succession, so that an appreciable number of particles would not be counted by either observer. Without numerical data concerning the acts of blinking of these two workers, no correction can be applied to their estimates of Z, but an error of ten per cent is well within the bounds of possibility, as will be seen by reference to the fifth column of Table 1.

In regard to scintillation counts, an abstract from some work by Chadwick[6] is suggestive: "When the scintillations appear on the screen at convenient intervals, it is possible for the two observers to compare their impressions of the intensity of the scintillations. It sometimes happens, particularly when dealing with the weaker scintillations, that a scintillation which appears bright to one observer is weak to the other." There seems little doubt that the weaker scintillation was seen by one of the observers during one of his periods of mobile vision (c. 0·01 and 0·25 sec.). Rutherford's remark (*loc. cit.*) "that the superior efficiency of an experienced observer appears to be due to greater concentration, to control of spontaneous movements of the eye, and to practice in using the ex-central portions of the retina, thereby avoiding the insensitive fovea-centralis" now requires to be supplemented by the statement—"and above all to a low value of the blackout index".

It remains to discuss method 1 (*b*) in Table 2, and here numerical data on the act of blinking are available, at any rate for one of the observers (see Table 1). These workers used a longer period Elster-Geitel string electrometer for their work. The string took just under 0·2 sec. to be deflected, and the entire displaced period[7] was greater than 1 sec. Since these times are appreciably greater than Lawson's blackout period (0·1 sec.), it is certain, even taking account of his period of mobile vision (0·25 sec.), that this observer saw at least two-thirds of a kick which occurred at the moment of a blink, so that the blackout error can be disregarded in his case. In regard to the second observer (Hess), nothing is known of his blackout period, but it is recalled that his inter-blink period was definitely shorter than that of Lawson, so that his blackout indices would be greater. A slight discrepancy in the estimates of Z by these two observers might therefore be expected, and was in fact found[8]. Thus in the final series of observations their mean corrected values of Z were:

Hess (114 determinations): $Z = 3{\cdot}68 \times 10^{10}$,
Lawson (154 determinations): $Z = 3{\cdot}75 \times 10^{10}$.

In all, about 80,000 particles were counted in these final determinations. The accuracy to be expected from this number of particles is thus of the same order as the guaranteed accuracy of secondary radium standards (0·5 per cent), which are used in the measurement of the sources. On the evidence available at the present time, therefore, there seems to be no valid reason for suggesting a change in the accepted value of $Z = 3{\cdot}70 \times 10^{10}$, for its true value is scarcely likely to be greater than $3{\cdot}75 \times 10^{10}$.

Further Applications of the Blackout Indices

It is of interest to note the effect of the act of blinking in other branches of human activity. In the realm of sport it is of great importance. When we consider that a motorist who has a rapid rate of blinking may be blacked out intermittently for about 40 per cent of his driving time, or 40 per cent of the distance travelled, we can surely discern in this a primary cause of proneness to accident. In fast games like tennis or badminton, the ball or the shuttlecock will certainly be lost to sight during the 0·3 sec. of the blackout due to blinking. For people with a high rate of blinking, bowls is a much more suitable form of recreation. In flying, too, the airman does not appear to have been aware hitherto of the effect of blinking on his efficiency, either in bombing a target or in fighter combat, for in the period of his blackout or mobile vision he may have travelled a distance of the order of one hundred yards. The effect will be greater still for the pilot of a jet fighter. The blackout indices are also of great importance in cricket, for if they are high, the batsman or wicket-keeper may lose sight of the ball between the wickets, the fielder may readily miss what seemed a sure catch, and the umpire may give a wrong decision. In boxing, too, a damaged eye stimulates blinking and thus an increase in the blackout index, whereas the time constants involved in the sensory and optical blinking reflexes may be all-important to the boxer. Also in photography it is to be expected that, on the average, a group of people will have approximately normal time constants of blinking, and in consequence, at any moment, a definite percentage of them equal to the normal black-out index (c. 10 per cent) will be in the act of blinking. This prediction is confirmed by the examination of group photographs. Thus in two recent topical photographs of groups of 43 and 18 persons respectively, three had closed and three half-closed eyes in the first, and in the second two had closed eyes.

