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THE BEHAVIOUR OF GERMANY

"*Why and how are words so important that they can not be too often used.*" (NAPOLEON.)

DETACHMENT for a moment from the stress of personal circumstances and the attempt, however humble, to view with cool sanity world affairs of the moment, at once bring an uncomfortable feeling of bewilderment. More than that, there is a very present sense of something evil. Things accepted as obvious truths or the plain commonsense of everyday behaviour have gone by the board : so much of mankind is acting and thinking as if the simplicities of truth and honesty, fair dealing and plain speaking, self-respect and respect for one another, all the great whole summed up in the words 'do as you would be done by', are no longer valid, are indeed no more than the outworn catchwords of a grandmotherly age.

If the ordinary man in the street ignores these primary rules of conduct we call him neurotic, criminal or insane, according to the degree of departure from the ordinary. Does the same standard apply to nations ? Here we might listen to the psychologists, who hold an insight into the springs of conduct deep in every human purpose. One of them, H. G. Baynes, a practising psychologist, with the additional advantage of an intimate acquaintance with Germany and the Germans before the War, has recently put forward this approach in his book "Germany Possessed"*. It is not at all technical but a serious study of one of the great problems of humanity, meant for the man in the street intelligent enough to see beyond his own parochial boundaries.

Civilization, General Smuts has said, is undergoing a spiritual migration ; it is on the march. Something is happening. Our own lives have been made a mess of, caught up as we are in the sweep of something quite beyond ourselves. What then can be done for the others treading so closely behind ? The hurrying years do not leave so very much time wherein to take thought for the morrow.

At the root of it all lies this German business ; could we but grasp that, perhaps the horizon might be clearer. Still holding to that detachment, still accepting as fundamental that every human being is entitled to his own opinion, to be himself, what has happened to the kindly, beer-drinking, musical, philosophic, rather fat and middle-aged German that Carlyle knew ? The Germans have changed ; it is not the old Germany of before 1870, it is not even the Germany of the War of 1914–1918 ; it is something utterly different, and what is more, something utterly worse, something utterly vicious. It is again "the great blond beast avid and rampant for plunder". It is the *furor teutonicus*

* "Germany Possessed". By H. G. Baynes. Pp. 305. (London : Jonathan Cape, Ltd., 1941.) 16*s*. net.

of which Heine wrote in 1834: "and should that suborning talisman the Cross, break, then would come crashing and roaring forth the wild madness of the old champions, the insane Berserker rage of which the Northern poets say and sing. That talisman is brittle and the day will come when it will pitifully break."

Discarding wishful thinking and looking at things as they really are, one or two points stand out. The first is that the Germans really do mean it. It is absurd to imagine that the great mass of a mighty nation are being in any sense led, badgered or cajoled by a system which they do not accept into conduct of which they do not approve. The Germans would be quick enough to accept the spoils of victory if Hitler won. To suggest any other than that Germany is solidly behind the Nazi regime is to be blind to the history of the last hundred years.

A second point takes in the political thesis of the totalitarian State. Again the Germans do mean it. They accept and believe in, nay, passionately uphold, the doctrines of National Socialism. The very words are a contradiction in themselves, for it is not national save in its claim for the rights of the *Herrenvolk*, and not socialism save in the complete subordination of every living person to the over-riding mastery of an irresponsible rule. Hitler himself has said: "There will be no licence, no free space, in which the individual belongs to himself. This is Socialism—not such trifles as the private possession of the means of production." We prate freely of the ideals of democracy, as if they were self-evident truths, and dismiss in so many words any possible challenge in ethic or in fact. It were surely better to think quietly what it all means, what are the arguments behind it, which is the pith of this convulsion that has swept through the German people. That it is gravely wrong, there is no doubt. But we shall have to go on living with the German people afterwards, and perhaps if we could understand their error it might be better than merely punishing them for it.

No one can be literally free, for everyone is in himself at once the duality of an individual and a social unit. But the claims of the latter aspect bear upon all, are settled jointly and equitably, are granted, not taken. There are, moreover, advantages in counterbalance. That is in essence the principle of democracy. The differences implied in theory or in practice between the English, the American, the Chinese and the Russian standards are matters of detail, not of principle, which can be comparatively easily reconciled. It is largely a question of how much to render unto Cæsar.

The totalitarian idea says something quite different. The individual here is allowed no personal existence whatsoever, he is not himself in any sense at all except as one of the subordinate items of a multiple unit, just as in the exquisite harmony of the body, a cell in the skin, the liver, or the lung, is admittedly self-contained and is yet entirely bound up in the maintenance of a whole. The philosophy of the 'total State' claims to determine the place of every man. "The state is the absolute, the will that became substance." So Hegel, and so Fichte, Schopenhauer, Nietzsche, and others, in the will to power, the superman, the good of all before the good of one, and such-like phrases. It is interesting, by the way, to notice that the great prophets of the Nazi regime, Hegel and Nietzsche, both took pains to emphasize their dislike of Germany. "It is part of my ambition to be considered as essentially a despiser of Germany", is another quotation from Hegel not so often met with.

We may find it amazing that a nation, which has contributed so greatly to the progress of humanity, should have reverted to cynically deliberate fraud, cold-blooded murder, revolting and atrocious cruelty; but we ought not to find it surprising, for these are but the logical derivatives of the principle that might is right. Further, as has been said, Germany means it, Germany in the sense of the ordinary man in the street, who has put Hitler where he is and Germany where she now stands.

It would be interesting to trace the rise of the evil in Germany, the change that has overtaken her in the last hundred years or so, and to try to give proportionate weight to the many contributory and interacting factors, but this is not the time. Even allowing that many circumstances had effect, their import would still not really explain this strange phase. One senses the presence of something not normal, something evil, something insane. It is here that the study of emotional urges, or motivation, has its place.

People are thinking and talking about the rationale of German conduct; a recent leading article in the *Daily Telegraph*, inspired by many letters sent in, asks pertinently whether the soul-state that has produced Nazism is transient or congenital.

Psychology takes in not only the individual but also the crowd. It has long been recognized that any group of people, even as big as a nation, tends to react as a unit, that there can be a synthesis of separate mind-entities when diversity is momentarily or temporarily subordinated to a homogeneous and concerted feeling, impulse or action. In mass, an aggregate of isolated minds is capable of coalescing into something distinct, something coherent, something bigger. The subject may be further pursued in such books as Trotter's "Instincts of the Herd", or le Bon's study "La Foule".

Baynes puts forward the view that the collective unconscious of the German people has been swept into a hysterical outbreak, a reaction into an irreconcilable and unacceptable attitude, emotional, not consciously realized and considered. That is to say, not rational. There are, of course, two obvious factors, the intrinsic, that is, the nature of the people concerned, and the extrinsic, that is, the circumstances in which they found themselves. That their situation was difficult and unpleasant we may at once concede. But that in no sense implied the need of irrational and indeed non-moral response. At no time in the last twenty years have the problems of Europe been incapable of solution on moderate give-and-take grounds. But the path of Germany has been a subordination at every step to wild impulses of hatred and revenge, to the irrational, emotional, aggressive, behaviour of a child, which, of course, ultimately defeats itself.

This tendency has, indeed, been noted by independent observers. Lawrence of Arabia during a visit to Germany so far back as 1923 wrote with a strange prescience : "You stiffen your backbone and you listen to the night. There is a sense of danger. It is not the people. They don't seem dangerous. Out of the very air comes a sense of danger, a queer, *bristling* feeling of uncanny danger. Something has happened. Something has happened which has not yet eventuated. The old spell of the old world has broken, and the old bristling, savage spirit has set in . . . and it is a happening of far more profound import than any actual *event*. It is the father of the next phase of events." Jung in 1936 saw clearly the cruel force pressing upon Germany. "Germany is a land of spiritual catastrophes, where certain facts of nature allow only a patched-up peace with reason." These two very apposite quotations are taken from Baynes's "Germany Possessed".

Crowd psychology holds yet another quality in the curious, again irrational, yet vivid, immediate and intense response to a certain type of individual. The type so able to influence the collective unconscious has something of the mystic about it. They are intuitives, themselves receptive of and guided by impulses without the ken of the ordinary man. Intuition is probably present to a small extent in every one, to a distinct degree in a limited number, and notably so, very rarely. Certain individuals are undoubtedly capable of undergoing states of consciousness in which they would appear to make an unusual contact with the realities of space and time. Joan of Arc provides a good example. A poor country girl, she heard voices bidding her take up the redemption of her people ; she succeeded in imposing her will not only on an ignorant peasantry but also on the first soldiers of France, and swiftly transformed the whole military situation. There are other instances in history of the same sort of thing, explanation of which is not easy.

The German Fuehrer is one of these "daemonic" personalities. His strange and obscure life, his peculiarities of behaviour, his childish tempers, his prejudices, his intuitions, his inspirations ("waiting until he knows"), and his intense and vehement power over a German audience stamp him as something unusual. Note that it is not just the credulous man in the street whom he has swept along with him ; it is also the hard-headed German General Staff and much of the intelligentsia. All this makes the greater pity that with such gifts he should have given his country's policy the sinister twist of these last years.

Is Germany then in the throes of an intense mass movement, a crowd hysteria, a surge of the old savage unconscious rushing down the slope of the irrational, the childish, the neurotic ? Can their compulsive drive against, not some, but all their fellow-men, be so explained ? Their actions are not normal. Their causeless suspicions, as of 'encirclement' and against Russia ; their intense need for self-assertion, the sure stamp of inferiority, as in the '*Herrenvolk*' and the 'Aryans' ; their crudity ; their cruelty ; their lack of every decency. To be suspicious, to break faith, to lie, to cheat, to murder—the common man knows that it does not work. There is no need of moral words, it simply does not work. How then can the Germans do these things ? There can only be one outcome. Therein lies support for the conception of a nation "possessed".

Of course, there are obvious difficulties. The whole subject is new and unexplored. Patient and persistent study not only of this episode but also of many others is demanded to reinforce such a hypothesis, no matter how feasible. That Germany has stepped down from the climbing stairs of civilization into some callous, cynical, egocentric crudity cannot be altogether accepted as a new phase. Frederick the Great with all his good qualities was not conspicuous for keeping faith ; Bismarck was responsible for the episode of the Ems telegram ; and we all remember something about a 'scrap of paper' in the War of 1914–18. German atrocities are not a new story ; they were spread, with some justification—to use restrained language—in 1870 and in the last war. German philosophy has been alone in advancing doctrines to which German conduct to-day gives but the logical expression. In short, their present state of mind cannot be altogether regarded as unexpected ; it could even be legitimately argued that Germany was the only nation from which such might have been expected. Alternatively, there may be something in the national make-up rendering them more unstable, more suggestible, more liable to some such breakdown.

"Germany Possessed" offers a sane and serious study of the why and how of all this unpleasant muddle. More than that, it dispels with a happy insistence the traitor doubts that may beset even an honest mind and a clear conscience. It submits a contribution certain to be helpful in the ultimate problems that will clutter up so heavily the final disentanglement. Without necessarily agreeing with every detail, everyone can find in Baynes's book much to approve, much that is reasonable and much that is encouraging. That it may superficially appear without immediate practical application is untrue; mankind advances not in arithmetical but in geometrical progression. The alarming hypothesis of yesterday is the happy certainty of to-day. Psychology may be a new science, it may submit surprising, perhaps revolutionary, concepts, but its admitted conquests in the individual field insist that it be at any rate heard in the collective sense. The mere appearance of such a thesis at this present moment justifiably infers that even under the vivid edge of a cruel conflict man can still hold to the high, ardent and vehement purpose of co-operation in the conduct of this life. Difficult, yes; but then ideals are made that way.

DESERT SANDS AND DUNES

The Physics of Blown Sand and Desert Dunes
By R. A. Bagnold. Pp. xx+266+16 plates. (London: Methuen and Co., Ltd., 1941.) 24*s*. net.

LIEUT.-COLONEL BAGNOLD is well kno for his scientific publications on desert sands and dunes, and for a book describing his travels in the Egyptian and Libyan Deserts. The present book combines these papers and much other original research into one comprehensive volume, which would, however, have possessed an added interest to readers if the introduction had included some reference to the author's work as a pioneer of motor travel in the desert. Descriptions of desert features in various parts of the world have been written by many travellers, but this book is unique in that the author has combined the results of experimental research in a wind tunnel with personal observations in the desert. The subject has a particularly topical value in connexion with the present war operations in the Libyan Desert, and the explanations of many desert features vitally affecting such operations will interest a wide range of readers. There is also scope for applying the researches to other kindred problems, such as the encroachment of desert sands over cultivated land, which is a serious menace in certain parts of the United States.

The contents of the book are divided into three sections dealing respectively with the physics of grain movement, small-scale effects such as surface ripples and ridges, and large-scale dunes. The first section shows in a fascinating way the mechanism of the interaction between sand grains and wind, as observed both in the desert and in the wind tunnel. Contrary to popular impression, dust storms in which fine particles are carried to a considerable height in suspension in the air are of comparatively rare occurrence in the true desert country. Sand grains can be lifted by the wind only to a height of several metres at the most, and the author shows by photographs and diagrams how the bulk of the sand movement is limited to a height of a few inches above the desert surface. These sand grains travel in a succession of leaps alternating with impacts on the surface grains, the process being given by the author the name of saltation. There is also a slow creep of the surface grains due to the impact of the grains in saltation, the whole process being considerably affected by the size and nature of the desert floor deposit.

The second section deals with an original method devised by the author to express graphically the size grading of sand deposits, and the application of this method to a study of deposits formed under varying conditions of wind velocity. Small ripples formed on the sand surface are shown to be entirely different in origin from the familiar ripples left on the ocean shore, in spite of the similarity of appearance.

The third section, on large sand dunes, is of a descriptive nature, since the scale of formation is beyond the scope of laboratory imitation. Although some of the theory advanced is admittedly tentative, the author has built up a convincing explanation of how sand dunes rising to a height as great as a hundred metres and extending for nearly a hundred kilometres, may be formed by the interplay of varying winds acting alternately from different directions. The enthusiasm of the author is shown by an account of experiments to determine the internal structure of the dunes which involved pouring precious water over the surface, the different layers being distinguished by the rate of seepage. The final chapter, which should really have been an appendix, since it is not necessarily a large-scale effect, describes the so-called singing sands. The solution of this problem has not yet been attained, but the account of preliminary experiments shows that the author has made considerable progress in this problem and will no doubt find a successful explanation when he is able to relinquish his present duties.

Although written primarily for the geologist and civil engineer, many sections of the book will be of great help to those engaged in other branches of science. Thus the section on the grading of desert sands could be applied to many industrial powdered materials ; the theory of the motion of sand grains under the influence of wind action could also be applied to the movement of dust in mine galleries, to deposits of dust in large pipe lines and indeed to pneumatic conveying of granular materials in general. Apart, however, from its specific applications to definite problems, the general reader will be rewarded with a fascinating description of a natural phenomenon which appeals strongly to the imagination.

H. Heywood.

EDUCATION YESTERDAY AND TO-DAY

Education To-day

By John Dewey. Edited, and with a Foreword, by Joseph Ratner. Pp. xvi+86. (London : George Allen and Unwin, Ltd., 1941.) 5*s*. net.

Since the end of the nineteenth century, John Dewey has been the most effective force in the development of American education, while on this side of the Atlantic he has won for himself a large body of disciples, and the influence of his reforming zeal may be seen in British schools as well as in those of the United States. Many teachers will, therefore, welcome the publication of this volume of essays, written between 1897 and 1908, and selected from the large *corpus* of his writings to give the dominant themes of his educational work. These are summarized in "My Pedagogic Creed" (1897), which forms the first chapter of the book, and the relevant articles are then applied in a series of essays on "The Primary-Education Fetich", "The People and the Schools", "The Place of Manual Training in the Elementary Course of Study", "Democracy in Education", and "Religion and Our Schools". Some of these are inevitably dated, and the battles for which Dewey fought thirty or forty years ago have been largely won : yet the victory has nowhere been so complete or so secure that all danger of a counter-attack is removed, and though the title given to this book is rather misleading, yet its contents have a relevance to the problems of to-day which cannot be ignored, and they are shot through and through with flashes of universal truth and wisdom which make them independent of time and place.

One of Dewey's chief services to education has been to humanize it. For him, all its subjects and activities, whether considered from the teacher's or the learner's point of view, must be translated into terms of human nature, and be made relevant to human needs and human interests. We get away from the false but common view that education is an operation we perform on somebody else (and nearly always exclusively on his mind), to the truth that it is always a co-operation, and a co-operation in which the *whole* of both partners to it is concerned : it is the whole child who is being educated, the whole man who is educating him, and the process is not an action which the one carries out on the other, but a transaction between the two. In these thoughts we have "the controlling factors in the primary curriculum of the future—manual training, science, nature-study, art and history. These keep alive the child's positive and creative impulses, and direct them in such ways as to discipline them into the habits of thought and action required for effective participation in community life." Thus education becomes "a process of living, and not a preparation for future living", the school "a social institution", and the synthesizing force in a child's school subjects and activities his own social activities. The culture we teach must not be a "hand-me-down garment", an "intellectual suit which other people have worn", but the natural culture of childhood, adolescence, and manhood, a culture compounded of many elements, among which the technical and the spiritual will both have their place. Religion is to be taught not as a body of doctrine, but as a way of life—and the way of life is to be seen in the common life of the school : the schools "serve best the cause of religion in serving the cause of social unification", and the intellectual integrity which they teach is potentially much more religious than any outworn belief which it may displace.

The teacher's human needs must be considered too, and the chief of these is the "recognition of his intellectual and spiritual individuality" : he must be trusted, and his judgment upon matters of educational importance (whether inside the school or outside) must be respected and effective : otherwise we have an undemocratic education for a democratic community. It is men, not walls, that make a city, but education makes the men, and the educational system, if it is to do its work, must reflect and "simplify existing social life".

It is along these lines that Dewey fights his battles. Are the battles won ? There is much to encourage us, but there is also much to make us uneasy. In Great Britain since the beginning of the century we have done much to put the child in the centre of the picture, and we remember more often than we did that it is John and Mary whom we are teaching, and not arithmetic or reading. But there are still far too many teachers 'subject-ridden' (What is a 'subject', and how does it differ from our 'object' ?). From the totalitarian States there is developing a strong attack on the whole theory of education as a human activity, and there will be repercussions of this among the democracies. Culture is in danger of becoming the preserve of the educated few, and one of the chief problems of our day is that of synthesizing cultural and vocational activities. To judge from the B.B.C. material, religion and religious education are hardening in the cement of orthodoxy. While teachers are ostensibly free, they are perhaps the least trusted of all professions, and their influence on educational policy is dangerously restricted : it is an ominous sign that proposals for education after the War should have been prepared for the Board of Education by its Civil Servants as a confidential document, and should be kept from the teaching profession. Assuredly, the republication of Dewey's "essays" is not untimely.

