THE AMATEUR SCIENTIST IN BRITAIN (2)*

By R. BRIGHTMAN

IN the physical sciences the amateur is still rendering services. Maurice Gorham, former head of the Television Service of the British Broadcasting Corporation, has pointed out that broadcasting owes its resuscitation in the 'twenties to the amateurs[23]. Their activities, enthusiasm and incessant demands, culminating at the end of 1921 in a petition to the Post Office from sixty-three societies representing 3,300 amateurs asking for wireless telephony transmissions, "primarily to serve the scientific purpose of improving the receiving arrangements", but referring to weather reports, news, etc., which were already being received from foreign wireless stations, in a way that showed clearly that what they wanted went beyond purely scientific tests. This time the Post Office yielded and authorized the Marconi Company to broadcast speech and music for the amateurs, to the extent of one programme of fifteen minutes duration each week, and thus the first authorized broadcast made from Writtle on February 14, 1922, is due mainly to the activities of amateurs. At the present day, a new organization, to be known as the Radio Amateur Emergeney Network, is being formed. When it is complete it will include some fifty key stations and about four hundred auxiliaries, all operated by amateurs. Most of the key stations are already linked. The amateurs operating the fifty key stations have all undertaken to provide emergency sources of power independent of the public electricity supply.

Again, Sir Edward Appleton has borne witness to the value of the pioneer work of D. J. Heightman and other amateurs in connexion with solar-radio noise[24]. Attention, he points out, was first attracted to this phenomenon by the reports of wireless amateurs who, round about the period of the last sunspot maximum, noticed the existence of a curious hiss in their receivers on wave-lengths of about ten metres, which they found to occur in day-time only, and to be associated with periods of solar activity. During the War, with the more sensitive and more directional ultra-short-wave receivers in operation, many further reports of the reception of this noise became available, and Sir Edward Appleton used the period of pronounced sunspot activity, January 30 to February 14, 1946, to make a special detailed study of the phenomena. His examination of the evidence available confirms the theory he and J. S. Hey had already advanced that the noise is due directly to ultra-short-wave electromagnetic radiations, which originate in active areas on the sun, and travel from the sun to the earth with the speed of light.

The intense radio-wave emissions from sunspots were also first recorded by war-time operators on Army *G.L.* equipment. When the *V*2 rocket bombardment of London began, every method of giving even a few seconds warning was explored. Among these, radar equipments used by Anti-Aircraft Command were modified in the hope that the rockets would give a transient radar echo as they travelled high up in the atmosphere[25]. They did, but it was soon found that short-lived echoes were obtained and warnings given when no rockets were about. These spurious echoes were studied by J. S. Hey and his colleagues in the Army Operational Research Group, who eventually concluded that they were caused by meteors in the earth's atmosphere.

It is, of course, scarcely correct to ascribe such work to purely amateur effort. It is unlikely, for example, that anything would have arisen from this latter work had not a fully qualified scientist been responsible for investigating all such unusual occurrences, or had not the members of the Field Study Course been excavating under expert guidance. They do, however, illustrate the force of an observation made by Mr. Justice Lloyd-Jacob in his Bernard Dyer Lecture to the Society of Public Analysts[26]. Mr. Justice Lloyd-Jacob, suggesting that the most promising areas for future scientific growth are those that lie between the various well-established scientific fields, stressed the importance of collaboration of the right kind if these fields are to be developed. What is wanted, he suggested, is not so much the skill to experiment in the field of another scientist, but the competence to understand, to criticize and to appreciate the experiment and the results that the experiment secures. Upon such lines the most useful teamwork was done during the War, and had not secrecy considerations prevented the publication of many of the details of this collaboration, the concepts and characteristics of the scientist would not have remained so unfamiliar to most of his fellow-men. Mr. Justice Lloyd-Jacob observed that some better understanding of the scientist might have saved him from those dangers to which mob hysteria over nuclear-fission appear to expose him. It needs only superficial acquaintance with the outcome of security investigations in the United States, for example, to appreciate how real is the danger to science itself to which Mr. Justice Lloyd-Jacob alludes.

There are other reasons, however, why the wider public appreciation of the scientist and his work is desirable. In the introduction to his "History of the Rise and Influence of the Spirit of Rationalism in Europe", published in 1865, W. E. H. Lecky wrote:

"But when towards the close of the eighteenth century the decline of theological passions enabled men to discuss these matters in a calmer spirit, and when increased knowledge produced more comprehensive views, the historical standing-point was materially altered. It was observed that every great change of belief had been preceded by a great change in the intellectual condition of Europe, that the success of any opinion depended much less upon the force of its arguments, or upon the ability of its advocates, than upon the predisposition of society to receive it, and that that predisposition resulted from the intellectual type of the age. . . .