In conclusion, it may be mentioned that all electrical valve counting circuits, by virtue of their time constants, must suffer from the disadvantage of blackout, but as the effects are calculable, they need not necessarily involve serious error in the count. Another electrical analogy is to be found in the time base of the cathode ray oscillograph, in which the fly-back time corresponds to the blackout period in blinking. In this case, also, the error involved can readily be determined.

[1] In particular, Ponder, E., and Kennedy, W. P., *Quart. J. Exper. Physiol.*, **18**, 89 (1928); Blount, W. P., *ibid.*, **18**, 111 (1928); Luckiesh, M., and Moss, F. K., *Illum. Eng.*, **35**, 19 (1940); Hall, A., *Brit. J. Ophthal.*, **29**, 445 (1945). General references: Duke-Elder, W. S., "Text-Book of Ophthalmology", **1**, 643–647 (Henry Kimpton, London, 1942); Glasser, Otto, "Medical Physics", 679–681 (Year Book Publishers, Inc., Chicago-Illinois, 1944).

[2] Miles, W. R., *Amer. J. Physiol.* (*Proc.*), **72**, 239 (1925).

[3] Macleod's "Physiology in Modern Medicine", 278 (1941).

[4] Taken from "Radiations from Radioactive Substances", by Rutherford, Chadwick and Ellis, 63 (Camb. Univ. Press, 1930).

[5] Rutherford, Chadwick and Ellis, 544–550. See also Geiger, H., and Werner, A., *Z. Phys.*, **21**, 187 (1924); Hess, V. F., and Lawson, R. W., *Phil. Mag.*, **48**, 200 (1924).

[6] Chadwick, J., *Phil. Mag.*, (7), **2**, 1056 (1926).

[7] Lawson, R. W., and Hess, V. F., *Wien. Ber.*, (IIa), **127**, 465 (1918).

[8] Hess, V. F., and Lawson, R. W., *Wien. Ber.*, (IIa), **127**, 456 (1918).

THE ECOLOGICAL APPROACH TO BOTANY

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THE last forty years have witnessed the growth and establishment of the *idea* of ecology. Twenty years ago it was possible for botanical professors to pronounce that they simply disbelieved in ecology, and it was a word of mystery to the general public. 1911 saw the publication of "Types of British Vegetation" by Prof. A. G. Tansley, and in 1913 the

British Ecological Society was founded, with its periodical *The Journal of Ecology*, to which in 1932 was added *The Journal of Animal Ecology*. In 1939 there appeared the monumental volume, "The British Islands and their Vegetation", by Prof. Tansley, which demonstrated by its advance upon "Types of British Vegetation" the tremendous extension of our ecological knowledge of British vegetation, and in 1942 Sir Edward Salisbury's book, "The Reproductive Capacity of Plants", which showed the progress of autecological investigation.

This expansion of ecology is due to the realization that natural history is not, after all, outside the scope of exact scientific inquiry, and it reflected that the eagerness of the old quest for knowledge of living organisms in the field had been coupled with new techniques and the methods of modern science. The consequence of this expansion is that ecology is now acknowledged by men of science and comprehended by most laymen.

Few, however, comprehend the power of the ecological idea, or how forceful a means it is proving to be in the expansion of knowledge, and in the advance of civilization. We have begun by the recognition that in schools and colleges the mere collection and identification of species and genera must, in educational interests, as well as scientific, give place to studies of the intimate biology of plants and animals, and of the relationships between them and their environment. The complexity and the scientific interest of the situation thus disclosed have affected scientific research in the widest fields: marine biology, with its studies of herring shoals, whale fishing, sealing, and seaweed survey; ornithology, with its intensive and extensive census and migration studies, and starling, rook, wood-pigeon, and sea-bird inquiries; entomology, with its immense fields of applied science, and locust, tsetse, wireworm and aphid investigations; vertebrate ecology of fur-bearing animals and lemming, rat, grey squirrel and coypu; forestry, with its problems of exploiting and equally of maintaining natural forest; all these and many other sciences bear witness to the penetration of the ecological idea into appropriate scientific fields, and of its fruitfulness therein.

It owes its success simply to the timeliness of the reaction against premature simplification of biological interpretation, and premature syntheses from basic generalizations. It is a study demanding constant return to the primary data, which are the observations in the field, and constant emphasis on the reaction of the organism as a whole in its environment.