M. L. JACKS.

THE STRENGTH AND STRUCTURE OF THE EARTH

Strength and Structure of the Earth
By Prof. Reginald Aldworth Daly. (Prentice-Hall Geology Series.) Pp. x+434. (New York : Prentice-Hall, Inc., 1940.) 3.50 dollars.

THOSE who have some acquaintance with Prof. Daly's researches and writings will expect both pleasure and profit from his latest book ; nor will they be disappointed. Geophysics demands the co-operation of workers in a number of different sciences, and with the modern tendency of research to run along narrow paths there are few who have the wide knowledge required for a grand synthesis. Thus, there has from time to time been a cleavage of opinion on various vital matters between, say, geologists and mathematical physicists, although each had much to learn from the other. Happily, there has arisen in recent years a spirit of close co-operation, and some of the fruits of it are seen in the volume under review. Prof. Daly combines the wide knowledge of the geologist with a clear grasp of the modern advances in geodesy and seismology—no mean achievement. His exposition is attractive, and is illuminated by a wealth of suggestions, many of them frankly speculative, many indicating possible quantitative tests, and all of them worth recording.

The reader who is three-quarters of the way through the book will notice that so far the book had dealt exclusively with isostasy ; indeed, it might be asked why the title is not simply "Isostasy". Had the last chapter been omitted and the remaining eleven chapters been left as a treatise on isostasy itself, the book would still have been worth the writing. The final chapter, however, on the strength of the earth-shells, could not have been written except in the light of a detailed description of the results of geodetic surveys. The wide acceptance of the idea of isostasy has afforded excellent illustrations of the use and misuse of inductive inference. As a working hypothesis, based on a large body of data, there has from the first been much to recommend it ; the too-ready acceptance of an over-simplified model apparently gave some writers the impression that world-wide isostasy was a fundamental law, even though not more than two per cent of the earth's surface had been gravitationally surveyed.

In this book great care has been taken to put the development of the idea of isostasy in its proper historical setting. It was Pierre Bouguer who in 1749 stated in his book, "La Figure de la Terre", his belief that the measurements made between 1735 and 1745 on the meridian arc in Peru indicated a much smaller attraction of the Andes than their estimated mass would suggest. Shortly afterwards R. J. Boscovich attributed this to a thermal expansion of material in depth ; he suggested that the deficiency or void ("vide") within the mountain compensates ("compense") for the overlying mass. In 1836 Sir John Herschel expressed the view that the removal of rocks by erosion to distant basins would entail horizontal flow of the plastic matter below. F. Petit, too, had proved in 1849 that the agreement of the astronomical and geodetic latitudes of Toulouse indicated a deficiency of attracting matter beneath the Pyrenees. Thus the ground was to some extent prepared for the classic work of Archdeacon J. H. Pratt, whose first paper was read in

December 1854, and of Sir George Airy, whose paper was read in January 1855. In the course of Everest's triangulation of India it was found that the difference between the geodetic latitudes of two stations, Kaliana and Kalianpur, on the same meridian, was not the same as the difference of their astronomical latitudes; the difference, in fact, was about 5″. Pratt calculated the deflecting effect of the attraction at these stations of High Asia, and on this basis predicted a difference of about 16″, almost exactly three times that actually observed. Later work by Pratt took account of the relatively weak attraction of the ocean to the south of India. Airy remarked that, surprising as Pratt's discovery was, it might have been foreseen on the current view of a fluid interior of the earth (or at any rate fluid at the time mountains were formed); he showed that on likely hypotheses the crust was not strong enough to hold up the mountains, and attributed their support to projections of the light crust downwards into the denser matter on which the crust was, in effect, floating—somewhat after the fashion of a floating iceberg. Hence the idea of the 'roots of the mountains'. Pratt, working on the idea of vertical expansion of large blocks of the crust, supposed the attenuation of density to be distributed uniformly to a certain depth, which for High Asia he estimated as about 100 miles. Between these two models one could evidently construct any number of others in which the two modes of compensation are combined. The word 'isostasy' was coined in 1889 by C. E. Dutton for the ideal state of equilibrium of a fluid or plastic heterogeneous body, and the question he proposed was: How nearly does the earth's figure approach to isostasy? Substantial extracts from the original papers of Pratt, Airy and Dutton are quoted by Daly. Measurements of the intensity of gravity tell the same story as measures of deflexion of the vertical.

Much of the book is taken up with a description of the way in which the approach of the earth to isostatic equilibrium has been tested by plumb-line and pendulum. The very fine work of J. F. Hayford and W. Bowie in the United States showed that that country approximates closely to the isostatic state; for their reductions they used a Pratt type of compensation extending to a depth of 113·7 km. Their results rather led to the expectation that isostasy would prove, to a close approximation, to be a world-wide phenomenon; they suggested, too, that compensation followed the Pratt model. A very important paper by Heiskanen in 1924 showed that the available European data indicated on the whole a close approach to isostatic balance, and that there was very little to choose between the Pratt and the Airy types of compensation, a result that was also true of gravity in the United States. Within the last ten years new observations have greatly changed the outlook. Hunter and Glennie have shown that India departs notably from the isostatic state, and the measurements of gravity by Vening Meinesz during extensive voyages in a submarine have revealed large belts of astonishingly large gravity anomalies. None the less it is still convenient to collate the observations by adopting an isostatic model and to speak in terms of deviations from complete isostasy.

A chapter on "Nature's Experiments with Ice-caps" brings us nearer to the main purpose of the book. The post-Glacial uplift of Fennoscandia, which still seems to be continuing at a measurable rate, is generally ascribed to isostatic adjustment following the removal of the ice-sheet; a similar recoil is found in north-eastern North America. Estimates of the viscosity of the underlying material have been made, but the data, and the use of the data, are decidedly precarious. The outstanding problem that geodesists and geophysicists hope to solve is whether the material below the 'crust' behaves in the long run as a fluid, or whether it has residual strength; this weak layer is termed the 'asthenosphere'. A related problem is the extent to which the crust can bear loads without fracturing, that is, the horizontal extent of the supposedly independent crust-blocks.

The researches of Jeffreys, which indicate in the asthenosphere a strength approaching that of granite, are seriously challenged by Daly, who readily admits that there are too many unknowns in the problem to permit at present of a unique solution. Daly suggests that below the asthenosphere, and probably extending down to the fluid, dense core of the earth, is a "mesospheric shell" of moderate strength and of density somewhat greater than at the asthenospheric level; this strength and density are held to arise through crystallization under pressure. The suggestion is made that the asymmetry of figure of the earth may arise from a permanent inequality in the mesospheric shell, the imperfectly healed wound left when the moon was torn away from the earth—a new variant of an old theory originally due to Osmond Fisher. An attempt is made to account for deep-focus earthquakes, but it is doubtful if the sudden freezing of a sunken mass of glass would release sufficient energy.

This stimulating treatise is illustrated by a large number of excellent clear diagrams, and the type is easy to read. The computations have evidently involved the author in much hard work, and he has done a great service in collating and rendering easily accessible the results of a number of researches scattered through a wide range of publications. R. STONELEY.

The Aeroplane of To-morrow
By Noel Pemberton-Billing. Pp. 307. (London: Robert Hale, Ltd., 1941.) 12*s.* 6*d.* net.

THIS is a difficult book to review. One does not dare to dogmatize about anything in the aeronautical world, but the science of flight is now becoming sufficiently established to enable us to look a short way ahead with reasonable certainty. The author's conclusions as to how progress in speed or carrying capacity of heavier-than-air craft can be made, in general by an increase in wing loading, are certainly true; but the light-hearted way in which the book sweeps away, or else ignores, the attendant difficulties, rather shakes one's faith in it as a serious scientific work.

The principal part of the book is devoted to an elaboration of the author's idea of a "slip wing" aircraft, a form of assisted take-off for a highly loaded aircraft (already developed by the Short-Mayo flying-boat) evidently by his assistant, Mr. Roger Tennant, whose work he acknowledges. His figures quoted for a suggested long-range high-speed bomber are accurate aerodynamically, but in the event of a failure necessitating an emergency landing immediately after commencing a flight, the whole of the bomb and petrol loads would have to be jettisoned, and even then the author contemplates landing with a wing loading of 40 lb. per sq. foot. This is scarcely a happy procedure in the vicinity of a crowded aerodrome. This is admittedly an isolated case, but it is typical of the whole book. The best that can be said is that it puts the case of one particular avenue of possible progress in plain language such as can be read by the ordinary man, and in this sense it is useful and worth reading. One looks in vain for anything new, which the title rather leads us to expect, or anything that is not already known by serious students of aeronautics.

Intermediate Inorganic Chemistry
By Dr. J. W. Mellor. New edition, revised by Dr. H. Irving. Pp. xx+690. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 9*s.*

THE revision of this book has been carried out by Dr. Irving, who states in the preface that "he has been at pains to preserve the essential character of the book". Thus, while the numerical data have been extensively revised, only minor changes have been made to the subject-matter. The reviewer feels very strongly, however, that it would have been worth the extra cost of repagination to have omitted many of the old graphical formulæ, as well as details of, for example, hyponitrous acid, hydrazoic acid and the thionic acids, which are scarcely suitable for students at this stage. Incidentally, this would have provided space for the inclusion of one or two modern processes, such as the manufacture of nitric acid from ammonia, which ought to have been mentioned in this edition. Apart from these criticisms, and perhaps the debatable point of whether it was wise to omit the electronic theory of valency, the reviser appears to have accomplished his task successfully. A. C. C.

Honeycraft in Theory and Practice
By J. A. Lawson. Cheaper edition. Pp. xii+228+18 plates. (London: Chapman and Hall, Ltd., 1940.) 3*s.* 6*d.* net.

THIS is a reprint of one of the best-planned books on practical bee-keeping known to the reviewer. The author perhaps allows his own preferences too much scope in his exclusive recommendation of the Italian bee, and in confining attention to the 'Stoney-Archer' type of hive, although the latter, in a simplified form, is now well known and widely used under the name of 'National Standard'. The W.B.C. type —still the hive most used in Great Britain, and well suited to the climate—is dismissed in a few lines of criticism. Considerations of space would, however, probably make impossible the adequate description of more than one hive type; and the author's is a good choice.

It is to be regretted that the book has not been brought up to date in the many matters of biology and physiology, and of the physics of honey, in which knowledge has advanced since its first publication in 1931. Some of these are of practical value, and all of interest to the intelligent beekeeper. It is to be hoped that this will be remedied in a future edition.

The practical section is good, containing many useful hints and few slips. The illustrations are well chosen and produced, and really illustrate the points to which they refer. The type is large and the finish excellent, combining with the pleasing style to make the book agreeable to read. A. D. B.

Algebra
A Text-Book of Determinants, Matrices and Algebraic Forms. By W. L. Ferrar. Pp. vii+202. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 12*s.* 6*d.* net.

THIS is a text-book intended primarily for undergraduates. It is designed to give a broad basis of knowledge comprising such theories and theorems in those parts of algebra which are mentioned in the title as are of constant application in other branches of mathematics.

The book is divided into three parts: namely, determinants, matrices, and linear and quadratic forms. It will be seen at once that there are notable omissions from the usual conception of a text-book on algebra, but the author states in the preface that these omissions are deliberate.

The arrangement of the text rather resembles a geometry in its orderly array of definitions and numbered theorems, but it must be confessed that a decimal numeration of theorems to correspond with that of the paragraphs would have greatly facilitated reference. Although the treatment throughout makes pleasant and easy reading, the author is to be particularly congratulated on his exposition of matrices, which provides just what is greatly needed in many current applications.

There are numerous and well-chosen exercises, with occasional hints, and suggestions for further reading to build on the foundations so ably laid in this book.

SCIENCE AND TECHNOLOGICAL ADVANCE

TO cover effectively the wide field of technological advance, almost all of which is closely bound up with corresponding developments in science, was certainly beyond the aim of the Conference on Science and World Order held during September 26–28. As it was, the papers presented covered a wide and varied field.

Sir Harold Hartley, chairman of the Fuel Research Board, claimed that most of the scientific discoveries of the last two hundred years could not have made an effective contribution to the progress of civilization without the successive technological developments that have made energy available. The main results of this progressive utilization of energy were: (1) Power-driven machines with a continuous increase in the productivity of labour and material resources, first in industry and later in agriculture. (2) Means of rapid transport by land, sea and air, facilitating the development of new countries, making available the world resources of raw materials and food, and providing new markets for industry. (3) Development of metallurgical and chemical industries, producing secondary raw materials for industry and fertilizers for agriculture. (4) The high-voltage distribution of electricity, making possible the dispersal of industry and thus avoiding the over-crowding of urban areas.

Following on these has come another no less far-reaching revolution—the domestic—which has done so much to raise the standard of health and comfort in the home, which may be regarded as repayment by the technician of a long overdue debt for social consequences of mechanization of industry in the nineteenth century.

Fundamental research will yield continuing improvements in methods of utilizing fuel, distribution and storage of electricity, uses of power, and in production of substitutes for mineral oil from coal or vegetable products against a possible shortage. The ultimate goal is the utilization of the sun's radiation currently by some photochemical or photo-electric device or engine, to take the place of the solar energy stored in coal and oil.

The problem of energy was also comprehensively treated by Prof. A. C. G. Egerton, of the Imperial College of Science and Technology. To-day, the world makes use of 1,300 million tons of coal, 270 million tons of oil and 55 million tons of natural gas per annum. Only a very small fraction of the solar radiation (1/60,000) is currently utilized in the form of the food produced by plant life, or in the form of hydro-electric power, through the atmospheric mechanism. If ever the vast stores of energy in the make-up of the atoms can be released, controlled and used, another industrial revolution may be expected. Therefore, in preparing for a new world order, it is necessary to have more accurate knowledge of the material resources of the world and particularly the sources of energy and to plan on the basis of that knowledge.

In a paper by Dr. G. Lewi, Dr. O. Eisler and Dr. J. Cisar on "Problems of the Technology of Unutilized or Insufficiently Utilized Raw Materials and Waste Products", the authors stressed the exhaustion of some raw materials, and the war-time wastage of valuable materials. New methods are required for dealing with new raw materials, or those not sufficiently or efficiently exploited. Nitrogen has already been fixed from the air; other materials as abundant, such as clay and sea water, are waiting to be used, the former as a potential source of light metals. Large quantities of magnesium chloride, which is largely a waste product in the manufacture of potash, ought to be a rich source of magnesium.

There are also new possibilities in the use of wood. The problem involves, first, the best and most efficient methods of processing, leaving as little waste products as possible and, secondly, the further optimum utilization of unavoidable by-products hitherto regarded as waste. Of primary importance is avoidance of the wastage of utilization of coal, an improvement being, for example, the use of naphthalene for the increasingly important carbon-black. Attention was also directed to restoring harmony between the production and consumption of natural raw materials and of their synthetic artificially produced substitutes. Progress made during the War in this direction must be perpetuated.

Dr. C. H. Desch, of the Iron and Steel Institute, likewise discussed the conservation of natural resources. He pointed out that the political pledge to accord access to raw materials means international control of such sources after the War. Minerals, including coal and oil, which are the principal sources of power at present, are capital, and assets, once consumed, can never be renewed. While allowance must be made for technical improvements in working leaner ores and in mining at greater depths, it appears that certain minerals, such as oil and tin, are within calculable distance of exhaustion. Estimates vary widely, but copper, tin, gold, and phosphates, at the present rate of production, are believed to have a further life of less than a century. Coal and iron may last for thousands of years, while the estimates for oil reserves are very conflicting. Little information is available for the sparsely occurring minerals, such as nickel, tungsten, molybdenum and vanadium, which are increasingly essential for high-class steels. In the first quarter of the twentieth century the quantity of ores taken out of the earth was greater than in the whole of previous history (say, six thousand years after copper was first mined), and at the current rate of development, the world production of many minerals doubles itself in 10–20 years.

Dr. L. E. Howlett described "Canada's Optical Industry" as an example of how the State can establish a new industry to fill a gap in its economy and to supply an urgent need. A great amount of the preliminary investigation of the possibilities, needs in materials and personnel were made by officers of the National Research Council. As a result of this extensive work the Department of Munitions and Supply established an entirely Government-owned company—Research Enterprises, Ltd.—which is charged with the responsibility of producing manifold types of optical instruments required for military, naval and air operations. Although this company is under the responsibility of a different ministry of the Crown from the National Research Council, the resources for research and development and technical counsel which the National Research Council can provide are always at its disposal.

"Science and Technological Advance Applied to Building", was the title of the paper presented by Mr. R. Fitzmaurice, of the Building Research Station He explained why building tends to lag behind other industries in the use that it makes of scientific advances. In the last twenty years, however, much has been done in establishing basic scientific principles which govern building problems. Of principal importance are: the acoustics of buildings, heating and ventilation, daylight illumination, and the exclusion of dampness. Auditoria no longer need result in unintelligible speech, and refinements in design are alone required to reveal the full tonal balance of an orchestra. Technically, local and external noises can be reduced below nuisance values. The cost entailed in these problems has been materially reduced by a proper study of conditions.

More exact control of the usage of fuel has directed attention to provision of heat and ventilation, with greater comfort to the users. The principles underlying the transfer of water in porous parts of buildings have been elucidated, and there is no longer any justification for dampness in buildings.

To apply this knowledge more rapidly, greater emphasis might be given to elementary science in the training of workers in the building industry, including architects, builders, craftsmen and surveyors.

In a paper on "Some Recent Applications of the Theory of Elastic Dislocations", Prof. Enrico Volterra, of King's College, Cambridge, described concrete structures as an example of the utilization to a maximum degree of the resistance of the material employed in building. This was achieved by a study of the conditions of elastic-plastic equilibrium, and of pre-stressing structures. The first study increases knowledge of the state of stresses and deformation of structures when the elastic limit of the material is passed, which then becomes the plastic condition. The second study enables stresses favourable to its stability to be established within the structure. The combined study is called the theory of elastic dislocations, and is the result of the blending of science and technology upon which progress in civil engineering is based.

"Technical Advances in Biology" formed the subject of a discourse by Dr. C. H. Waddington, of the Strangeways Laboratory, Cambridge. Dr. Waddington dealt mainly with agriculture, although medical advances were touched on, such as the alleviation of malnutrition, the conquest of tropical diseases, and the reversal of the falling reproductive-rate, the latter being a political rather than a technical medical matter. Great changes in the production of plant products will probably be brought about; tank culture, with or without artificial lighting, is likely to spread. The control of hormones affecting the growth of particular organs is still comparatively new. Vernalization, in the U.S.S.R., has led to adjustment of the latency, growth and flowering of plants to climatic conditions. There have been spectacular results in utilizing hybrid vigour in maize, and this technique will probably spread to other crops, such as tomatoes. The wealth of new wild forms which have recently been placed at the plant breeder's disposal will make practicable the extension of the zones in which certain flowers flourish. The importance of extending the potato to the tropics and the arctic can scarcely be over-estimated. The recently acquired control over the production of tetraploids, both pure-bred and hybrids, by means of drugs such as colchicine, can scarcely fail to produce entirely novel crop-plants of importance.

