. 4*d*.). At the ripe age of sixty-eight, he reports a remarkable physical and spiritual rejuvenation, and describes the performance of tests of physical endurance which were possibly more arduous than scientific. In his opinion the beneficial properties of grass may be related to its chlorophyll content, and reference is made to the experiments of Prof. Buergi of the University of Berne. It may be recalled that this work is frequently quoted in advertisements in the popular Press in support of the supposed rejuvenating properties of a commercial preparation of this pigment.

While it is very doubtful indeed whether authentic medical opinion would support the view that chlorophyll has any real therapeutic virtue, it is possible that Mr. Branson may have benefited from the high vitamin content of his unusual diet. To those who might be persuaded to take advantage of the numerous recipes for the use of grass which he has propounded, we would repeat with emphasis his own advice of *festina lente*. Even small amounts of grass might prove injurious to digestive organs less robust than those of Mr. Branson. The injudicious ingestion of amounts made possible by the zeal of an ardent food reformer might easily give rise to intestinal obstruction, which would certainly be serious and possibly fatal.

FORTHCOMING EVENTS

[*Meeting marked with an asterisk is open to the public.*]

SATURDAY, JULY 19

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the London Branch of the Institute of Physics) (at 49 Cromwell Road, London, S.W.7), at 2.30 p.m.—Discussion on Thunderstorm Problems.

FRIDAY, JULY 25

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. Sydney Chapman, F.R.S.: "Chree and his Work on Geomagnetism; Geomagnetic Time Relationships; and The Future of World Magnetic Surveying" (First Charles Chree Address).*

REPORTS AND OTHER PUBLICATIONS

Great Britain and Ireland

Eire: Roinn Talmhaidheachta (Department of Agriculture), Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1939, 1937, 1935, 1933, 1931, 1929, 1927. (P. No. 4658.) Pp. 20. (Dublin: Stationery Office.) 6*d*. [266

Jealott's Hill Research Station. Bulletin No. 2: Culture of Plants in Sand and in Solutions. By W. G. Templeman. Pp. 28. (Bracknell: Imperial Chemical Industries, Ltd.) [17

Other Countries

Brooklyn Botanic Garden Record. Vol. 30, No. 2: Thirtieth Annual Report of the Brooklyn Botanic Garden, 1940. Pp. iv+37–190. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [256

U.S. Department of Agriculture. Circular No. 593: Apparatus and Technique for the Study of the Egg Parasites of the Beet Leafhopper. By Chas. F. Henderson. Pp. 19. 5 cents. Farmers' Bulletin No. 1866: Wireworms and their Control on Irrigated Lands. By M. C. Lane. Pp. ii+22. 10 cents. Technical Bulletin 743: Experiments with *Trichogramma minutum* Riley as a Control of the Sugarcane Borer in Louisiana. By H. A. Jaynes and E. K. Bynum. Pp. 43. 10 cents. Technical Bulletin No. 744: Life History of the Sugar-Beet Wireworm in Southern California. By M. W. Stone. Pp. 88. 15 cents. Technical Bulletin No. 758: Selenium Occurrence in Certain Soils in the United States, with a Discussion of Related Topics—Fifth Report. By K. T. Williams, H. W. Lakin and H. G. Byers. Pp. 70. 15 cents. (Washington, D.C.: Government Printing Office.) [256

Royal Observatory, Hong Kong. Upper Temperatures and the Properties of Air Masses over Hong Kong. (Appendix B to Hong Kong Meteorological Results, 1940.) By G. S. P. Heywood, under the direction of C. W. Jeffries. Pp. 14+5 plates. (Hong Kong: Royal Observatory.) 2 dollars. [266

Fifty-seventh Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1939–1940. Pp. 10. (Washington, D.C.: Government Printing Office.) [266

Newfoundland Government: Department of Natural Resources. Research Bulletin No. 11: The Newfoundland Lobster Fishery: an Account of Statistics, Methods and Important Laws. By Dr. W. Templeman. Pp. 42. (St. John's: Department of Natural Resources.) 20 cents. [17

Editorial and Publishing Offices

MACMILLAN & CO., LTD.,

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

Telephone: Whitehall 8831 Telegraphic Address: Phusis Lesquare London

Advertisements should be addressed to

T. G. Scott & Son, Ltd., Three Gables, London Road, Merstham, Surrey

Telephone: Merstham 316

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

 Registered as a Newspaper at the General Post Office