"The pressure of the general intellectual influences of the time determines the predispositions which ultimately regulate the details of belief; and though all men do not yield to that pressure with the same facility, all large bodies are at least controlled. A

* Continued from p. 565.

change of speculative opinions does not imply an increase of the data upon which those opinions rest, but a change of the habits of thought and mind which they reflect. . . .

". . . The doctrine, that the opinions of a given period are mainly determined by the intellectual condition of society, and that every great change of opinion is the consequence of general causes, simply implies that there exists a strong bias which acts upon all classes of men and eventually triumphs over every obstacle."

Mr. Justice Lloyd-Jacob's remarks remind us of Lecky's doctrine of the climate of opinion; but whereas Lecky had in mind particularly the way the discoveries of physical science were entrenching upon the domain of the anomalous and the incomprehensible, and by enlarging our conceptions of the range of law, and revealing the connexion of phenomena that had formerly appeared altogether isolated, had formed a habit of mind far beyond the limits of physical science, we, in our day, are more concerned with the way in which public ignorance or hysteria can limit the operations of science itself.

To take one or two examples:

The Report on the Conservation of Nature in England and Wales, published in 1947, observes[27]:

"In the long run the success of wild life conservation must depend predominantly on the completeness with which wild life problems and their implications are known, and on the extent to which public opinion accepts them and therefore gives support to the necessary measures of conservation.

"We are impressed with the futility of pursuing wild life conservation policies which are not widely understood and backed by public opinion, and of creating a multiplicity of offences or restrictions upon the liberty of the individual, in order to curb the misguided activities of very small sections of the population."

Similarly, Sir Arthur Tansley recorded the view that the establishment and fruitful functioning of national Nature reserves and a biological service would not be secured without a greatly increased permeation of the general mind with the outstanding importance of their objects.

Dr. E. A. R. Ennion, addressing in August 1950 the Conference of Delegates of Corresponding Societies at the British Association meeting in Birmingham, likewise observed[28]:

"Reserves cannot be administered properly by remote-control committees whether of strictly scientific or of predominantly sentimental composition. Still less could reserves be supervised successfully from a window in Whitehall. Their ultimate safeguard lies in the studied care and vigilance of amateur field naturalists up and down the land."

In August 1951, Dr. D. A. Allan[29], surveying the "Scottish Scene" in his presidential address to the same Conference at Edinburgh, remarked that the trained biologist required to supervise Nature reserves and to carry out ecological research involved, needed the support of "a special Home Guard of local amateur naturalists, including botanists, entomologists, ornithologists and zoological specialists".

Besides this scientific and practical aspect which obviously calls for a real effort at education, there is a cultural or spiritual aspect which is no less important. As the Huxley Committee observed[30], the educational benefits to be had from a constructive wild-life policy extend beyond the cultivation of a healthy public opinion and the technical training of science students to the wider sphere of general and adult education. In this context there is a quotation from the third report of the Nature Reserves Investigation Committee: "A serious student, whatever his calling, who could visit and have intelligently demonstrated to him even a good example of the sites here proposed, would have received a liberal education in one of the most stimulating and formative fields of thought". By building up an appreciation of the interest and beauty of Nature and public consciousness of the aims of conservation, the Huxley Committee considers that the adult educational facilities provided in the Nature reserves would complement and ease the work to be done in National Parks. Now that the Nature Conservancy is well established, it can be confidently expected that, with Mr. E. M. Nicholson as its director-general, who is probably even better known as an ornithologist than as the senior Civil servant who had been secretary to the Lord President's office since 1945, there will be no failure to cultivate the amateur's support and co-operation, and that the Conservancy will encourage and, where possible, extend voluntary efforts in the field of research, especially ecological research, for which it is responsible.

This is not all, however. Prof. S. W. Wooldridge has stated that at no time did the youth of Britain need more greatly to be shown the mental stimulus combined with solace of mind and spirit which come from learning to read and understand the country[31]. It is of vital importance that interest in Nature and in living things should be stimulated and encouraged by every possible means. Only by strengthening this side of people's minds can we hope to counter excessive preoccupation with stark mechanism and the crude materialism to which it often leads—so dangerously characteristic of modern civilization—by a deeper understanding of living beings and of life. Sir Arthur Tansley[32] also has urged that this is as important to the continuation of civilization as an ever-deepening understanding of Nature and of the complex structure and working of her productions is the very foundation of most of man's practical activities—in the first place his own physical and mental health, then agriculture and the care of animals, and then such pursuits as forestry, control of pests, water supply, drainage, and so on.