The improvement of productivity in animals has always been more difficult than with plants. Artificial insemination already allows the sperm of a tested male to be used on many more females than otherwise would be possible. A tissue method of keeping testes alive might increase the number indefinitely. Hormonal methods of inducing ovulation have already been used to get two crops of lambs a year. Methods of producing super-ovulation are also known and, combined with the transplantation of the ova to other females, might enable us to multiply by a considerable factor the offspring of a valuable female. A first step has been taken towards the artificial production of tetraploids in mammals, and the doubling of hybrids cannot be considered technically out of the question. The hormonal control of sex-development may yet play a part in poultry and, perhaps, the dairy industries. Methods of separating female- from male-producing sperms have already had some success and may soon play a large part in the same two industries. The use of growth hormones for inducing giant forms, which might conceivably reproduce themselves true to type, is a possibility which may be realized within a few years.

The greatest technical advance which may be expected shortly is organization. The liaison between advanced institutes for practical and for theoretical biology is much less close in Great Britain than in many of the leading countries, such as Sweden, the U.S.S.R. and the United States. The return of many biologists from war-time tasks to biology will be a suitable time to introduce a well-considered re-organization of the whole scheme of biological teaching and practice, from the primary school to the university. Such a reorganization has been long over-due.

In dealing with industrial research and the universities, Dr. F. H. Boer inquired into the possibilities of promoting a beneficial exchange between science and industry. The application of new scientific discoveries and methods to industry and the consequent furtherance of research, necessitates a very close collaboration between men of science and all those concerned in the application of science, but in most countries collaboration between universities and industrial research laboratories is not close enough. The fear that industry will lose its secrets is one of the main factors, though in practice one finds that many of the so-called secrets are not secrets at all. In some large industrial research laboratories close co-operation between scientific workers and technicians exists, and the scientific workers are in touch with the universities.

Leaders of industrial research laboratories must be scientific men with highly developed technical minds and imaginations, and preferably some of them should hold a semi-official position at a university. Smaller industries should unite to establish and maintain sufficiently large research laboratories; there can be no place for small isolated research laboratories in the future, in Dr. Boer's opinion. The Government should endeavour to bring the smaller industries together, and to induce minorities to accept majority decisions. If industry realizes that its first task is to serve the community, then science will minister to industry unreservedly.

The technological advances of the last few decades, which, as Mr. Ritchie Calder pointed out, amount to a second industrial revolution, have made it incumbent upon scientific men to make certain that these advances are used to the benefit of humanity. The immediate task, in the words of Sir Harold Hartley, is to ensure that in the replanning of the world full use is made of the basic knowledge that science alone can provide, particularly in the fields of nutrition and energy, with all that they imply for the well-being of mankind.

SCIENCE AND WORLD PLANNING

SCIENCE and world planning was the subject of one of the sessions of the Conference on Science and World Order, and, in one form or another, planning was implicit in most of the papers presented at the Conference.

The need for planning was stressed by many speakers, and during the discussions on human needs and post-war relief the immediate aim of world planning was clearly stated to be the relief of human suffering and the provision of an adequate standard of life to human beings everywhere. Preparations with this immediate aim in view must be made now.

World planning is not a task to be lightly undertaken or one in which quick results can be expected. As M. Maisky, the Soviet Ambassador, reminded the audience, it took the U.S.S.R. twenty years to reach its present advanced state of planned economy. In his view, the chances of replanning the world are years ahead. He characteristically claimed that the immediate plan for all of us is to win the War. Nevertheless world planning can and must be undertaken, provided we do not lose sight of our immediate objective, that of winning the War, and thus ensuring the opportunity to plan.

Some people object to planning because they fear that it would sacrifice the energizing force of competition. But, as Mr. Maurice Dobb, lecturer in economics in the University of Cambridge, pointed out, competition to-day is not what Adam Smith and the early economists extolled. We have now monopolistic competition, where the public interest tends to be thwarted rather than asserted, and the economically weak subordinated to the economically strong. This is the alternative with which we have to compare economic planning.

The post-war world will need larger economic units and more economic intercourse between nations. But it will need also the maintenance of full employment and the ending of exploitation of weak nations by strong. This synthesis demands a new regime of international planning. It implies the dominance of the social interest over the sectional, of the common good over individual profit.

The need for a new outlook was also stressed by Lord Hailey when dealing with colonial planning : ". . . a modern world which can combine to control the production of tea or rubber, or tin, or copper, in the interest of an investing public might well find the means of exhibiting a greater solidarity in dealing with issues vital to the welfare of Colonial peoples."

Mr. M. Wynants, of the Belgian Commission for the study of post-war problems, who spoke on town planning, was one of the few who attempted to look at the problem of world planning as a whole. He pointed out that the post-war world will be very different from the world we knew, and therefore we must face without delay the need for drastic solutions to the political, economic, social and moral problems. These are aspects of one and the same reality, and it is impossible to propose a solution in one of these fields without automatically bringing about corresponding reactions in the others.

Among the tasks mentioned by Mr. Wynants that can be satisfactorily accomplished only by international planning are : access to raw materials, development of backward areas, public works of an international character, human migration. A solution to these problems will be dependent upon a corresponding organization of political relations.

Town and country planning—according to Prof. William Holford, of the University of Liverpool—is chiefly concerned with the use of land for a variety of human purposes which may be broadly grouped as (*a*) agriculture and forestry, (*b*) development, including industry, (*c*) recreation and (*d*) transport.

The problems of agriculture were outlined by Sir John Russell, director of the Rothamsted Experimental Station. The agricultural systems of pre-scientific days, he stated, had two features in common : they aimed at providing complete subsistence for the community, and at conserving the land. The three-field or strip system common in Great Britain, round the Baltic, in northern India and elsewhere aimed further at an equitable distribution of good and bad land.

As practised in Europe, the strip system had the merit of permanence but was of low productiveness and had to be abolished. The U.S.S.R. adopted one method and Poland another, but a change was essential. In Great Britain the change to unified holdings was made before the scientific era, and technical improvements raised the output per man higher than in any country in Europe, though the output per acre was less than in the smaller western countries of small holdings. In the new economic system introduced since the War, under which specified prices will be received and specified wages must be paid, and with the help of scientific methods, the indications are that high output per acre will be attained, as well as high output per man (see also Nature, of October 18, p. 456).

The dangers of deforestation were touched upon in a paper prepared by Lord Onslow, who made an appeal for the conservation of the wild life of the world. Within the last hundred years or so, several dozen species of animals of æsthetic, scientific and commercial value have been exterminated, and it is of the utmost importance to save others from a similar fate.

"Free play given to economic forces in the past has led to localization of a single industry in one district and has resulted in derelict areas and 'ghost towns' when that industry was depressed", stated Prof. P. Sargant Florence, of the University of Birmingham. Recent scientific progress has on the whole intensified the economic trend towards industrial concentration ; if the social and socio-economic criteria are accepted and dispersion of industry is adopted as a policy, hard thinking and fighting lies ahead for planners.

Dr. Othmar Ziegler, lately of the University of Prague, dealt with the transport problems of the Danube States, and estimated that if transport can contribute to raising the standard of life in south-eastern Europe to one third or one half of that of western Europe it will furnish employment, through the expected increase in exports, to tens of thousands of workmen in western Europe.

The world's heat and power requirements was the subject of a paper by Sir Harold Hartley, who pleaded for a detailed consideration of the world's energy resources, their utilization and conservation, in the light of post-war schemes of reconstruction. If all the potential water resources were to be harnessed, the estimated energy would not exceed 30 per cent of the requirements, so that burning of fuel must continue to supply the greater part of the world's energy consumption until some other source, such as the direct utilization of the sun's radiation, has been made practicable upon a large scale.

Carbonization of raw coal and the use of electricity in a co-ordinated scheme, designed to secure maximum advantages from both, will help to solve the problem of smokeless cities and provide cheap energy needed in homes. Wider application of energy on farms, and in conditioned transport and storage, would increase productivity and accelerate processing. With the scientific knowledge we now possess it should be possible to plan with much greater certainty than in the past.

Dr. Ove N. Arup, a civil engineer from Copenhagen, inquired into the reasons why modern buildings lack many of the desirable qualities which modern science and technique have made possible : warm, sound-proof rooms, well ventilated and provided with labour-saving devices. The difficulty appears to lie in specialization, and Dr. Arup asked whether a "composite mind" could be created in the form of an organization that would achieve a well-balanced synthesis from the wealth of material available. There exist already teams which include architects, engineers, heating specialists, etc., but so long as such groups work for profit they may try to keep their experience secret or advocate materials and processes in which they have interests. An extension of the present research stations is needed, to carry out the checking up and classification of existing technical information, and the creation of planning organizations.

The nature of modern science demands not only planning and team work, stated Mr. D. P. Riley, of the University of Oxford, but also international planning and team work. To overcome the language difficulty a co-ordinated system of abstracting would be very valuable. More frequent international conferences should be held and their scope should be enlarged so that, with a modified organization of conference procedure, they may become valuable world-planning commissions.

Prof. Jacques Metadier, formerly professor of biological physics in the University of Poitiers, advocated the setting up of an international society for scientific research, a kind of co-operative society to which everyone concerned in the exploitation of scientific discoveries would have to contribute a small percentage of their profits. Out of the resulting fund payments would be made to scientific workers whose researches had been economically exploited, and, in addition, research scholarships would be created and pensions would be made available to research workers over a given age, even though their labours may not have had practical applications.

Turning from visions of what the future might bring, to research now being carried out relating to planning and to post-war reconstruction, Prof. Alvin H. Hansen, of Harvard University, gave an outline of what is being done in the United States. For the last eight years the National Resources Planning Board has been engaged in studies relating to the natural, human, scientific and economic resources of the nation. Some of its activities in connexion with social welfare have already been noted (see p. 455). In addition, the Board is required to maintain a six-year programme of Federal Public Works.

In 1934 the Board sponsored a survey of the extent of soil erosion, which led to the establishment of the Federal Soil Conservation Service with authority to make surveys, conduct research, establish demonstrations and educate the public about soil conservation. In 1936 the new Agricultural Adjustment Act combined the dual purpose of soil conservation and agricultural production, and the Flood Control Act charged the Department of Agriculture with responsibility for watershed treatment.

One of the most significant achievements of the United States Government during the past ten years has been the redevelopment of the Tennessee Valley, with an area nearly as large as Great Britain. The large-scale planning carried out by the Tennessee Valley Authority was described by Prof. L. Gulick (see p. 388). Planning, said Prof. Gulick, is not only compatible with a democratic system of multiple parties, free elections, free criticism, free discussion, free enterprise and private capitalism, but it is essential in releasing the energies of freely co-operating individuals and governmental and private corporations in fulfilment of plans and objectives.

Mr. Hugh P. Vowles, on the other hand, who has made a study of large-scale electrification in several countries, considers that scientific planning upon a comprehensive scale is incompatible with private capitalism. There can be no co-ordinated development of power and associated resources, since one authority would plan electrification and another gas supply without pausing to consider whether they fit together, or with other associated activities. In the Soviet Union, he claimed, co-ordinated planning covers all aspects of exploitation of power and material resources, with the public welfare kept steadily in view.

This ends the series of summaries of deliberations of the Conference. In this, and in the previous five reviews, an attempt has been made to bring together pronouncements bearing upon specific subjects, so as to form a consecutive whole. Unfortunately, the contributions considered, though generally good in their particular field, frequently bore little relation to one another ; they will serve excellently, however, as material for a future conference on world planning.

SCIENCE IN THE DEFENCE OF CIVILIZATION

RADIO MEETING AT MOSCOW

WORLD-WIDE interest and sympathy has been aroused by the appeal of the meeting of men of science held in Moscow on October 12. Messages of greeting, sent in advance to the meeting, included one from Sir Henry Dale, president of the Royal Society of London, declaring solidarity with the Soviet men of science and those of the whole world who are united in the struggle against Germany's attack on freedom, including free scientific research.

The Secretaries of the Royal Society also sent messages declaring that Russian men of science are fighting for all that is essential for the development of science, and that their great achievements in science will serve as a firm support in this struggle.

In the name of forty thousand members, the secretary of the British Medical Association sent greetings to the representatives of medical science in the Soviet Union, and wishing success in the common task of freeing humanity from its sufferings in a new, better world which will be built after the War.

Other messages were sent including greetings from Sir Richard Gregory, president of the British Association, Prof. Julian Huxley and Prof. J. B. S. Haldane and Mr. and Mrs. Sydney Webb. Many messages were sent from the United States, including those from the president of Harvard University, representatives of Columbia University, the Universities of Chicago and New York and from many other American men of science.

The Association of Scientific Workers, in its message, welcomed the timely action of Soviet men of science in organizing the meeting. Its message concluded : "We British scientists deeply appreciate that our Soviet colleagues are right in the front-line of the struggle against Fascism, and we send them our warmest greetings. We feel that world-wide contact between scientific workers, in order to exchange information, ideas and technique, will be an important factor in ensuring victory. In particular, the closest collaboration must be created between Soviet, American and British scientists. We represent between us a free intellectual power which Hitler cannot emulate. Let us make certain that it is used to the full to win the war and create a better world. Our Association is organising a Conference in January to discuss in detail how we, as scientists, can increase production, protect the people's health, and train reserves of technicians. Let us hear from your scientists all over the world how you tackle these problems."

Prof. V. L. Komarov, president of the Academy of Sciences of the U.S.S.R., was prevented by indisposition from attending the meeting. He sent the following message : "Brothers in the common cause, scientists of the world, creators of culture and progress, this is a decisive and momentous hour for humanity.

"The sinister hordes of modern vandals are holding out a mortal threat to world civilization. The mightiest democracies of modern times, together with all freedom-loving peoples, are mobilizing their forces against the enemy of mankind. Part of the arsenal of the anti-Fascist coalition is the unlimited creative power of science.

"The scientists of the Soviet Union are ardently taking their share in promoting the industrial, cultural and military progress of their country. The knowledge of danger multiplies our strength and will to victory. Throughout the vast expanse of their country, Soviet scientists are seeking new sources of raw material and power, developing new technological methods and designing new plant with the purpose of expediting victory.

"Soviet scientists appeal to the science of the world to aid the greatest and most worthy cause of modern times. We appeal for the union of all forces for the utter defeat of Fascist Germany. The time is short ; decisive days have come. The future of mankind, its progress and plans demand the annihilation of the reactionary Hitlerite clique."

Prof. Butyagin, who took the place of Prof. Komarov, said : "Hitler is the enemy of science, progress and enlightenment. He has destroyed culture in France, Holland and the Slavonic and other countries which he has occupied. Hitler seeks to suppress culture and science all over the world. Therefore it is our task to fight for the liberty of humanity. The scientists of the Soviet Union are taking a whole-hearted part in the industrial, cultural and military development of the country. Soviet science has been responsible for great achievements, for the translation of the scientific literature of various nationalities, for new development in many fields."

Prof. P. Kapitza, who was formerly Royal Society Messel research professor and director of the Royal Society Mond Laboratory, and is well known for his work in magnetism and low-temperature research, pointed out that in the past twenty years military technique has made great strides, and there is no doubt that, with the present level of knowledge, it may make greater strides still. Fascism employs science solely for the purposes of war. The task to-day is to eradicate Fascism, which has already caused so much misery and destruction all over Europe. The scientific resources of the democratic countries are considerably larger than those of Nazi Germany. Under the ægis of Nazism, the level of even the exact sciences has declined frightfully in Germany, and partly for this reason German technique has already begun to lag behind in many respects.

Science has not exhausted its potentialities of combating the aggressor. Consequently, if other men of science join their efforts to those of the U.S.S.R., the enemy will be defeated all the sooner, and the menace threatening the world will be averted.

Prof. T. O. Lysenko, well known for his work on the process of vernalization of seed, said that true science directs its creative efforts to the discovery of the laws of Nature, to mastering and directing these laws for the benefit of social welfare. On the basis of the teachings of Charles Darwin, Soviet men of science have achieved advances in the planned alteration of the nature of plants important for agriculture. They have created remarkable new varieties of plants and animals.

Present-day German men of science pervert and defile biological science. The Nazi racists distort biological science in order to give a so-called 'scientific basis' for the Nazi theory of higher and lower races, for the ruthless extermination of millions of people.

Scientific discoveries can improve the living conditions on this earth. Bloodthirsty Nazism, however, does not set itself the aim of making life happier and easier by conquering the forces of Nature for the service of man, as can be done through the medium of science. Its aim is to devastate the earth by robbery and violation.

The true men of science, biologists of the United States, Great Britain, the Soviet Union, who respect humanity and its creations, do not defile the science of biology, do not use it in order to enslave humanity. With their scientific work, they help humanity to make better and better use of natural resources . Modern science is inseparable from democracy, and we must do our part in liberating humanity from Fascist tyranny.

Prof. A. E. Fersman described the Soviet Union as a country stretching from polar islands to the tropics, reaching heights of more than seven and a half kilometres, and with valleys lying hundreds of metres below the sea-level, with deserts and stretches of land of permanent frost and ice, of more than ten million square kilometres, a vast country inhabited by the greatest variety of nations, speaking a hundred and fifty different languages, with their national cultures, habits and ways.

For many years it was desolate and unexplored. More than half of it had never been investigated by geologists or geographers. Only fourteen kinds of metals out of the ninety elements of the Mendeléeff table were extracted from its earth. The plants of its tropics were growing wild.

But the country has risen to new heights during the last twenty years. Tens of thousands of scientific expeditions have carefully explored its unknown parts. During this last quarter of a century, the first geological map of the U.S.S.R. was made, and during these years about 75,000 new fields where useful ores could be extracted were found. The amount of coal resources known increased ten times, that of iron ore thirty-three times, copper and lead more than ten times. Many of these ores have never been extracted before. Mendeléeff's table has been practically covered by the variety of our extractions.

The rich soil, too, was explored. Agriculture developed all over the country, in the north, in the deserts of middle Asia. A new geography was started in the country. A network of railway lines was covering it—connecting the industrial centres with the far-away southern Urals, the heights of the Altai, the rough forest district of the Pechora. It was a grand picture of peaceful labour, transforming the earth by human reason and scientific work.

Now this work of conquering the forces of Nature has been crudely interrupted by the wild aggression of barbarism. Soviet science has switched over, and turned its powerful knowledge wider, fuller still for the protection of the Soviet country. War not only requires more raw materials. It also requires thousands of new materials for defence work. It opens up a wide field of activity to all geologists and other men of science. Then, when Fascism is smashed, science will again return to its peaceful course, and will place the fruits of its labour at the disposal of a liberated world.