The value of this approach is apparent in the quality and bulk of the results achieved, and in a demand for trained ecological research workers which far outstrips supply. Wherever biological material is involved, be it rubber, teak, penicillin, slugs, lettuces, lice, cotton, or cat-fish, there comes the need for ecological inquiry, and naturally this is most realized where great natural resources in unexploited lands are being surveyed for their potentialities. Let there be no question: only an ecological approach will now serve us in these regions. Gone are the days of the old German dogma that forests should be grown like crops of potatoes, and rapidly vanishing are the prospects for the heedless garnering of the earth's natural products. The immense destructiveness of modern exploitation has been brought home by the ghastliness of soil erosion phenomena in all parts of the world; but avoidance of such ills inevitably depends upon adequate ecological understanding of the systems of animal and plant life, soil, and climate which are involved.

There was a day when T. H. Huxley wrote and spoke with powerful effect against the neglect of biological teaching, and of biological knowledge, on the substantial ground that man himself is an animal. It needs little effort to extend this thesis, to-day so readily approved, to the understanding that we humans are not distinct from the biome; but that human communities, be they what they may, *all* form an inseparable part of the larger environment. There is no break in kind between the relationships of the great eco-systems of plant and animal communities, and those which include fewer or more human beings: the minor role of the sparse bushmen in their own forest environment grades into our own within a complex mechanical civilization. Since still the human agents remain animal in nature, sustain themselves within communities, and subsist on biological materials, they are no less part of the eco-system than were their ancestors. It is, indeed, appropriate and needful that to the complexity of the world's social problems there should increasingly be brought to bear an ecological and realistic interpretation. This is not to demand here and now the setting up of commissions, institutes or departments of human ecology, but to point out that such problems will be solved only by a generation which has been trained to adopt a sufficiently broad ecological outlook.

It is in our favour that the youth of Great Britain, more than at any time before, receives encouragement to develop such an outlook. Schools (encouraged by syllabuses of progressive examination bodies) devote increasing time to it, and are strongly assisted by the admirable organisation of the Council for the Promotion of Field Studies.

It has never escaped the attention of Prof. Tansley, who for so long has been the inspiration of British ecology, that the standard of school and university teaching in ecology depends upon the quality of the text-books available, and he has added to the debt which the science (and the country) owes him by sponsoring the timely issue of three ecological text-books, which will shape all elementary ecological study in Great Britain for some years to come. These are, first, "An Introduction to Plant Ecology"[1], written by himself, upon the basis of his well-known "Practical Plant Ecology". This keeps the general character of the older book, but also includes chapters on the modern theory of communities, succession, and life-form. The soundly balanced philosophical outlook and the clarity of style which Prof. Tansley commands would alone suffice to justify the book, which, in fact, is indispensable to all taking up the study of ecology, be they teachers or students, and at school or university level.

One of the pioneers to develop school ecological studies was E. Price Evans, who is also known for his work upon the ecology of Cader Idris. He and Prof. Tansley have combined in the writing of "Plant Ecology and the School"[2], a slenderer and more elementary work than that just mentioned, and aimed to make apparent by actual instances exactly how ecology can be practised in schools. This work rightly stresses the *integrative* influence of such ecological studies, and recommends their incorporation in studies of regional geography, and in general science courses. The authors properly observe that plant ecology is not so much a 'subject' as a method of approach to the study of plants, and this holds equally, of course, for all fields of ecology.

The last book of the trio under review, "Practical Plant Ecology", is by Prof. R. C. McLean and Dr. Ivimey Cook[3]: it gives an account of the field methods and field apparatus which have been found useful in the botanical courses of the University of Cardiff. Its matter-of-fact descriptions of apparatus and technique come down to the level of average students, and will give the means to many hitherto uninstructed folk of gratifying their desire to apply precise measurement to botanical field study. The many examples of records made by students indicate the enthusiasm which the authors have engendered in their classes. There is, of course, a danger that students may record data of temperature, light, or *p*H, without any comprehension of applicability to the ecological situation being examined; but this can be guarded against by good teaching, and by conjoint use of the "Introduction to Plant Ecology". It is the commencement of careful record and measurement that is for the moment of prime importance, and this book will go far to ensure it. Messrs. Allen and Unwin are to be congratulated upon providing schools and universities with three excellent books, so satisfactorily supplementing each other; it now remains to meet a similar need in the realm of animal ecology, and to show the way to teach the study of the biome, with its complex integration of both plant and animal life.