Prof. A. N. Frumkin spoke in the name of all Soviet chemists. Among the weapons with which Fascist Germany is attempting to strengthen the legend of its invincibility, an important part is played by the high level of German chemistry. Without doubt, the development of chemistry and chemical industry are among the most essential factors on which modern warfare depends. At the beginning of the War of 1914–18, Germany occupied undoubtedly the first place in chemical industry, the high level of which helped her to a great extent to overcome the difficulties caused by the blockade. However, in spite of such great achievements as the development of the production of synthetic ammonia, etc., the chemical industry in Germany was unable to avert the exhaustion of its resources and the final collapse.

In the period after the War, there was a strong development of chemical industry in the United States on the basis of the oil industry. Apart from this, the achievements of German chemical industry were largely due to the high level of scientific research. This basis of scientific research was broken up by the decline of German science when Nazism came to power.

In the period between the War of 1914–18 and this War, German chemical industry, which was then on a technical level much superior to that of Tsarist Russia, was developed. In spite of this, we can be sure that if chemistry was unable to save Germany in the War of 1914–18 it is still less able to save it now. The Soviet chemists have been able to evolve a number of new and important methods of production. At the present moment, they are mobilizing all their strength to help in the struggle against Fascism. The Soviet chemists will collaborate with the men of science in Great Britain and the United States who signed the appeal to fight Fascism.

Prof. Frumkin called on men of science throughout the world to use their knowledge for the invention of new methods in the fight against Fascism. In the face of the Fascist attack there can be no place for 'science for the sake of science', for 'science which must remain neutral'.

The Soviet men of science then issued an appeal to all men of science, the substance of which was as follows: "Soviet scientists gathered at the Anti-Fascist meeting in Moscow appeal to scientists of the whole world to unite their forces against Hitlerism, the greatest enemy of culture and science. By participating in the war of our country against Fascism we are endeavouring not only to do everything within our power to expel from our territory the Fascists who have been inflicting unheard of and bestial tortures on our citizens, but also to help in establishing a democratic life for all peoples and to come to the aid of science and culture now threatened by Fascism. This menace of Fascism hanging over the whole world seeks to destroy freedom, civilization and all scientific progress.

Hitler's vandals have closed down the centres of culture in the countries which they have occupied. Universities and schools have been closed in Belgium, Norway, Holland, Latvia, Lithuania, Poland, Yugoslavia, Greece and Czechoslovakia. Fascist reaction has stifled scientific thought in France. Fascism has defiled science. In the place of the power of reason the Fascists have proclaimed the power of brute force, ignorance and base instincts. In place of biology, the majestic science of the laws of life, the Fascists invented their inhuman racial theory, with the object of justifying their domination of the whole world. For sciences which foster greater unity among peoples and better mutual understanding, such as geography, ethnography and history, Fascism has substituted so-called geo-politics, with the sole aim of justifying Germany's right to predatory invasion and the enslavement of other peoples. Fascism has replaced the humanism characteristic of the spiritual development of peoples by the creed of eternal war and progressive marasmus, by depravity, the enthronement of darkest reaction and the mass murder of the weak, the old and the infirm. Fascism is a deadly menace to culture and science which are most dear and precious to us. In their common work for the conquest of Nature, scientists throughout the world pay the greatest attention to the furtherance of culture and the welfare of the human race, whereas Fascism utilizes the achievements of modern science and its technique for destruction and extermination.

"Our scientific work has always been closely related to the requirements of the peoples of our country, which coincide with the interests of the whole of humanity. Our scientists have always put their work at the disposal of our country in making available its immense natural resources and developing its national economy. The scientific development of our national economy permitted the creation in twenty years of large-scale industry and a reorganized agriculture, which has increased the standard of living of all the peoples of the Soviet Union.

"Our country grew in strength as a result of the collaboration of all the nationalities inhabiting the Soviet Union. By the laws of our constitution all nationalities have equal rights and are equally respected as members of our large Soviet family. Our scientists study the history of all peoples of the Soviet Union, study their folk-lore and enrich Russian national culture. This work has fostered the unity of our people and their mutual respect for each other's culture.

"We Soviet scientists are convinced of the final victory over Fascism and its complete annihilation. We consider that the mutual understanding and respect of all nations, based on equality and the independent culture of each country, is the basis for their collaboration.

"We appeal to the scientists of the whole world at a time when the Soviet people have to bear the brunt of Hitler's war machine, when our towns are being destroyed and our people subjected to plunder and torture, at a time when the question of the existence and liberty of the peoples of the Soviet Union, Great Britain and the United States are being fought out on our battle-fields.

"All people interested in culture and science must unite to prevent Hitler from destroying the nations one by one."

ABERDEEN UNIVERSITY VACANCY

CHAIR OF NATURAL HISTORY

The Secretary of State for Scotland announces that the office of Regius Professor of Natural History in the University of Aberdeen will become vacant on February 1 next owing to the resignation of Professor Lancelot Hogben, M.A., D.Sc., F.R.S., who has been appointed to the Chair of Zoology in the University of Birmingham.

It is proposed to take steps with a view to the filling of the vacancy in Aberdeen.

Applications for the Chair, accompanied by two copies of recent testimonials, should be addressed to the Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1, and should reach him not later than November 22, 1941.

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The Council invite applications for the post of Secretary to the Association. Applicants should have previous business or administrative experience and some scientific or technical training; preference will be given to those with a knowledge of the rubber industry. Salary £400 to £500 per annum according to qualifications and experience. Write, giving full particulars, to: Acting Director of Research, 105 Lansdowne Road, Croydon. Applications should be received not later than November 8.

Indexer and Abstractor. A woman graduate is required whose principal duty will be the indexing and abstracting of articles of chemical interest in current medical and biological literature. Candidates should have a degree in science with honours in chemistry, and with physiology or biology as a subsidiary subject. They should be able to read French and German easily and to use a typewriter. Applications should be addressed to the Secretary, Wellcome Research Institution, 183 Euston Road, N.W.1.

Microscopes, second-hand, a large selection of instruments in perfect condition; 8d. stamp for list.—Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

A large firm of chemical manufacturers in North-West England has vacancies for a number of chemists, either male or female, for research and process work of national importance. Applicants should be qualified chemists, holding B.Sc. Degree or A.I.C. Research or industrial experience an advantage. Salary from £250-£350 per annum, according to age and experience. British nationality essential. Write Box E.25, Lee & Nightingale, Liverpool.

The British Council require an Assistant Editor, skilled in scientific journalism, to assist in the publication of Monthly Science News. Man or woman. If man, should be over thirty. Salary according to qualifications. Apply, sending full qualifications, to British Council, 3 Hanover Street, London, W.1, marking envelope "Science."

Beilstein's Handbuch. Vols. 15-31 and Supplements 23-27; Berichte d. Deutschen Chem. Gesell. 1900-1939; Jnl. Amer. Chem. Soc.1929-1941; Helvetica Chim. Acta. 1918-1940; Houben-Weyl, latest Edn.; Kunststoffe 1913-1939; and similar Journals, wanted by THE MUSEUM BOOK STORE, LTD., 45 Museum Street, London, W.C.1.

Wanted. One-twelfth objective, preferably with iris.—Vaughan, M.P.S., 56 Bexhill Road, London, S.E.4.

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ACTIVITY OF CARBONIC ANHYDRASE WITHIN RED BLOOD CORPUSCLES

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

Carbonic anhydrase, the enzyme which catalyses the reversible reaction $H_2CO_3 \rightleftharpoons CO_2 + H_2O$, is present in a large concentration in the red blood corpuscles[1], the gastric mucosa[2,3,4] and the pancreas[5] of vertebrates, especially mammals. The enzyme plays a very important part in the carbon dioxide transport by the blood, and its activity is directly or indirectly linked with the reactions involved in the acid-base equilibrium in the body.

It was shown recently that carbonic anhydrase is a zinc-protein compound where zinc forms the active part of the enzyme molecule[6,7]. Although carbonic anhydrase is present in mammalian erythrocytes in a very large concentration (namely, 0·21 gm. of pure enzyme per 100 c.c. of erythrocytes) the activity of this enzyme cannot be detected on intact blood cells by applying to them the standard manometric or colorimetric methods. In fact, the entire study of this enzyme, including that of the kinetics of the reactions it catalyses, has so far been carried out either on laked blood or on hæmoglobin-free enzyme preparations[1,7,16]. On the other hand, the small activity exhibited by the corpuscles in manometric experiments carried out under certain conditions[8] cannot definitely be ascribed to this enzyme as no control experiments were done under precisely the same conditions on corpuscles treated with one of the inhibitors of carbonic anhydrase.

In the present article we propose to describe a simple spectroscopic method by means of which the catalytic activity of carbonic anhydrase within the corpuscles can be easily demonstrated and studied quantitatively. This method is based upon the following facts:

(1) Hæmoglobin within the red blood corpuscles can easily be oxidized to methæmoglobin without affecting the integrity of the cell walls.

(2) Methæmoglobin can act as an indicator[9,10] changing its colour and the pattern of its absorption spectrum with the change of pH from 6·5 to 9·5.

(3) The change from acid to alkaline methæmoglobin within the corpuscles can easily be observed[11] by treating them with alkaline phosphate or carbonate solutions. The reverse reaction can be seen by treating the alkaline cells with carbon dioxide or acid phosphate solution.

(4) The velocity of these changes can be determined spectroscopically with great precision.

(5) Carbonic anhydrase is strongly and reversibly inhibited by sulphanilamide[12] which rapidly penetrates within the corpuscles and which, unlike other inhibitors of carbonic anhydrase (such as potassium cyanide, hydrogen sulphide and sodium azide) does not react with methæmoglobin.

The catalytic activity of carbonic anhydrase within the corpuscles can, therefore, be determined by comparing the velocity of the changes from acid to alkaline methæmoglobin and *vice versa* in presence and in absence of sulphanilamide.

Preparation of Methæmoglobin Corpuscles

The red blood corpuscles of 100 c.c. of defibrinated horse blood separated from serum are washed with 0·9 per cent sodium chloride. 50 c.c. of washed corpuscles are mixed with an equal volume of isotonic solution of sodium nitrite (1·06 per cent), left standing five minutes, washed four times in 200 c.c. of 0·9 per cent sodium chloride and suspended in 100 c.c. 0·9 per cent sodium chloride. The suspension *A* thus obtained is composed of brown cells showing a distinct absorption spectrum of acid methæmoglobin.

On addition of alkaline phosphate or of carbonate solution to this suspension its colour turns from brown to red and the absorption spectrum of acid methæmoglobin is gradually replaced by that of alkaline methæmoglobin.

Spectroscopic Study of Methæmoglobin Corpuscles.

The changes in the absorption spectra of these corpuscles were followed at 17° by a method devised previously for the study of methæmoglobin[13], the observations being carried out by means of a microspectroscope ocular attached to a microscope (Fig. 1). 2·5 c.c. of suspension *A* are mixed with 150 c.c. 0·9 per cent sodium chloride forming a dilute suspension *B*. 3 c.c. of *B* are put in the flat-bottom vessel *g* 16 mm. in diameter immersed in a small glass water-bath *h* placed on the microscope stage. The depth of suspension in *g* is therefore $\frac{3}{3{\cdot}14 \times 0{\cdot}8^2} = 1{\cdot}5$ cm. The standard suspensions of acid and alkaline methæmoglobin corpuscles are introduced into compartments e_1 and e_2 of a double-wedge trough 15 cm. long and 2·3 cm. wide (inside measurements). These suspensions

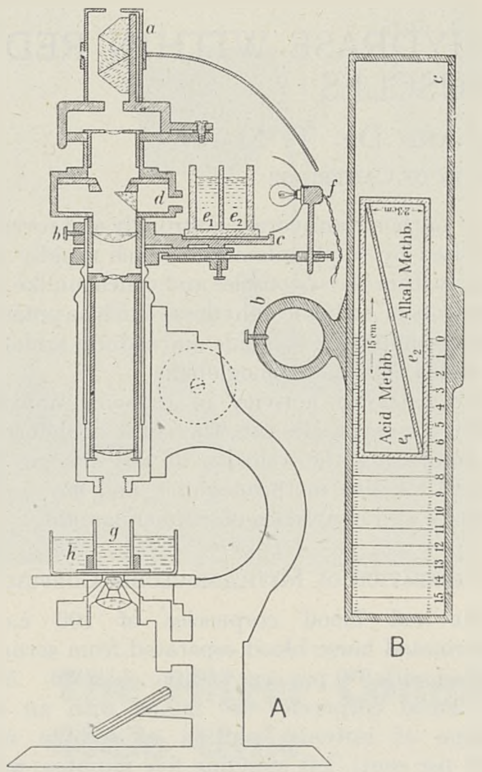

Fig. 1.

are prepared in such a way that in a depth of 2·3 cm. they match completely the 1·5 cm.-deep suspension of vessel *g*. For this purpose 1·63 c.c. of stock *A* is suspended in 120 c.c. 0·9 per cent sodium chloride forming stock *C* ; to 60 c.c. of this suspension is added 15 c.c. of $M/5$ phosphate solution of *p*H 6·4 forming the suspension for the side e_1 of the trough, to the remaining 60 c.c. of stock *C* is added 15 c.c. of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide solution forming the suspension for the side e_2 of the trough. The trough is placed in front of the side aperture *d* of the micro-spectroscope on a brass platform *c* attached by means of a ring *b* to the microscope tube. The position of the trough is read on a scale fixed to the platform and covered by a sheet of glass along which the trough can be easily moved. The vessel *g* is illuminated in the usual way, while the trough is illuminated by a 4-volt filament lamp *f*. The intensities of both lamps can be regulated by means of independent rheostats. While keeping the illumination of the two spectra equal by adjusting the rheostats, the trough is moved along the platform until the position is found where the intensities of the absorption bands of the spectra obtained from the suspension in *g* and from that in the trough are equal. At the beginning of the experiment the suspension in vessel *g* received 0·1 c.c. of $M/5$ phosphate solution *p*H 6·4 and the position of the trough is adjusted and read on the scale. The vessel *g* then received 0·1 c.c. $M/5$ sodium carbonate which is rapidly and thoroughly mixed with the suspension of corpuscles. The trough is moved along the platform towards the left and its positions at which both spectra match are read from the scale at intervals of 10, 15, 20 seconds or longer if necessary. The percentage of alkaline methæmoglobin formed is obtained by multiplying the reading (in centimetres) of the scale by 100/15. Thus if the reading is 6·5 cm. the alkaline methæmoglobin formed will be 43·2 per cent.

Concentration of sulphanilamide	Time for 50% change (sec.)
0	34
$5 \times 10^{-6} M$	52
$5 \times 10^{-5} M$	75
$5 \times 10^{-4} M$	210

The experiments described above were followed by others in which a small amount of sulphanilamide ($5 \times 10^{-4} M$ final concentration) was added to suspension *g* one or two minutes before the addition of carbonate. The results of a typical experiment in presence and in absence of sulphanilamide, which are shown in Fig. 2, clearly demonstrate the catalytic activity of carbonic anhydrase within the red blood corpulscles. The effect of other concentrations of sulphanilamide which was determined by the time (in seconds), required for 50 per cent change is shown in the accompanying table.

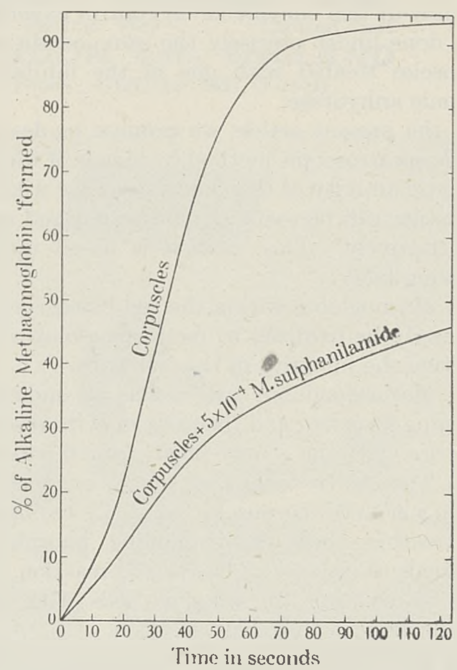

Fig. 2.

That no laking takes place during all the experiments described in this article is clearly demonstrated by the colourless supernatant fluid left after centrifuging off the corpuscles in suspensions *g*.

Chloride Shift

The method described above affords also an easy approach to the study of Hamburger's chloride shift. It is well known that the red blood corpuscle is impermeable to metallic cations, so that when, for example, bicarbonate ions move into or out of the corpuscle, the ionic equilibrium on both sides of

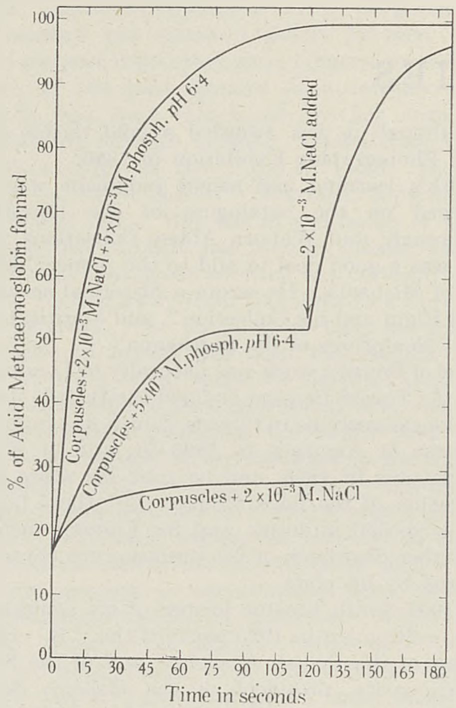

Fig. 3.

the membrane is re-established by the movement of chloride ions in the opposite direction, which is in accordance with Donnan's membrane equilibrium theory[14,15,16,8]. The available chloride ions in the corpuscle may therefore become the limiting factor in determining the amount of another anion which can pass through the membrane[16]. On the other hand the concentration of the chloride ions in the corpuscles can be greatly reduced by washing them in an isotonic phosphate solution[8]. It is, however, important to note that washing the corpuscles in acid phosphate makes them impermeable also to anions. Thus, acid methæmoglobin in such corpuscles does not turn alkaline even after prolonged incubation in an isotonic mixture of sodium chloride and sodium carbonate and yet on plasmolysis methæmoglobin becomes completely alkaline. The simplest way for removing chloride ion from corpuscles without affecting their permeability is to wash them in an isotonic alkaline phosphate solution or in a solution of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide. The corpuscles washed in this way and suspended in 12 per cent sucrose solution show about 85 per cent alkaline methæmoglobin. Such corpuscles were used for spectroscopic experiments carried out as above, except that acid phosphate is now added to alkaline corpuscles and the velocity of the formation of acid methæmoglobin is recorded. The results of these experiments summarized in Fig. 3 clearly show that the addition of acid phosphate alone produces only a slow and incomplete change from alkaline to acid methæmoglobin. A rapid and complete formation of acid methæmoglobin takes place, however, if together with the same amount of acid phosphate a small amount of sodium chloride is added to these corpuscles. The fact that this rapid reaction is also inhibited by sulphanilamide shows that also the chloride shift depends on the activity of carbonic anhydrase. Cl′ in this reaction can be replaced by Br′ and I′.

The results obtained spectroscopically, which are moreover in agreement with previous views on the subject[8,16], are corroborated by direct estimations of chloride diffusing from the corpuscles into the surrounding medium. For this purpose methæmoglobin corpuscles or untreated red blood corpuscles are washed in 6 per cent glucose solution. 2 c.c. of these corpuscles are suspended in 11 c.c. of isotonic glucose solution, kept for thirty minutes at room temperature and cooled to 0° C. The cold suspension is treated then with 1 c.c. of $M/5$ sodium bicarbonate in $M/10$ sodium hydroxide and the corpuscles are rapidly centrifuged within two minutes, leaving 10 c.c. of supernatant fluid *D*. The second sample of 2 c.c. of corpuscles is suspended in 11 c.c. of 6 per cent glucose solution containing 70 mgm. sulphanilamide and then treated in the same way as the previous sample, giving finally 10 c.c. of supernatant fluid *E*. The third 2 c.c. sample of corpuscles is also suspended in 11 c.c. of 6 per cent glucose and, without previous treatment with carbonate, the corpuscles are centrifuged off, leaving 10 c.c. of supernatant fluid *F*. The estimation of chloride in these three fluids, carried out in the usual way[17,18], gave the following results : sample *D* obtained in absence of sulphanilamide contained 2·5 mgm. chloride, sample *E* obtained in presence of sulphanilamide contained only 1·63 mgm. chloride, and the untreated sample *F* contained 0·3 mgm., chloride. While a delay in centrifuging up to fifteen minutes has no effect on samples obtained in the absence of inhibitor, those in presence of sulphanilamide after four and fifteen minutes delay in centrifuging contained respectively 1·9 mgm. and 2·5 mgm. chloride.

All this clearly shows that sulphanilamide, as would be expected, delays the reactions which induce the 'chloride shift'.

The main results of our investigation consist, therefore, in the direct spectroscopic demonstration : (*a*) of the activity of carbonic anhydrase within red blood corpuscles, and (*b*) of the link between this activity and the chloride shift which forms part of the mechanism controlling the acid-base equilibrium in blood.

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OBITUARIES

Mr. A. H. Smith, C.B., F.B.A.

MR. ARTHUR HAMILTON SMITH, who died on September 27, was best known among classical scholars and archæologists by his Catalogues of Classical Sculptures and of Engraved Gems in the British Museum, but in unobtrusive ways he rendered valuable service to ancient art and archæology.

He was born near Glasgow on October 2, 1860, the son of Mr. Archibald Smith. He was a scholar of Winchester College and of Trinity College, Cambridge. In the Classical Tripos Part II he was placed in the first class in 1883. In 1886 he entered the British Museum as an assistant in the Department of Greek and Roman Antiquities, at a time when the great reorganization initiated by Sir Charles Newton had reached the stage at which the antiquities could be catalogued and described. To Arthur Smith were assigned the "Catalogue of Engraved Gems" (1888), a modest but very useful book, and the "Catalogue of Sculpture" in three volumes and on a more extensive scale, which occupied the greater part of his years of museum service. He also wrote the popular "Guide to the Department of Greek and Roman Antiquities" to which many owe their first introduction to ancient art in general. Unofficial but closely related to his departmental work was his editing of the first two fascicules of the "Corpus Vasorum" for Great Britain, an early contribution to a vast project, of French origin, which needed judgment and industry such as his in its first rather experimental stages. He had already contributed in an unusual and interesting way by devising a 'cyclograph' in which a cylindrical or conical object was carried forward along the circumference of a circle, and at the same time rotated in front of a photographic camera at the centre, so that a record of its curved surface was made on a flat print. The procedure was that of the rotary printing press ; though unless the surface was approximately cylindrical there was distortion, and if it was convex in a second direction there was loss of focus also. To demonstrate his invention Smith published a series of "White Athenian Vases in the British Museum" with collotype plates ; but the device has not been much used, though it was awarded a gold medal at the Berlin Photographic Exhibition in 1896.

Smith's learning and sound judgment were well employed on the catalogues of the Lansdowne, Yarborough, and Woburn Abbey Collections, where there was a good deal to add to the pioneer descriptions of Michaelis. He wrote a historical account of "Lord Elgin and his Collection", and a critical study of the "Sculptures of the Parthenon".

Most of Smith's work was naturally in London, but when the Turner Bequest enabled the British Museum to make excavations in Cyprus, Smith was for a while in charge at Amathus in 1893–94, and at Enkomi near Salamis in 1896, and he took his share in the publication of the finds (1899). But these lay outside his special interests, and for Enkomi there was the further drawback of the preposterous chronology favoured by his chief.

In 1909 Smith became keeper of his Department, and on retirement in 1925 received the C.B. He was a fellow of the British Academy, and of the Society of Antiquaries, president of the Hellenic Society, 1924–29, and for long the editor of its *Journal*. For many years he was treasurer of the British School of Archæology in Rome, and chairman of its Faculty of Archæology, History, and Letters. In 1928–30 he went to Rome as its director, and returned in an emergency in 1932. His administrative experience and sound knowledge of his own subject were invaluable here, but he had little experience of students or academic life. Another external interest was in Byzantine art, and he was one of the founders and managers of the Byzantine Research Fund, later administered by the British School at Athens.

His unassuming manner and hesitancy of utterance did not conceal his kindly and humorous outlook on men and things, and his knowledge and judgment were always at the disposal of others.

JOHN L. MYRES.

WE regret to announce the death of Prof. R. B. Wild, emeritus professor of materia medica and therapeutics in the University of Manchester, aged seventy-nine.

NEWS AND VIEWS

The Prospect Before Us

On p. 477 of this issue appears an argument which attempts to explain the behaviour of present-day Germany. On p. 490 are published extensive abstracts from the messages sent by Russian men of science to others in democratic countries. These messages constitute first a direct appeal to all decent men; but they go farther than that. They tell of the progress of science in post-revolutionary Russia. As shown in an article on "The Rise of Science in Russia" (Nature, September 27, p. 357), science in that country was initiated chiefly by men invited for the purpose from other more progressive countries. Science of the past quarter of a century in the U.S.S.R. has been developed by her own sons, as shown in the two articles "Present-Day Science and Technology in the U.S.S.R." and "Biological Science in the U.S.S.R." (Nature, September 27, pp. 360 and 362). But one of the faults of modern science in the U.S.S.R. has been its intense nationalism, though that great country has certainly shown signs of veering away from this drawback during the past ten years. The tendency to keep her scientific discoveries to herself has been too evident in the U.S.S.R., so it is no cause for surprise that many other men of science have questioned, even suspected, Russian scientific claims in the recent past. That cause for complaint is, we are glad to see, fast disappearing. For example, glancing through the correspondence columns of Nature over a period of the past ten years, we see an increase in Russian contributions which runs concurrently with a corresponding decrease in contributions from Germany. These naturally inspire the questions: Where is it all leading: what is the prospect before us? Looking back, we must realize that the U.S.S.R. had the despotic Tsarist regime behind it; small wonder that to-day they are 'realists'. On the other hand, present-day Germany with her science in chains has a past of great scientific achievement based on the best traditions.

We might say there are at least three sources of inspiration for a man of science as such—fear, gain, service. Who can doubt that present-day Russian men of science are inspired by service—service to their own country? Nevertheless, we feel that in the past they have kept themselves too much to themselves. Their science has been directed solely to their own needs: as M. Maiski recently stated, Russian science is planned; "there is no place in the U.S.S.R. for pure science"—a rather unfortunate statement, since we do not believe that pure science has been altogether taboo in the U.S.S.R. Nazi German so-called science is, on the other hand, inspired solely by fear or gain—by fear of political or military overlords or by the desire for Nazi favours or personal profit. From the designing of murderous weapons of war to the postulation of absurd racial theories, it is clear that little true science exists in that unhappy country. And all this went on before war broke out—it has been going on since 1933. There has been such complete subjugation of science that what there is left must remain suspect, if not, indeed, the subject of ridicule, such as the Nazi-inspired philosophy of Stark, one of the world's greatest physicists (see Nature, 141, 770; 1938). All this makes the prospect of those concerned for the future of science one of enormous difficulty, fraught with many tough problems, but none of them insurmountable. The vexed question of pure as opposed to applied science will be one which will have to be considered with cool judgment.

Of course there are, and there will be, extremes and extremists. Even now it is often difficult to decide what is pure and what is applied. The period between a scientific discovery and its application to human society must vary within very wide limits. If planning aims at reducing that period to the minimum, then planning is good; but where the period cannot be envisaged at all, as in the more theoretical sciences and philosophies, we must not allow the extreme materialists to eject such branches of science from the programmes of the future. The ultimate prospect must be a thorough study of the impact of science on society. That cannot be undertaken under any form of duress; there must be complete freedom. But the extremes must be brought to book. Those who will look only at such sciences which can show immediate application must broaden their views. On the other hand, there are those who deliberately hold themselves aloof from any effect their science may have on human society; they are, to say the least of it, selfish, though how often has one heard them claim that they are the only champions of scientific freedom. Science, planned but free, must be the ultimate aim. But the immediate aim is more urgent. This is no time for half-measures and compromise; neither is it the time for ideals. The truth is, Russian men of science have appealed for scientific collaboration with the immediate aim of crushing Nazi barbarism. Men of science in all free countries must respond to that call. That aim demands an immediate unity of purpose and action in smashing aggression; the complete unification of world science must be left to times less terrible and urgent, though not necessarily until the end of the War.

Arrest of French Men of Science

On October 19, the Vichy Government confirmed the arrest in Paris by the German authorities of five prominent professors of the University of Paris, namely: Prof. E. Borel, professor of mathematical physics; Prof. P. Langevin, professor of experimental physics in the Collège de France; Prof. L. Lapicque, professor of physiology; Prof. C. Mauguin, professor of mineralogy; Prof. A. Cotton, professor of physics. According to some sources they are charged with spreading de Gaullist propaganda, according to others with pro-British sentiments, while some newspapers lay emphasis on the fact that the political activity of Profs. Langevin and Borel has been well known since the time of the Front Populaire. Prof. Langevin was imprisoned earlier this year and released later for health reasons.

According to *The Times*, these arrests are causing bewilderment in Haute Savoie, as even the former political opponents of these men of science cannot believe that they have been arrested on account of their personal views. Some light may be thrown on the affair by a recent article published by M. Laval in his newspaper the *Moniteur du Puy-de-Dôme*. In this he says that now that Germany has conquered her enemies, who are those of France, the latter must conquer her disorder and errors and hold out her hand to Germany. Laval then declares that all French persons who are still imbued with anti-German prejudice should be at once dismissed from public offices. He adds that this prejudice now exists, mainly among the intellectuals, where it may be regarded as a remnant of anti-Fascism. In Haute Savoie the view is expressed that the above 'ultimatum' by Laval inspired the Vichy Government to act accordingly, as the French authorities certainly lent a hand in the arrest of the Paris professors.

German Persecutions in Poland

We have received from the Association of Polish Professors and Lecturers in Great Britain (Polish Research Centre, 32 Chesham Place, London, S.W.1) a letter protesting against the second series of persecutions by the Germans of Polish men of science and others since the War began. The fury of the first German attack on Polish science and culture was raging in November 1939, when 180 professors and assistants of the oldest Polish university, that of Cracow, were deported "as criminals" to the concentration camp at Oranienburg. Now we are witnessing the second German attack on Polish science, carried out in the newly occupied territories and aiming at completing the destruction. On occupying Lwow the Germans executed Prof. C. Bartel, professor of mathematics in the Lwow Technical College (see Nature of October 4, p. 402); they also arrested sixty other professors, among them a number of elderly men. The German persecutions are an integral part of the methodical campaign aiming at the total destruction of Polish culture. All the Polish universities, technical and agricultural colleges, commercial academies, all research institutes, all scientific societies, including the Polish Academy of Sciences, have been closed by the Germans. The same fate has befallen all secondary schools. The scientific apparatus and the equipment of laboratories have been transported to the Reich. The Polish museums were and still are being looted. Publication of books and periodicals as well as of independent newspapers has been suspended. Monuments which showed the artistic culture of the nation have been pulled down and destroyed.

All the professors of the University of Poznan have been expelled, deprived of all their personal possessions and left starving. Some of them, headed by Prof. Bronislaw Dembinski, honorary professor of history, have died as a result of the dreadful conditions of life to which they were exposed. Eighteen professors of the University of Cracow, among them the most prominent representatives of Polish science, have died as a result of tortures suffered in the concentration camp of Oranienburg. The professors of the Catholic University of Lublin were kept in prison for some months and some of them are still in concentration camps. Recently a number of Warsaw professors perished as victims of undeserved persecution. "To this black record of German persecutions a new page has been added—the persecutions of Lwow. Executions and concentration camps for Polish men of science—that is what the German 'crusade in the defence of civilisation' has brought with it." In view of these new German crimes which bear full witness to a total degeneration of Hitlerite Germany, we feel sure that men of science in all free countries will wish to join in this solemn protest by Polish savants in Great Britain.

Developments in Agricultural Research

The extended field of activity and additional financial resources which have recently been granted by the Government to the Agricultural Research Council have opened the door to new developments in this branch of applied science. A large part of the Council's activities will still be devoted to co-ordinating, and advising on, the work of the various research institutes to which the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are making maintenance grants, and to furthering the interests of these institutes in every possible way; but it is the Council's intention to devote some part of the funds to be expended at its own discretion, for which it is answerable to the Lord President of the Council, to the furtherance of agricultural research in university departments, and to the enlargement of its own scientific staff. It is, in particular, the Council's desire to encourage both senior and junior research workers in the biological sciences to enter the agricultural field. In pursuance of this policy, the Council has established two new research units under its direct control, a Unit of Animal Physiology, and a Unit of Soil Enzyme Chemistry.

The Unit of Animal Physiology will be under the direction of Sir Joseph Barcroft, with the assistance of Mr. A. T. Phillipson and Dr. R. A. McAnally. This Unit will, by agreement with Prof. E. D. Adrian, be housed in the Department of Physiology at Cambridge, and will work in close liaison with the Institute of Animal Pathology and the Institute of Animal Nutrition. In the first instance, the staff of this Unit will devote a large part of their time to the study of ruminant digestion. The Unit of Soil Enzyme Chemistry will be under the direction of Dr. J. H. Quastel, assisted by Dr. P. J. G. Mann and Mr. D. M. Webley. By agreement with Sir John

Russell, this unit will be housed in the Rothamsted Experimental Station. Dr. Quastel and his staff will, in the first instance, be engaged mainly in the study of the influence on soil fertility of enzyme systems derived from soil bacteria, or from other micro-organisms.

Scientific Films

THE possibilities of scientific films are immense. They appeal directly to the eye, and their appeal can be reinforced by spoken or printed text. Their capabilities in representing motion enable them to illustrate processes which cannot otherwise be adequately conveyed to the mind. By the control of speed they can be used to demonstrate actions taking place too quickly or too slowly for the unaided eye to grasp ; and the wide possibilities which they offer in magnification and reduction bring processes of nearly all dimensions within the compass of the screen. The mechanism of motion pictures also enables full use to be made of reversal, super-imposition and stroboscopic effects in the production of scientific films. Recognition of the value of these films is leading slowly to their use in general scientific education. Another direction in which their future seems bright, although at present almost unexplored, lies in the popularization of science and in conveying in an acceptable manner some understanding of the relation of science to other forms of human work and culture. A further use of scientific films lies in various fields of research in which permanent records are required of processes in action.

Yet in the sphere of their production, scientific films have many difficulties with which to contend. Their production is scarcely a commercial proposition. They cannot effectively compete with the ordinary popular entertainment films. Also, the technique of their production calls for highly specialized and gifted talent, not likely to be attracted to the business unless the prospects are good. As a consequence, the number of institutions and organizations showing scientific films is small, and it will not expand rapidly until there is a wider selection of better films to draw upon. To promote the use of such films, the Scientific Films Committee of the Association of Scientific Workers, 30 Bedford Row, London; W.C.1, has recently issued a leaflet on "The Scientific Film", in which a summary is given of the possibilities available in the production and use of films for scientific purposes. This Committee offers its services in the selection of films and in drawing up programmes for different types of audience. Having adopted the practice of viewing scientific films as they become available, the Committee is in possession of information of considerable value to prospective users, and incidentally also to film producers. A small grant from public funds for scientific films would be of great educational worth. In its absence, the field is occupied to a considerable extent by films prepared for commercial and industrial firms, many of which are excellent in themselves, but not entirely free from bias of some kind or other. In spite of this, if full use were made of such films as are available, a great step forward would have been made.

Conditions of the Peking Man Bones

IT must always come as somewhat of a relief to the ordinary anthropologist that quite ordinary explanations are adequate to account for conditions to which more romantic solutions have been attached. It is, therefore, with some sense of thankfulness that we learn that Prof. F. Weidenreich has decided ("The Extremity Bones of Sinanthropus Pekinensis." *Paleontologia Sinica.* New Series D. No. 5. Peking : Geol. Survey of China) that the breaking of certain limb bones of Sinanthropus in the caves of Choukoutien has been due to the activities of the hyæna rather than, as he formerly postulated, to a series of cannibal feasts on the part of Peking man. He still believes it necessary, however, to invoke the assumption "that Carnivores and man competed in the breaking of bones both human and animal". May it not be possible that Carnivores have also produced the broken condition of the skulls ? In another way this latest publication on Sinanthropus is pleasing, for it makes it quite evident that the Peking man's femur "is identical with the human femur in size, form, proportions, and character of the muscular markings, differing in all these features from the anthropoid thigh bone in much the same way as any human femur". It is also certain that his humerus is exactly as it is in modern man : and the same applies to the only two other limb bones so far discovered—the clavicle and the os lunatum. For some, it may be rather a descent to earth, but for the science of physical anthropology it is surely a gain that we are at length permitted to know that Sinanthropus possessed the most ordinary and typically human limb bones, and that he walked as upright as the best of us.

Scottish Rock Carvings

THE September issue of *Antiquity* contains a note by Prof. V. G. Childe on some finds of rock carvings in Scotland. Two of these are in Argyll and one in Midlothian. The first photograph shows a hind engraved in outline from Gleann Domhain, Argyll. The figure is in profile, two long ears appearing side by side and only two legs. There is a blunt and intriguing tail and an eye is shown. The style of this engraving reminds one forcibly of the Arctic culture rock drawings of Norway and Sweden (Scandinavian Art Group I). Prof. Childe's second photograph is of a fish which has been found near Roslin, Midlothian. This carving is not merely an outline but rather appears to be done in low relief and it, too, might have links with Scandinavia. Not so the third find, of a stylized, rather shapeless, animal figure from Dunadd, Argyll, which is very different in style from either of the other two and might easily belong to a different and later culture group.