[1] Introduction to Plant Ecology: a Guide for Beginners in the Study of Plant Communities. By A. G. Tansley. Entirely revised and enlarged second edition of "Practical Plant Ecology". Pp. 260. (London: George Allen and Unwin, Ltd., 1946.) 8*s.* 6*d.* net.

Plant Ecology and the School. By A. G. Tansley and E. Price Evans. Pp. 98. (London: George Allen and Unwin, Ltd., 1946.) 6*s.* net.

[3] Practical Field Ecology: a Guide for the Botany Departments of Universities, Colleges and Schools. By Dr. R. C. McLean and Dr. W. R. Ivimey Cook. Pp. 208. (London: Allen and Unwin, Ltd., 1946.) 9*s.* net.

SCIENCE AND U.N.E.S.C.O.

MEETING AT MEXICO CITY

IN this article we are concerned mainly with the present results from the successful drive to put the 'S' into 'U.N.E.C.O.'. The presence of some thirty scientific men from the thirty-three countries represented at the second general conference of the United Nations Educational, Scientific and Cultural Organisation, held in Mexico City last November, was an earnest that the 'S' had come to stay; the careful preparations for the programme made by Dr. Joseph Needham and the staff of the Natural Sciences Division and the clear statements made by the representatives of the scientific working party in the plenary sessions account largely for the successful piloting of the various scientific projects past budgetary and other obstacles.

To one accustomed to the atmosphere of international gatherings of scientific men, a first impression of a meeting of the United Nations Educational, Scientific and Cultural Organisation is that, whereas science is truly international in outlook and has learnt to work along international lines, culture is essentially national or racial in outlook and is only just beginning, save on the more mechanical side of museums and libraries, to walk easily along the international path. While the eloquent protest of Sir Sarvepalli Radhakrishnan that the culture of the East is insufficiently represented on the staff of the Organisation was received with sympathy and applause, speeches which sounded as though they might have been delivered at Lake Success were seen to lie clearly outside the sphere of the Organisation's interests and activities. The temper of the meeting clearly indicated a desire for as complete co-operation as possible: political differences were barred, though in some cases national or racial differences were accepted as playing an inevitable part under present conditions.

The programme of many varied schemes for 1948 put forward in advance of the meeting by the Executive Board called for an all-over budget of 8,500,000 dollars. As a first step, this was reduced by the full meeting of delegates by 800,000 dollars, so that when the various sectional working parties met to discuss their programmes in detail, they knew approximately the size of the grant that they were likely to receive and they could modify the proposed plans accordingly. The chairman of the working party of the Natural Sciences Division was Dr. H. J. Bhabha. The programme ultimately adopted by this party and accepted by the plenary session included the following items:

(1) *Grants in Aid to Non-governmental Organisations* (for example, the International Scientific Unions and other bodies of an international character), to meet travelling expenses, publication charges, etc.; a total of 240,000 dollars was approved.

(2) *The Hylean Amazon Scheme.* The Organisation is generously supporting in its initial stages the proposal to found an international scientific institute at Belem to study the problems of the great forest zones and the basins drained by the valley of the Amazon. Physical geography, including soil science, biology, anthropology, agriculture and nutrition all provide special problems to be considered. Brazil, as the country most concerned, backs the scheme strongly. It is being supported by the other countries involved in the area—Bolivia, Colombia, Ecuador, Peru, Venezuela and the British, French and Dutch Guianas—also by the United States and at its own request by India, as a country much interested in tropical problems. The Organisation is making a grant of 100,000 dollars in 1948 for initial surveys. Of this sum, 50,000 dollars comes from the money for the Field Science Co-operation Office for Latin America; Mr. E. J. Corner will be in charge of the initial organisation.

(3) *Field Science Co-operation Office.* In addition to the Office for Latin America, which is to be assigned for the present to the Hylean Amazon, there already exist two field offices which act as links between the main centres of learning and research and countries remote from such centres. One is at Nanking, serving Far East Asia and the Philippines; the other is at Cairo for the Middle East. The officers in charge are Mr. J. Smid, of Czechoslovakia, and Dr. L. T. Thuriaux, of Belgium, respectively. An additional office for India was agreed to by the conference.

(4) *Popularization of Science and of its Social Implications.* Following upon two meetings of experts called together in Paris and in New York during October last, the United Nations Educational, Scientific and Cultural Organisation decided to stimulate research and surveys in this field by fellowships, by co-operation with existing bodies working on the subject and by the preparation and circulation of reports.