The influence of the Scandinavian Arctic Culture—itself probably an offspring of the northern Mesolithic civilization—on eastern Britain has long been suspected, suggested by certain finds of stone implements as well as by the engraving on a piece of flint crust which was found in the earliest levels at Grimes Graves. The new Scottish discoveries, especially the Gleann Domhain hind, powerfully reinforce this notion, and even go farther with the inference that the Arctic Culture not only reached our eastern coasts, but indeed, penetrated considerably inland—at least in the northern areas of Britain.

Corrosion in Steel Chimneys

In the last twenty years, developments in the size and efficiency of boiler plants have led to the abandonment of huge masonry chimneys serving a number of boilers in favour of a separate chimney for each boiler. In *Engineering* of September 12, Mr. A. V. Staniforth shows that this has been brought about not only for the sake of the advantages accruing during overhaul and repair from such sectionalizing, but also because the very large units, now common, call for much larger chimney areas. The normal chimney was built of lapped riveted plates, but corrosion was found to be very rapid. At one large power station, five steel stacks, each 7 ft. 6 in. in diameter by 80 ft. high, constructed of ⅜-in. mild steel plates riveted together, had corroded away in parts to paper thickness in five years in spite of annual internal and external cleaning and painting. In all cases the corrosion had become most serious at, and had undoubtedly started from, the joint laps and rivet heads, and was most marked in the upper parts of the chimney. The temperature of the gas entering the chimneys was about 250° F., at which the steel temperature, particularly near the top of the chimney, often fell below dew point, especially during the colder periods of the year. This caused the deposition of moisture, sometimes increased by rainfall. Combining with the sulphurous gases, it formed sulphurous acid which attacked the steel. The moisture running down the chimney collected along the joint laps and rivet heads, and thus was responsible for the especially severe corrosion at these points.

In solving the problem it was considered desirable first to eliminate the points of corrosion, namely, the lapped joints and rivets, and secondly to find some type of lining which would afford adequate protection to the steel plates. Modern developments in electric welding suggested the use of welded butt joint chimneys, which are easy to construct and give a smooth parallel barrel free from all foci for corrosion. In protecting the interior of the chimney plates from corrosion, asbestos sheeting of certain types was found reasonably suitable. The five steel stacks mentioned above were replaced by lined stacks in 1935, and five years later a section of the lining was removed from one of the stacks. It was then found that no corrosion of any kind had taken place and that the mill scale was still on the steel. Another advantage is that the heat-insulating effect of the lining cuts down the heat loss, and so the period during which the temperature of the steel falls below the dew-point is very much reduced. Tests showed that with a gas temperature of 290° F., the outside temperature of an unlined stack was 210° F., while the lined stack had an outside temperature of 150° F. The lower outside temperature of the stack reduces considerably the cost of maintenance of the outside of the chimney by increasing the life of painting.

Health of Hawaii

According to the report of the Board of Health of Hawaii for the fiscal year, the lowest death-rate ever recorded for these islands, namely, 7·18 per 1,000 inhabitants, occurred in 1940. There were 3,025 deaths in a population of 423,332, the chief causes being heart disease, cancer, congenital malformation and disease, tuberculosis and nephritis. Pneumonia dropped from the second to the eighth leading cause of death, a fact which was attributed to the use of serum and sulphapyridine, which were distributed free to practitioners for the medically indigent. The birth-rate was 22·62, as compared with 21·79 in 1939. An outbreak of 101 cases of infantile paralysis with 10 deaths occurred during the year. The death-rate from tuberculosis was 63·2 per 100,000, the lowest on record. There were 56 cases of typhoid fever, which were attributed principally to carriers; no cases were traced to milk or to the potable water. There were 77 cases of typhus with 1 death. There were 1 case of human plague which ended fatally and 47 cases in rodents as compared with 129 the previous year.

Announcements

The Lister Medal for 1942, which is given in recognition of distinguished contributions to surgical science, has been awarded to Prof. Evarts A. Graham, professor of surgery in Washington University, and he will deliver the Lister Memorial Lecture in 1942, or later, under the auspices of the Royal College of Surgeons of England. This is the seventh occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh, and the University of Glasgow.

It has been decided not to award any Nobel Prizes this year.

The Tenth International Ornithological Congress, which was to have been held in the United States in 1942, has been indefinitely postponed.

A malaria survey of Trinidad was recently begun under the supervision of Dr. Mark F. Boyd and Dr. W. G. Davis of the Rockefeller Foundation.

Messrs. Rowntrees, of York, have made a grant to Dr. F. C. Happold, reader in biochemistry in the University of Leeds, of £150 a year for two years for research work on nutritional problems.

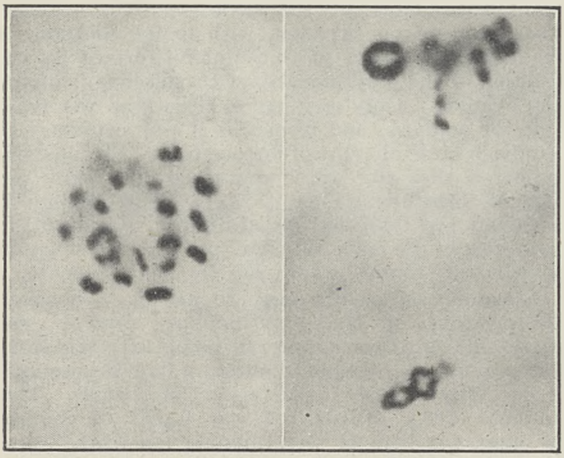
Erratum.—It was stated in Nature of October 18, p. 457, that Dr. E. Kodicek, who contributed a paper on post-war relief at the recent British Association meeting, was formerly lecturer in psychology in the University of Prague; this is incorrect. He held the position of head of the Department for Vitamins and Hormones at the University Clinic, Charles University, Prague.

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.*

Chromosome Breakage and Sterility in the Mouse

Snell[2] has shown that the offspring of X-rayed male mice produced before the onset of complete X-ray sterility contain a certain proportion—depending on the dosage—of semi-sterile individuals, which when outcrossed to unrelated animals throw litters of reduced size. This semi-sterility could be shown to be inherited and was assumed to be due to an interchange of segments between non-homologous chromosomes induced by irradiation. The genetical behaviour of semi-sterility was extensively studied in breeding experiments[2,3,1]. A great number of valuable data on zygotic lethality during the early embryonic development was also collected by various investigators[4,5,6,10], yet so far no cytological analysis of chromosome behaviour in interchange heterozygotes has been attempted. With this programme in view, three semi-sterile lines, *A*, *B* and *T*, each from a differently treated male, were produced by us using the X-ray technique of Snell.



a *b*

Photomicrographs showing the association of four chromosomes during the meiotic division in males of line *A* (*a*) and of line *T* (*b*).

The presence of the interchange was usually determined by the breeding test. Interchange *B*, however, was first identified cytologically in a number of mice and later verified by the breeding test. The breeding results so far obtained show that the average litter size produced by outcrosses of the semi-sterile individuals in line *A* is 2·6 (11 litters), in *B* 4·2 (15 litters), and in *T* 3·6 (44 litters). In the related but untreated control lines it is 7·7. Spermatogenesis in the interchange hybrid has shown that an association of four chromosomes is regularly present during meiosis (Figs. *a* and *b*). In lines *B* and *T* it is represented as a chain of four chromosomes, and in *A* it usually forms a ring. The association of four in an interchange hybrid, if metaphase orientation is at random, will lead to the production of six kinds of sperms in equal numbers; four out of the six will have one chromosome segment in duplicate, another segment not represented at all. Fertilization of eggs with unbalanced sperms will result in the production of 66·7 per cent defective zygotes. These expectations have been confirmed experimentally in plants and Drosophila. We can confirm it for line *T* of our mice, the only line in which a sufficiently high number of individuals has been tested as yet. Out of twenty-six animals tested eleven proved to be fertile and fifteen semi-sterile, which is a good agreement with expectation, namely, 8·7 fertile and 17·3 semi-sterile.

The cytological analysis of interchange hybrids of lines *A*, *B* and *T* has shown clearly that the different degree of sterility is determined by the frequency of multivalent association and by the type of orientation of the quadrivalent. The behaviour of multivalents during the first meiotic metaphase and the data of the breeding test suggest that in lines *B* and *T* a long and short segment of two non-homologous chromosomes are interchanged and that the breakage points are located far away from the centromere. In line *A*, on the other hand, the interchange involves larger segments with breakage points adjacent to the centromere. The high incidence of sterility in line *A* is due to the high frequency of non-disjunction which follows.

In line *T* there was a sudden increase in fertility between the first and following generations. The average litter size in F_2 (6 litters produced by one semi-sterile son of the original X-rayed male outcrossed to various fertile females) was 2·0. In F_3 22 litters produced by outcrossing 3 semi-sterile F_2 males and 4 semi-sterile F_2 females had an average size of 3·7, and in F_4 this average remained materially unaltered at 3·8 (17 litters produced by outcrosses of 4 F_3 males and 2 F_3 females). The 3 F_2 males, however, had not only a very small litter size but also failed to produce litters with several females known to be fertile, although vaginal plugs were observed in two instances showing that mating had taken place but remained unsuccessful. No offspring for breeding could be secured from these males except one daughter which did not carry the interchange. Thus the F_3 consisted only of descendants from the less sterile F_2 individuals. No exceptionally sterile individuals were observed among the F_3, the average litter sizes for each tested individual all ranging near the average for the semi-sterile group of this generation as a whole. These data indicate that, beside the segmental interchange present in all semi-sterile individuals, minor structural changes or mutations with a deleterious influence on fertility were also brought about in the chromosomes by irradiation and handed on by chance segregation to some individuals of the next generation. These additional changes are eliminated rapidly on account of the high degree of sterility they cause when superimposed on the major chromosome rearrangement.

Further experiments are in progress with the view of establishing lines homozygous for the interchanges, and of combining the different interchanges in order to test whether there is a position effect, and to find out if some of the interchange chromosomes of the various lines are common or not. Meanwhile we may point out that there can no longer be any doubt that X-raying germinal cells in man involves the serious risk of inducing heritable sterility in the descendants owing to embryonic mortality of zygotes with an unbalanced chromosome complement.

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Natural Occurrence of Polythionic Acids

IN 1937 I assisted Dr. A. L. Day in a survey of the thermal region of the North Island of New Zealand, and part of the work carried out for him was the collection of samples of the waters of the most vigorously boiling pools in the various hot spring areas. During the analyses at the Dominion Laboratory, Wellington, advantage was taken of the opportunity to examine the samples for the presence of polythionates. The method used was titration with sodium hydroxide solution after addition of mercuric chloride to the neutralized sample. The examination of seventeen acid waters from seven areas showed the presence of polythionates in only two waters, but these were from the most active springs. One was the "Black Pool" at Ruahine, near Rotorua, the largest and most vigorously boiling pool in the thermal region, and the other, the "Black Geyser", a perpetual spouter at Ketetahi Hot Springs on the slopes of Mt. Tongariro. On the authority of Mitchell and Ward, from whose book the method was taken[1], it was assumed that as the waters contained hydrogen sulphide, the only polythionate present was the trithionate. However, it has since been pointed out to me by Dr. A. Kurtenacker (private communication) that this is not correct.

The occurrence of a polythionic acid in Nature was first reported by J. S. Maclaurin, late director of the Dominion Laboratory, who in 1911 discovered pentathionic acid in the water of the lake in the crater of White Island[2]. This lake, of an area of about fifteen acres, containing 5 per cent free hydrochloric acid, was a feature probably unique in the world. Unfortunately, it no longer exists. It was drained in 1912 to facilitate the working of the sulphur deposits. It is probable that the drainage helped to bring about the landslip and steam outburst that completely changed the character of the crater. Apart from the loss of twelve lives, the cost of the work in this, and later efforts, far exceeded the value of the few thousand tons of sulphur extracted. A little scientific investigation would have indicated the exaggeration in the estimates of the amount and purity of the sulphur deposits. It is doubtful whether the present features offer the same interest to the scientific worker or tourist as those destroyed. The island is still threatened with exploitation, for it has been allowed to pass into private hands, and proposals are occasionally mooted to use the natural steam for the production of salt from sea-water. This is but one example of the regrettable lack of appreciation in New Zealand of the varied, and often unique, features of the thermal region, and there is still no move to safeguard and conserve for posterity all the hot spring areas under one control, for example as a national park.

In 1939 I spent a week on White Island, carrying out chemical and physical investigations on an expedition organized by Dr. P. Marshall. Fumaroles and steam vents are now the main type of activity, and hot springs are rare. However, at the bottom of a depression about 50 ft. deep, named "Middle Crater", there was found a vigorously boiling pool, and a sample of this was taken.

Since the previous work, methods for the complete analysis of solutions containing polythionates had become available in the book by Kurtenacker[3]. These depend on titration, with iodine solution, of the varying amount of thiosulphate formed by the reaction of the polythionates with sulphide, sulphite and cyanide. Only one litre of the water was available for analysis, and from this it was necessary to remove a large amount of ferrous iron. The analysis indicated that the water contained 170 mgm. per litre of tetrathionate ion (S_4O_6''). This amount is not much less than that found by J. S. Maclaurin[2] in the water of the lake, 240 mgm. per litre, although the polythionate found by him was the pentathionate.

A sample sufficiently large to permit a thorough investigation of the polythionates present was obtainable only from a more accessible area, and early this year it was possible to obtain a four-litre sample of the "Black Geyser" at Ketetahi Hot Springs. This sulphate water of pH 5·4 was found to contain 99 mgm. per litre of tetrathionate ion (S_4O_6'') and 66 mgm. per litre of pentathionate ion (S_5O_6''). Further work appears desirable on the particular polythionates which can occur in Nature.

The presence of polythionates in hot springs is not merely of academic interest. The origin of these sulphur acids might be ascribed either to the oxidation of hydrogen sulphide by the oxygen of the air as a step in the formation of sulphuric acid, or to the interaction of hydrogen sulphide and sulphur dioxide, present as constituents of the ascending volcanic steam. The first explanation does not seem probable. Some confirmation of the second explanation is given by the fact that small amounts of sulphur dioxide were actually found in the fumarole gases of White Island. Besides the discovery of J. S. Maclaurin, the only instance of the natural occurrence of polythionates is that recorded by Day and Allen[4], who found pentathionate in incrustations in the crater of Lassen Peak. In this case also, sulphur dioxide was found in fumarole gases.

I have pointed out[5] that if the passage upward of magmatic steam is slow enough to enable equilibrium in gas reactions to be maintained until the steam has cooled to 400°–500° C., there would be no appreciable amount of sulphur dioxide unconverted to hydrogen sulphide. The presence of sulphur dioxide in fumarole gases, and possibly also the presence of polythionates in the hot springs, would indicate rapid cooling from a magma near the surface. It would be much simpler to estimate polythionates in waters than to determine sulphur dioxide in fumarole gases, and this estimation might be a useful way of judging the activity of an area, or following changes in activity with time.

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[3] Kurtenacker, A., "Analytische Chemie der Sauerstoffsäuren des Schwefels" (Stuttgart: F. Enke, 1938).

[4] Day, A. L., and Allen, E. T., "The Volcanic Activity and Hot Springs of Lassen Peak" (Washington: Carnegie Institution 1925).

[5] Wilson, S. H., *N.Z. J. Sci. & Tech.*, 20, 246 (1939).

Flow of Air through Rocks at Low Rates

DURING routine measurements of the permeability of rocks carried out in 1939–40, certain anomalies were observed when the rate of flow was extremely low. It was seen that when the rock was highly impervious and the velocity of the flowing air was consequently low due to limitations in the pressure, a plot of the pressure loss *v.* rate of flow did not yield a straight line passing through the origin. Darcy's law having been established with such rigour by many workers before, however, necessitated the rejection of the anomalous results as due to "experimental errors". The same type of anomalies, however, were again observed recently in measuring the permeability of other samples. Thus, it was decided that the phenomenon be investigated, after having first refined and adapted the apparatus for measurements at extremely low rates of flow.

Fig. 1 shows the results on one sample which was subjected to the test. The ordinate is the product of $\bar{Q}$, the rate of flow at mean pressure, $(P_1 + P_2)/2$, where P_1 and P_2 are inlet and outlet pressures in atmospheres, and μ the viscosity of the air at the temperature of observation, divided by the cross-sectional area of the sample, A. The abscissa is the differential pressure across the sample (P_1-P_2) divided by the length of the sample, L. It is seen that at low rates of flow, or low differential pressures, the graph is a curve and not a straight line.

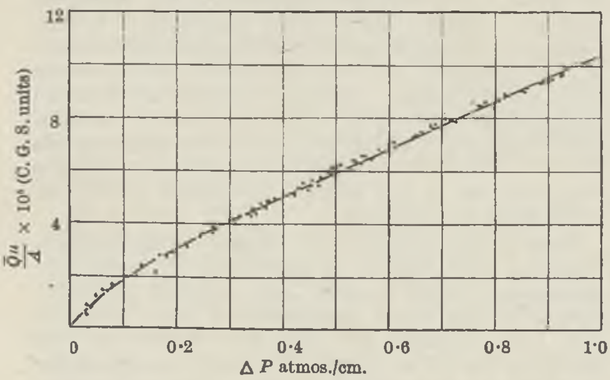

Fig. 1.

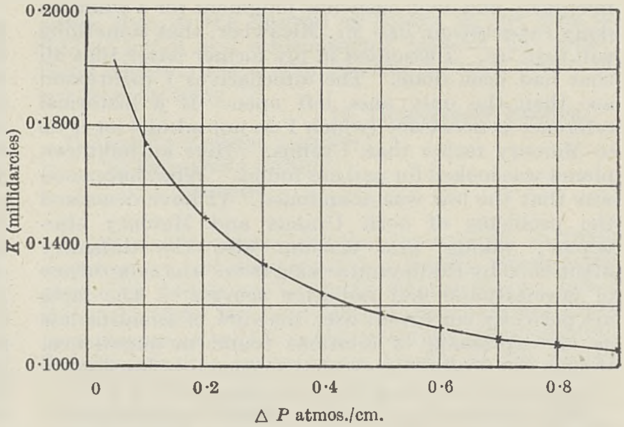

Fig. 2.

Fig. 2 shows the results in another form. The permeability, which is the tangent at each point of graph on Fig. 1, is plotted against the pressure differential. It is seen that instead of the constant value for permeability demanded by Darcy's law, a variable permeability is obtained, falling to an assymptotic value at higher rates of flow. The assymptotic value is what is usually obtained in permeability measurements using fairly high rates but necessarily limited to the viscous regime.

The possibility of turbulence is completely excluded by the nature of the tests, by the fact that at higher rates of flow in Fig. 1 the curve straightens out into the normal viscous regime curve, except for the anomaly that it does not pass through the origin exactly, and further by the fact that the region where the graph curves does not follow the equation

$$\Delta p = av + bv^2.$$

Other tests reveal the fact that the permeability value first increases to a maximum, after which it descends in value until it reaches the assymptotic value indicated.

Full description of the experiments will be published later in another place.

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and Refining,
University,
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Sept. 18.

The Philosophy of Physical Science

SIR ARTHUR EDDINGTON has not met my point (NATURE, Sept. 20, p. 341). Assuming, in accordance with his claim, that criteria could exist which would determine that a law was applicable to certain experiences, I asked what he would do if such experiences were found to violate an "inviolable" law. He has related what Adams and Leverrier did when experience afforded an opportunity of testing a law not held to be inviolable. My question still remains.

I agree that if a law appears to be broken, the physicist asks whether a factor has been overlooked. He also reviews his calculations to look for errors, repeats his observations to make sure he was not mistaken, and even suspends judgment for a while, in daily expectation, like Mr. Micawber, that something will turn up. I assumed in my former letter that all that had been done. The alternatives I mentioned are then the only ones left open. If a historical reference is necessary (which I do not admit) let it be to Mercury rather than Uranus. Here an unknown planet was looked for and not found. What happened was that the law was abandoned. (I have discussed the problems of both Uranus and Mercury elsewhere[1], taking into account also the difficulty mentioned by Eddington arising from "the congruence of gravitational and radiative sources". The facts are perfectly consistent with the view of scientific law as an expression of relations found in experience, though not with the view that science is a description of an external world of physical objects.)

Some interesting points are raised by Eddington's further elucidation of his position, but I refrain from following them up since it is already difficult enough to concentrate the discussion on the main issue. It is no digression, however, to suggest that when he says he is trying to make sense of modern physics but not of experience, he contradicts himself, for modern physics expresses relations found in experience. I find it difficult to believe him serious when he writes : "I cannot find that modern physics imposes any such condition of relevance [that is, a 'condition implying some special relevance to experience'] on the laws which it accepts as fundamental." Suppose the facts now available concerning the orbit of Mercury, gravitational deflexion of light, etc., had accorded with Newton's law and not with Einstein's. I am ready to believe that Eddington's trust in human reason would lead him to accept Einstein and reject Newton, in the sure and certain hope that some perhaps never to be discovered sources of gravitation existed which would justify him. But does he seriously assert that "modern physics" would do the same ? If so, twenty thousand physicists will know the reason why.

In reply to the question implied in Sir Arthur's last paragraph, I would say that at the top of things is experience. I was, of course, adopting his metaphor, which is ill-adapted to my view. I do not picture science as digging beneath a surface layer of experience to reach some metaphysical necessity, but if I do express myself in that way I must say that unless the bottom layer can itself support experience (other experiences, of course, than those through which the spade went), then science is digging in the wrong field. But the picture is very unsatisfactory. I prefer to think of the experiences so far obtained as arranged by us in a pattern. By inspection we can infer the plan of the pattern and continue it beyond the area covered by existing experiences ; and if future experience falls into place in the extended pattern, we have some confidence that the plan is the one we are seeking. If it does not, then we rearrange existing experience into another pattern into which the new experience will fit. The essential point is that experience is the beginning and end of the business : it suggests the pattern and controls its development.

I await an answer to the question : If the scheme of inviolable law is violated by an experience to which the criterion shows it to be applicable, what about it ?

HERBERT DINGLE.

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S.W.7.

[1] "Through Science to Philosophy", pp. 93–95 (Oxf. Univ. Press, 1937).

I FIND it very helpful in all discussions on the philosophy of science to make two distinctions. The first is to restrict the word 'science' to those studies involving experiment with something other than symbols. This rules out mathematics as a science and prevents, for example, the confusion that arises when it is held up as an example of the perfect science. The second distinction, which is of the greatest importance, is to distinguish between science and exact science. Exact science is that part of science which deals with the numbers produced by the reading of pointers—Eddington's "pointer readings". This is very far from being the whole of science, although it is often held up as being the ideal aim of all sciences. (It is sufficient to recall that the theory of evolution, perhaps the most convincing of all scientific theories, does not rest on measurement or even on simple counting.) Science deals with the experiences of ordinary life, tables, octopi, schizophrenic persons and so on, but exact science deals only with numbers obtained by conventional methods of measurement. Thus it may well happen that the philosophy of science is different from the philosophy of exact science.

To account for the structure or relationships of symbols we naturally start with symbols and use methods of dealing with symbols, namely, mathematical methods. But to account for the structure of tables, we clearly cannot start with symbols, but must follow Newton's rules of reasoning in philosophy, namely, "We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising ; nor are we to recede from the analogy of Nature. . . . The extension, hardness, impenetrability, mobility, and vis inertiæ of the whole result from the hardness, impenetrability, mobility, and vis inertiæ of the parts ; and thence we conclude the least particles of all bodies to be also extended, and hard, and impenetrable, and movable, and endowed with their proper vires inertiæ. And this is the foundation of all philosophy."

Newton's philosophy is the philosophy of science ; Eddington's is the philosophy of exact science. Newton attempts to account for the experienced properties of bodies ; Eddington attempts to account for the relationship between the numbers produced by acts of measurement on the bodies, and admits that he is not trying "to make sense of experience". Thus Eddington has only to account for symbolic relations and so he starts with symbols—relata and relations—"the relata are the meeting points of the relations"[1]. Their structure "has some significance in regard to the ultimate structure of the world—it does not matter much what significance"[2]. His suggested method is to start with a symbolic structure of great generality and build up other symbols having various relationships. He then expects the scheme of relationships arrived at by the analysis of *metrical* observational knowledge to be identifiable among the plethora of schemes arrived at *a priori*. Once this is done, the rest of the metrical properties of the universe could be predicted.

Some further light may be thrown on the numbers resulting from acts of measurement by some considerations which I have put forward recently[3]. Stated briefly, these considerations start with the fact that numbers are put into Nature by the physicist, and it is suggested that, by studying the conventional measuring operations by which numbers are put in, we may be able to predict something about the numbers which come out. It appears that only two direct methods of introducing numbers are available, the measurement of length and the measurement of time. If we take L and T to represent a length and a time measurement respectively, it follows that the measurement of all physical quantities can be represented by L and T raised to various powers, the powers representing the subsequent treatment of the numbers, that is, whether they are multiplied or divided, etc. But L and T are not independent, for a measurement of length involves an interval of time, so that it is a space-time interval that is measured and a "pure" length measurement is not possible. This is a result of the finite velocity of light which is taken as a brute fact of Nature. This space-time interval can be symbolized by a number in two ways, either by measuring its length or by measuring the corresponding time interval and multiplying by c the velocity of light. Consequently we have a relation connecting length and time measurements, namely, $L=cT$: thus we could say that c is the rate of exchange between a length measurement and its corresponding time interval.

Now if we have a case where numbers have been introduced in two different ways—and this has arisen in electromagnetism where we have the electromagnetic and electrostatic systems—then if we take the ratio of measurements of the same physical quantity on the two systems, we can only get the rate of exchange between the two systems of introducing numbers or some power of it. But the measurements on the two systems can only be L and T raised to different powers, and if these are equivalent, they must be interchangeable by means of the equivalent relation $L=cT$. Thus c, or some power of it, must be the ratio of numbers expressing the value of a quantity on the E.M. or E.S. systems.

Sir Arthur has suggested a case where this might not be so, but from the above point of view, the ratio cannot be anything else but a power of the velocity of light. This conclusion involved the experimental result that the velocity of light can be *measured* to be a finite number: this could not have been inferred *a priori*, although, as Sir Arthur says, it could not have been measured to be infinite. There is a tertium quid: it might not have been measurable at all.

An analogy with two other systems of introducing numbers as symbols for aspects of experience, namely, the dollar and pound monetary systems, may help to make this clearer. The measuring of the magnitude of a physical quantity on the E.M. and E.S. systems, and showing surprise that the ratio of the numbers turns out to be a power of the velocity of light, and then concluding that light is electromagnetic in nature, is, on this view, as absurd as measuring the value of a piano in dollars and pounds, showing surprise that the ratio of the numbers is the same as the dollar exchange given in the financial columns of the newspaper, and then declaring that a piano is financial in its nature.

Sir Arthur says that the important question is whether the physicist will recognize "the bottom of things" when he reaches it; but cannot we say that we have *a priori* knowledge that at the bottom of symbolic relationships will be the relation of symbols? And cannot we say with Newton, that we know *a priori* that at the bottom of things, in the case of tables, octopi and schizophrenic persons, lies something which is not a symbol—not a "vain fiction of our own devising"?

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at University College,
Bangor.

[1] "The Nature of the Physical World", p. 230 (Camb. Univ. Press).
[2] "The Mathematical Theory of Relativity", p. 213 (Camb. Univ. Press).
[3] *Proc. Phys. Soc.*, 53. 418 (1941).

I AM glad to have had the opportunity in three earlier letters of debating the difficulty which some physicists find in my scientific epistemology; but I think the time has now come to conclude my share in a discussion which might continue interminably. It only remains to comment briefly on the letters printed above.

Prof. Dingle begins and ends his letter with a question which cannot arise. If the fundamental ("inviolable") laws are not assertions about experience, they cannot in any circumstances be violated by experience. In regard to the rest of his letter, the imagined misbehaviour of Mercury does not differ materially from the imagined misbehaviour of the Michelson-Morley experiment which has already been discussed. In his third paragraph Dingle contradicts me, but I see no justification for his assertion that *I* contradict myself.

Dr. G. B. Brown's letter, with which I am in general agreement, provides a text for some concluding remarks. He emphasizes that the characteristic features of "the philosophy of exact science" come from the fact that exact science is concerned with *numbers* resulting from acts of measurement. Thus we shall get to the root of the matter more directly if we focus attention on numbers—if on the experimental side we consider physical quantities rather than physical objects, and on the theoretical side we consider the numbers which appear in the fundamental laws (namely the fundamental constants) rather than the laws themselves.

Our laboratories and observatories are occupied in amassing numbers most of which could certainly not be foreseen without measurement. But theoretical physicists have sublimated out of this numerical material a set of fundamental laws which (after removing the inconsistencies between current wave mechanics and relativity theory) are found to contain no unforeseen numbers. The co-efficients in the fundamental equations are all of the same type as the co-efficient $\frac{5}{3}$ in the specific heat of a monatomic gas, or as the ubiquitous 2π, the mode of entry of which into the formulæ can be traced without ambiguity. This gulf between the system of the theoretical physicists, which involves no numbers except such as are clearly of their own devising, and the everyday occupation of physicists and astronomers with numbers which are clearly not of their own devising, gives a jolt to one's philosophy. When it became quite clear that the gulf was complete, leaving experience on one side and the theoretical system on the other side, without a single bridge so far as *numbers* are concerned, a radical change of outlook became necessary It is not likely that a first constructive effort to find a scientific philosophy adapted to this new situation has achieved finality; but, whatever defects may be found in it, there can, I think, be no going back to the type of outlook which Sir James Jeans and Prof. Dingle support.

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NATURE AND MEASUREMENT OF WHITENESS

THE mechanism by which a 'white' substance reflects light is fairly simple and is fundamentally the same for crystalline and vitreous powders such as snow and borax, for suspensions such as milk, paint and opal glass, and for fabrics and paper. In all these cases, a multiplicity of transparent particles or fibres is suspended in a transparent medium of different refractive index, and a beam of light incident on the substance is specularly reflected and refracted at a large number of random interfaces, without any transformation and with very little absorption, resulting in a diffused reflexion. A coloured substance has the same mechanism, except for interference colours, but the minute particles also exert selective absorption on the light passing through them. If the difference of the refractive indexes between the particles and the surrounding medium is reduced, a white substance will have a reduced reflexion factor owing to reduction of the interfacial reflexion, and for the same reason a coloured substance will have an increased coloration, as may be simply shown by wetting a white or a coloured fabric. No reflecting substance has colour of its own, but only introduces colour by virtue of the selective absorption which it exerts on light falling upon it, and a white substance is uniquely characterized by its absence of selective absorption of light.

A 'white' light has no such unique character, and the range of lights which are called white can only be defined subjectively from the white-hot metal in a furnace at a temperature of about 1,700° K. to north sky daylight the colour temperature of which may be 10,000° K. It is, however, essential that standard white illuminants should be employed for measurement of white and of coloured substances, and ten years experience of Illuminants *A*, *B* and *C* specified by the Commission Internationale d'Éclairage in 1931 has proved them adequate for most purposes.

The Colour Group of the Physical Society held a discussion on whiteness on September 24, and three papers were read on different aspects of the problem of measuring near-whites. The introductory paper by J. G. Holmes, of Messrs. Chance Brothers and Co., Ltd., gave the theoretical background and indicated some of the visual and colorimetric problems peculiar to near-whites. It was pointed out that a white substance can be picked out quite critically either in daylight or in artificial light, whereas a particular yellow or blue calls for an effort of memory and for uniformity of lighting, and this sensitivity to small departures from whiteness is stimulated by the frequency with which white and near-white substances are employed in everyday life. The exact measurement of their colour is more exacting than that of coloured substances, and instrumental methods may be hard taxed to detect and to measure differences which are quite obvious to the unaided eye. The amount of departure from whiteness is usually expressed as the difference between the colour of the light reflected from a substance and the colour of the light incident upon it; a truly white substance making no change in the colour of the light.

A brief review was given of the instruments available and of their usefulness in industry. The usual type of trichromatic colorimeter is not satisfactory, as the method of building up a white light by adding together three strongly coloured primary lights produces a very uneven spectral energy distribution and, when this is compared with the light reflected from the specimen, the difference in energy distribution in the two halves of the colorimeter field renders the match liable to appreciable variation from one observer to another. This disadvantage may be reduced by employing a subtractive colorimeter, in which the selective absorption of the specimen is approximately reproduced by that of the subtractive filters, but all visual colorimeters have a small field size, leading to poor sensitivity. Spectrophotometric measurements are free from these disadvantages and good results can be obtained by visual or photoelectric 'abridged spectrophotometers', which measure reflexion factor in eight or more comparatively narrow spectral bands selected by filters, and by complete spectrophotometers which measure rereflexion factor in monochromatic light at a series of wave-lengths.

Dr. V. G. W. Harrison, of the Printing and Allied Trades Research Association, dealt with colour tolerances and methods of control in the paper industry. The natural colour of paper is yellowish, its hue being about 5800 A. and its saturation about 12 per cent with C.I.E. Illuminant *B*; the paper trade tends to call this 'white', and to call a true neutral pulp 'blue-white'. There is a marked preference for the latter colour which is not due to any tradition in the trade, and Dr. Harrison described experiments in which twenty observers were asked to compare the brightness of eight different papers. Analysis of their results showed that the physical reflexion factor of a paper is no measure of its brightness by subjective estimation, and that a blue-white paper actually appears brighter than a natural white paper the reflexion factor of which is about 6 per cent higher than the blue-white.

It seems that the eye is more sensitive to changes in saturation, or depth of colour, than in reflexion factor, and a paper is judged brighter if it has less selective absorption, which explains the common practice of a beaterman in a paper mill, who adds a dash of blue or black to his pulp to 'brighten' the paper. The accepted commercial tolerances are very close when papers have to be bound together in a book, and Dr. Harrison referred to a single run of paper from one mill which had to be graded visually into six 'colours' in order to ensure consistency. Colorimeter measurements failed to show any significant difference between the six grades, and in order to get sufficiently accurate data it was necessary to send the specimens to the United States for measurement on a recording photo-electric spectrophotometer. Subsequent tests on a photo-electric 'abridged spectrophotometer' gave very similar results, although these were not suitable for direct calculation of the trichromatic coefficients, and the tolerance for good commercial quality appeared to be closer than $\pm 0{\cdot}0005$ in the C.I.E. trichromatic coefficients and $\pm 0{\cdot}5$ per cent in the reflexion factor.

A manufacturer has to work to a standard pattern, and it is very difficult to check gradual change due to dirt and ageing without accurate measurement. An appeal was made for the provision of a rapid and accurate spectrophotometer available for frequent and inexpensive industrial testing of patterns, preferably under the auspices of a testing centre or research association.

C. G. Heys-Hallett, of the Morgan Crucible Co., Ltd., discussed the apparent whiteness of cinema screens. Coloration of the screen itself and the colour of the light from the arc are found to vary widely in many cinemas and to lead to serious distortion in the excellent colour films of the present day. This distortion can be overcome by standardization, but it is first necessary to measure the apparent colour and brightness of the combination of arc, optical projection system and screen in order to demonstrate to cinema proprietors the necessity for uniformity. Such measurements need not be on a standard system and do not need the high accuracy required in the paper industry, and Mr. Heys-Hallett described a photo-electric brightness meter which indicates screen brightness with no film in the projector and the relative brightness with each of three colour filters interposed in the beam.

The variation from cinema to cinema is large, being more than 50 : 1 in screen brightness and about 30 per cent in colorimetric saturation, with the result that many films are shown at a disadvantage. The variation in brightness is attributable to the use of the most powerful arc lamps in some of the smaller modern cinemas and unsuitable projectors in some of the older cinemas, rather than to the reflecting properties of the screen; whereas the variation in colour is due to the use of low-intensity and high-intensity arcs, the variety of mirror and lens collecting systems and the rapid ageing of the screen. It is interesting that the use of a blue filter in the projector to correct a yellowish colour is a definite disadvantage, contrary to experience in the paper industry, as the loss of screen brightness causes more subjective colour distortion than the partial correction given by the blue filter.

Demonstrations were given by lantern slide, and it was suggested that if the projected colour and brightness could be standardized at any practical value, colour films could be made to suit. Such a standardization could fairly easily be applied also in the United States and on the Continent, but it would restrict the development of huge super-cinemas until more powerful light sources are available.

THE 'G.E.C. HEAVY ALLOY'

In an article on the new 'G.E.C. Heavy Alloy' published in the *G.E.C. Journal* of August, G. H. S. Price and S. V. Williams, of the G.E.C. Research Laboratories, in conjunction with C. J. O. Garrard of the Witton Engineering Works, describe the preparation, properties and industrial uses of a tungsten alloy which is fifty per cent heavier than lead and has the tensile strength of a good-quality steel.

Of the common metals, lead is the only one which is substantially heavier than the general engineering materials. Lead, with its excellent corrosion-resisting properties, is a very useful metal, but it is weak mechanically, and for this reason its use is limited to those applications where the stresses are low. The precious metals such as gold or platinum are heavy metals, being two to three times as heavy as iron or copper, but their high price prohibits their use for general engineering purposes. Tungsten, however, has a density equal to that of gold and is also relatively cheap. A considerable tonnage of tungsten is used annually as an alloying element in the production of special steels, and for this purpose the metal is added in the form of powder or as a ferro-tungsten alloy. Tungsten is characterized by a very high melting point (3,400° C.) and this precludes the production of the pure metal by ordinary metallurgical processes. Pure tungsten in the form of ductile wire or sheet such as is used in the manufacture of electric lamps or radio valves, is produced by a powder metallurgical process. The successful development of the process about thirty years ago was one of the first and most important examples of this method of producing metals and alloys, a method which has been extended in many directions, particularly during the last few years.

So far as tungsten is concerned, a bar of pressed powder is sintered to a high temperature and afterwards worked by swaging, drawing or rolling to produce the metal in wire or sheet form. The sintering temperature required is in the region of 3,000° C. and this is obtained by passing an electric current (about 2,000 A. per 1/16 sq. in.) through the bar. The method of sintering, however, limits the size of the bar that can be conveniently handled, and having regard to the fact that it is only after a considerable amount of work has been done on the sintered bar that the metal approaches its theoretical density, it is evident that fully dense tungsten cannot be produced in massive form.

In the first instance, attempts were made to produce an alloy of tungsten and lead. Tungsten powder was mixed and pressed with a sufficient quantity of lead powder to fill the interstices between the tungsten particles, when the mixture was heated. It was found, however, that tungsten and lead do not wet each other, and homogeneous masses could not be produced. It was known that nickel and tungsten alloy very readily, and experiments were made using mixtures of tungsten powder with 5–10 per cent nickel. On pressing and sintering to a moderate temperature, alloys were obtained with densities of the order of 16·5–17 gm./c.c., which is more than twice that of steel (7·8) and about 50 per cent greater than lead. It was then found that the addition of a certain amount of copper assisted production, and although the quantities of nickel and of copper can be varied, the material which is known as 'Heavy Alloy' usually contains 90 per cent tungsten, 7·5 per cent nickel and 2·5 per cent copper. In addition to its high density, 'Heavy Alloy' has a tensile strength comparable with that of a good quality steel.

It is an interesting fact that although the light alloys of aluminium and magnesium are playing such a leading part in modern aircraft construction, it is in this field that ever-increasing use is being made of 'Heavy Alloy'. It is well known that tungsten is practically unmachinable, but 'Heavy Alloy', although it contains about 90 per cent tungsten, has excellent machining properties. The development of 'Heavy Alloy' with a tensile strength of 40 tons/sq. in. and a density more than twice that of steel opens up new possibilities for the designer.

CINEMA ACOUSTICS AND TELEVISION RECEIVERS

As was mentioned in the issue of NATURE of February 15, the Institution of Electrical Engineers now publishes extended abstracts only of papers in Part I of its *Journal*, the full papers being issued later in either Part II or Part III, according as the subject-matter of the paper is appropriately classified as power or communication engineering. Part III includes the Proceedings of the Wireless Section of the Institution, and the September issue of this part contains three related papers in full.

The first of these is by Messrs. C. A. Mason and J. Moir, and is entitled "Acoustics of Cinema Auditoria", and the paper describes the results of investigations made to discover the reasons for the difference in performance of sound reproduced by identical equipment in apparently similar cinemas. It was apparent from the preliminary investigations in four different theatres that overall frequency characteristics and reverberation times were not the controlling factors for good sound quality, which is defined in terms of both intelligibility and intimacy, the latter term being used for the impression conveyed to the audience that the sound actually proceeds from the picture on the screen. Experiments were then conducted with an impulse source comprising a short train of waves of a fixed audio-frequency emitted through the loud-speakers. By means of a microphone and cathode-ray tube equipment, measurements were then made of the paths taken by the reflected sound in the auditorium.

The results showed first that there was little distortion in the amplifiers and loud-speakers, but that the sound received in the auditorium comprised a direct pulse and some reflected pulses, the number and magnitudes of which depended upon the design and shape of the auditorium. The authors conclude from their investigation that while the reverberation-time of a cinema should approach the optimum value for good intelligibility, it is also necessary that the shape of the auditorium should be such as to avoid reflected-sound paths differing greatly in length from the direct path. The paper concludes with a detailed discussion of the practical design of an auditorium with good intimacy, as well as intelligibility, properties.

The second paper is by B. J. Edwards, and is entitled "The Design of Television Receiving Apparatus". This paper comprises a detailed description of the design of a particular form of receiving equipment for television reception to the standards provided for by the B.B.C. transmitter at Alexandra Palace prior to the outbreak of war in 1939. In portraying the detailed electrical and mechanical features of the design, the author shows the fundamental reasons for the adoption and evolution of the particular methods employed. For example, the advantages and disadvantages of electric and magnetic deflexion in cathode ray tubes are demonstrated, and in justification of the adoption of the fully magnetic tube, it is claimed that it gives reproduction of a television picture of superior definition and brightness, and that it lends itself to a slightly more economical design of circuit.

In the concluding portion of the paper, some speculation is given to the trend of design for television reception. The possibility of a general increase in the carrier frequency up to the order of 100 Mc./sec. is envisaged, and this will bring with it certain problems in the attainment of selectivity for reception; also the general demand for a larger picture is likely to result in the development of the small projection type of cathode-ray tube, giving a picture of high intensity of illumination, in association with a suitable projection lens constructed possibly of a suitable plastic material at a favourable price.

The third paper under consideration is of a theoretical nature. It is on "Electromagnetic Waves in Metal Tubes of Rectangular Cross-Section" and is contributed by J. Kemp. The attenuation of electric waves propagated through the interior of metal tubes of rectangular cross-section is calculated by the familiar telephone transmission formulæ, instead of by the usual classical method first used for this problem by Lord Rayleigh. The present author states that the characteristic advantages of the former method are its simplicity and the directness with which the final results emerge. The method reveals the existence of a link between two seemingly disjointed branches of telecommunication, first the classical circuit comprising a 'go' and 'return' path, and second, the transmission of waves through a hollow metal tube without a return path in the conventional sense.

DRUGS FROM THE EMPIRE

The Imperial Institute has reprinted as a booklet an article from the *Bulletin* of the Institute by Dr. M. Ashby*, surveying the possibilities of producing in the Empire drugs hitherto obtained from Central Europe. Dr. Ashby has done his work well and the publication is timely. There has been much unco-ordinated and misdirected activity in the field of drug supplies and this paper helps to set the problem in perspective. Two basic considerations have tended to be forgotten by enthusiasts who have sought to encourage new cultivation. One is that energies should be directed to essential drugs only; the other that to the commercial grower, the problem is a business problem as well as a patriotic one. By reason of lack of early official guidance, many enthusiastic amateurs in Great Britain are wasting both energy and ground in the collection and cultivation of plants having the weakest of claims to being essential in therapeutics. Dandelion, coltsfoot, camomile and the leaves of the lime are a few examples. They command good prices, but those who grow or harvest them would do better to concentrate on potatoes or onions. Belladonna, hyoscyamus, stramonium, digitalis and perhaps colchicum

* War-Time Drug Supplies and Empire Production. By Dr. M. Ashby. Pp. 39. (Imperial Institute, London, S.W.7.) 1s. net.

are probably the only drugs upon which ground or energy should be expended in Great Britain, and the cultivation of the first three is a task for the expert grower. One lesson of the War of 1914–18 which has been forgotten is that the cultivation or collection and the drying of medicinal herbs cannot be undertaken by amateurs efficiently. Inevitably there is great wastage and disappointment. Dr. Ashby emphasizes this in his sections on cultivation, harvesting, preparation and drying.

The problem for the commercial grower is, at bottom, whether he can get a price for his harvest sufficient to pay him to put extra land under cultivation. So far the Ministry of Health has fought shy of guaranteeing prices and the growers have consequently hung back. The yield per acre of ground under medicinal herbs compares at best unfavourably with the yield under foodstuffs, and the grower has in mind always the possibility of an ending of hostilities before his crop is disposed of. This is to-day the obstacle for the home grower: how much more is it likely to prove an obstacle for the Dominion or American grower. Dr. Ashby wisely emphasizes the need for some form of Government protection if Empire cultivation is to flourish.

The Ministry of Health has an advisory committee upon the cultivation of medicinal drugs, but there is still much confusion and unco-ordinated effort. What is needed is (1) active discouragement of the amateur or professional growing or collecting of herbs which have no important therapeutic value; (2) the allocation among home and overseas growers of future requirements of valuable herbs, with guaranteed prices; (3) the co-ordination of research into the conditions of cultivation that will produce the optimum yield of the needed constituents of the herbs.

There is little indication that the present committee has seriously settled down to this triple task, which is indeed less one for the Ministry, however able its advisory committee, than for a body such as the Agricultural Research Council in daily contact with the practical details of modifying plant stocks in required directions and with the relative value to the country of putting land under medicinal herbs or food.

THE MACKAY RADIO AND TELEGRAPH COMPANY COMMUNICATION SYSTEM

COMMANDER M. H. ANDERSON has contributed a paper to *Electrical Communication* (No. 4, 19, 1941) giving a historical account of the growth of the Mackay Radio and Telegraph Co., the successor of the radio communication business of the Federal Telegraph Company.

The Federal Telegraph Company commenced activities in California in 1909; it was organized by a group of Stanford University men who had secured the American rights to the patents of Poulsen and Pedersen of Copenhagen, Denmark. Up to that time the only practical method of radio communication had been by the use of damped waves generated by spark-type equipment. Operation was confined largely to radio communication with ships at sea; the use of radio for point to point communications was very limited, largely because of the inability to cover in a trustworthy way long distances, particularly in the day-time. The arc type of high-frequency generator developed by the Danish inventors made possible the use of sustained or undamped waves. This gave the Federal Company a definite advantage, and it established radio telegraph services interconnecting San Francisco, Los Angeles, San Diego and Portland (Oregon) in 1911, and San Francisco and Honolulu in 1912, and competed for business with the existing cable and land line companies.

The immediate success of the long-distance circuit between San Francisco and Honolulu encouraged the United States Navy Department and the Federal Telegraph Company to install in 1912 a Federal arc transmitter at the naval radio station at Arlington, Virginia, as a result of which this station was able to communicate with the San Francisco and Honolulu stations, during daylight hours, a feat never before accomplished. Eventually the Navy Department adopted the Federal arc system as standard for its services. In 1913, an extensive construction programme was started, including a chain of high-power naval radio stations for connecting Washington, D.C., with the Canal Zone, California, Hawaii and the Philippines. These ranged in power from 100 to 350 kw. and were supplemented by a system of medium-power equipments located at all important naval establishments on United States territory and on ships of the American Fleet. The climax of this development was reached when the Navy Department built the large radio station near Bordeaux, France, during the War of 1914–18, for which the Federal Telegraph Co. supplied two transmitters of 1,000 kw. each.

In 1914, the Federal Telegraph Co. entered the marine radio field at San Francisco, enabling ships plying the Pacific to secure daylight communication over great distances. Activity in this field developed rapidly.

When the United States declared war in 1917, Federal Telegraph's radio stations were taken over by the U.S. Navy, but the company continued its domestic telegraph business by utilizing leased wire circuits. In 1921, it constructed a new communication system along the Pacific coast with three complete duplex channels between San Francisco and Portland and three between San Francisco and Los Angeles. Other cities were connected by local lines to this main radio trunk system, so that by 1923 the Federal network included offices in Seattle, Tacoma, Portland, San Francisco, Oakland, Los Angeles and San Diego, besides marine radio stations.

In 1928 the Federal Telegraph Company's system was acquired, along with other properties, by the International Telephone and Telegraph Corporation, the name having been changed to the Mackay Radio and Telegraph Company (California) during the year 1927. The change in ownership occurred at the time when high-frequency vacuum tube transmitters were coming into use, resulting in reduction in the cost of establishing radio circuits. The Atlantic and Pacific groups of offices are interconnected by radio trunk circuits between New York and San Francisco, New York and Los Angeles and Chicago and San Francisco. This closely knit domestic system serves main business and population centres and the contiguous districts, totalling more than eight hundred communities. Messages may be filed with Mackay Radio to thirty-one countries and by means of its associated companies it can accept messages to any country in the world.

The third division of Mackay Radio Service—communication with ships at sea—is carried out by six powerful coastal stations. A Marine Division is maintained through which ship owners and operators may secure modern ship radio equipment, properly installed and adjusted to obtain the maximum range of communication.

FORTHCOMING EVENTS

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

TUESDAY, OCTOBER 28

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. E. H. Hunt: "High Places of Sacrifice in Palestine and Petra".

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. J. C. Dawes: "The Cleansing of Towns and Cities".*

THURSDAY, OCTOBER 30

CHEMICAL SOCIETY (Joint Meeting with the Plastics Group of the Society of Chemical Industry) (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. C. Redfarn: "The Constitution of Plastics".

FRIDAY, OCTOBER 31

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Sir Westcott S. Abell: "Merchant Sea-Power, 1919-1939" (Tenth Andrew Laing Lecture).

SATURDAY, NOVEMBER 1

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. E. B. Bailey, F.R.S.: "How Scottish Recumbent Folds were Discovered".

APPOINTMENTS VACANT

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

GRADUATE (MAN) TO TEACH CHEMISTRY AND MATHEMATICS—The Principal, Dudley and Staffordshire Technical College, The Broadway, Dudley, Staffs. (October 30).

INSPECTOR OF SCHOOLS (WOMAN)—The Director of Education, Education Offices, Deansgate, Manchester 3 (October 31).

ASSISTANT SPEECH THERAPIST—The Director of Education, Education Department, Newarke Street, Leicester (November 1).

INSTRUCTOR IN WORKSHOP PRACTICE AND PROCESSES in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (November 3).

LECTURER IN CHARGE OF THE MARINE ENGINEERING SCHOOL of the Hull Municipal Technical College—The Director of Education, Guildhall, Hull (November 3).

EDUCATIONAL PSYCHOLOGIST to work in the Child Guidance Clinic—The Director of Education, Education Office, Town Hall, Bradford (November 7).

SECRETARY to the Research Association of British Rubber Manufacturers—The Acting Director of Research, 103 Lansdowne Road, Croydon (November 8).

REGIUS PROFESSOR OF NATURAL HISTORY in the University of Aberdeen—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (November 22).

SENIOR LECTURER IN ENGINEERING SUBJECTS in the Halesowen County Technical School—The Secretary, Halesowen Higher Education Committee, 21 Gt. Cornbow, Halesowen, Worcestershire.

PSYCHOLOGIST (WOMAN)—The Medical Superintendent, Incorporation of National Institutions for Persons requiring Care and Control, Stoke Park Colony, Stapleton, Bristol.

ASSISTANT EDITOR to assist in the publication of "Monthly Science News"—The British Council, 3 Hanover Street, London, W.1.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Pharmaceutical Society of Great Britain. Centenary Commemoration, April 15, 1941. Pp. ii+84. (London: Pharmaceutical Society of Great Britain.) [910

Institution of Automobile Engineers: Automobile Research Committee. Tenth Annual Report, July 1st, 1940—June 30, 1941. Pp. 32. (London: Institution of Automobile Engineers.) [910

Imperial Agricultural Bureaux. Index to Horticultural Abstracts, Vols. 1-10, 1931-1940. Compiled by D. Akenhead. Pp. iv+160. (East Malling: Imperial Bureau of Horticulture and Plantation Crops.) 25*s*. [910

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 1, No. 8: Reciprocity, Part 6: The Wave Function of the Meson. By Kathleen Sarginson. Pp. 77-92. 1*s*. 3*d*. Vol. 61, Part 1, No. 9: On a Certain Variation of the Distributive Law for a Commutative Algebraic Field. By Abraham Robinsohn. Pp. 93-101. 9*d*. Vol 61, Part 1, No. 10: A New Way of Measuring the Velocity of Light. By Dr. R. A. Houstoun. Pp. 102-114. 1*s*. Section B (Biology). Vol. 61, Part 2, No. 10: Geological Notes on the Stubendorff Mountains, West Spitsbergen. By W. B. Harland. Pp. 119-129+3 plates. 1*s*. 9*d*. Edinburgh and London: Oliver and Boyd.) [1010

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 804, Vol. 239: The Asymptotic Expansion of Integral Functions defined by Taylor Series. By Prof. E. M. Wright. Pp. 217-232. 2*s*. 6*d*. Series B: Biological Sciences. No. 577, Vol. 231: Cones of Extinct Cycadales from the Jurassic Rocks of Yorkshire. By Prof. Tom M. Harris. Pp. 75-98+plates 5-6. 5*s*. 6*d*. (London: Cambridge University Press.) [1310

Edinburgh and East of Scotland College of Agriculture. Calendar for 1941-1942. Pp. 66. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.) [1310

Cork Historical and Archæological Society. Historical and Archæological Papers, No. 2: Three Centuries of Irish Chemists. Edited by Deasmumhan O. Raghallaigh. Pp. iii+30+4 plates. (Dublin: The Talbot Press, Ltd.) 2*s*. 6*d*. [1310

Other Countries

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 28: A Study of the Inheritance in Mean Fibre-length, Fibre-weight per Unit Length of Fibre-Maturity of Cotton. By R. S. Koshal, A. N. Gulati and Dr. N. Ahmad. Pp. 17. (Bombay: Indian Central Cotton Committee.) 8 annas. [310

Cawthron Institute, Nelson, New Zealand. Annual Report, 1940. Pp. 38. (Nelson: Cawthron Institute.) [610

Smithsonian Miscellaneous Collections. Vol. 101, No. 3: Environment and Native Subsistence Economics in the Central Great Plains. By Waldo R. Wedel. (Publication 3639.) Pp. ii+29+5 plates. (Washington, D.C.: Smithsonian Institution.) [610

Indian Lac Research Institute. Bulletin No. 44: Physical Chemistry of Resin Solutions, Part 3: Viscosity of Shellac Solutions in Mixed Solvent. By Santi Ranjan Palit. Pp. 663-674. (Namkum: Indian Lac Research Institute.) [710

Brooklyn Botanic Garden Record. Vol. 30, No. 3: Lilacs in the Brooklyn Botanic Garden, including Classification, Cultivation, Pathology. By Alfred Gundersen. (Guide No. 12.) Pp. 189-224. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) 25 cents. [910

India Meteorological Department. Scientific Notes, Vol. 8, No. 92: Correlation between Frost and the Preceding Meteorological Conditions, Part 2: Jaipur. By Barkat Ali and S. N. Naqvi. Pp. 91-98. 5 annas; 6*d*. Scientific Notes, Vol. 8, No. 93: Heat Radiation from the Atmosphere at Bombay and its Comparison with that at Poona. By R. Narayanaswami. Pp. 99-112. 9 annas; 10*d*. (Delhi: Manager of Publications.) [1010

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 43: A List of some of the More Common Plants of the Desert Areas of Sind, Baluchistan, Rajputana, Kathiawar and South-West Punjab, with their various Local Names as far as Available. Compiled by Y. Ramchandra Rao. Pp. v+45+3 plates. (Delhi: Manager of Publications.) 2.14 rupees; 4*s*. 9*d*. [1010

Year-Book of the Royal Asiatic Society of Bengal for 1940. (Vol. 7, 1941.) Pp. 200. (Calcutta: Royal Asiatic Society of Bengal.) 6.8 rupees. [1310

Records of the Geological Survey of India. Vol. 75, Professional Paper No. 13: A Note on the Bawdwin Mines, Burma. By E. L. G. Clegg. Pp. 14+2 plates. (Calcutta: Geological Survey of India.) 8 annas; 9*d*. [1310

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