The work of the Council for the Promotion of Field Studies, formed in December 1943, largely on the initiative of Mr. F. H. C. Butler, its present director, is appropriately considered in this context. Briefly, the aims of this Council, which was incorporated on June 13, 1946, are to provide facilities for every aspect of field-work at first hand, and to set up for this purpose residential field-study and research centres, distributed throughout the country, in localities selected for the richness and variety of their ecological features, geological and geographical interest and archæological and historical importance. The field-centres are available alike to all serious workers in the field, whether amateur or professional, whether as individuals or as members of a class from a school, training college or university; from a county college, technical college or youth service; whether as independent workers or as members of a research team, learned society or other corporate body. The Council wishes to co-operate closely with local societies and field clubs, and through the centres should also be able to play an important part in the training of the community in sound knowledge,

æsthetic appreciation and proper use of the countryside. The centres are intended just as much for the individual "amateur nature lover" as for parties from universities, training colleges and schools; in fact, it is one of the aims of the Council to encourage and help the ordinary person with an interest in some branch of natural history who wishes to learn more of this or allied subjects. It is precisely because they are not directly concerned with education that 'amateurs' contribute to a mixed party the spirit of genuine interest and enthusiasms which has nothing to do with examination results. Their contribution to any course is correspondingly valued. They are so often people of wide experience that they have a special contribution to make to discussion and argument on any course, and the work of the centres suffers accordingly when there is none in residence.

Since the first of the field-centres opened its doors at Flatford Mill in May 1946, more than 15,000 resident students have passed through them and the amateur naturalist has been accepted on a really large and comprehensive basis[33]. There are at present four such centres situated in totally contrasting types of country. Flatford Mill itself is specially well placed for the study of hydrobiology, and it is hoped here to develop besides long-term recording of hydrobiological conditions, including temperature changes in a slow-moving river, a training ground for ecological research. The Juniper Hill Field Centre, near Dorking, offers opportunities for the geographical interpretation of landscape, the siting and growth of settlements, plant and animal ecology and general nature study on the North Downs, the western Weald and the outer fringe of the London basin. The Dale Fort Centre, near Haverfordwest in Pembrokeshire, is particularly adapted for the study of bird life and marine biology and the ecology of a rocky coast. It offered in August 1952 for family parties, as an experiment, a holiday course based on the wind and the sea. An integral part of this Centre is the Skokholm Island Bird Observatory. The Malham Tarn Field Centre near Settle offers opportunities for the study of bird life and mammal life in characteristic limestone regions of the Yorkshire dales, including also courses on insects and on fungi, liverworts and mosses. One feature of the work at this Centre has been the annual collaboration since 1950 of the Royal Meteorological Society in a course held in September, and each of these four centres estimates the students in residence, generally for a week at a time, at 1,000–1,200 for the season.

While the need for facilities for field-work in Britain is thus increasing and the opportunities which the Council can offer are more important year by year, the Council finds increasing difficulty in maintaining its centres. It has already been compelled to raise its weekly charges to students to five and a half guineas, and although some firms like Imperial Chemical Industries, Ltd., have made substantial annual grants under deed of covenant in favour of the Council, much more support is required both from industry and from the scientific societies and other bodies if all the possibilities which the Council's work offers for encouraging the activity of both the professional and the amateur scientist in field studies are to be utilized to the full.

It should be apparent from the foregoing account that already much is being done in Great Britain to close the gap between the professional scientist and the amateur, or indeed the layman generally. In few countries have amateur naturalists made such important contributions to biological knowledge over so long a period as in Great Britain, but since the War there have been remarkable developments in other countries. In a paper reviewing the tenth International Ornithological Congress at Uppsala in 1950, where the large British party included characteristically strong amateur elements, Dr. Julian Huxley referred to the way the interest of the amateur in ornithology had been enlisted since the previous Congress in 1938. Besides the founding of the British Trust for Ornithology, which carries out various scientific investigations almost wholly from the efforts of amateurs, the Swedish Ornithological Society had grown to more than 1,500 members, mostly amateurs, since its foundation in 1945, and there have been similar developments in the United States, Holland and elsewhere. As a result of this, many men and women who would, at best, have become amateur bird-watchers or sentimental bird lovers, have become interested in the scientific aspects of bird life, and have had the satisfaction of helping in research and the advancement of scientific knowledge. Dr. Huxley instances important new knowledge, for example, on the fluctuation in numbers of particular species (like the common heron or the great crested grebe) within a country or region over a period of years, or the relation of clutch-size and of egg and fledgling mortality to geographical position and climatic variation, as discovered only through the co-operative efforts by amateurs. The British Trust for Ornithology itself, which exists to encourage observation by amateurs and to publish the results, has, in addition to the inquiries it has completed into the numbers and habits of rooks, the decrease of the corn-crake and the distribution of the woodcock, for some years been investigating the changes in the population of heronries in relation to the weather and the remarkable spread of the fulmar. The new Observatory on Bardsey Island, off the Lleyn Peninsula of Caernarvonshire, which is now making an appeal for funds on the lines adopted by the Fair Isle Bird Observatory of Northern Scotland, is the latest of twelve such observatories to be established in the British Isles, and the fourth along the west coast. It owes its foundation to the initiative of the West Wales Field Society and the Birmingham and West Midland Bird Club, and will offer opportunities for work by amateurs, particularly in setting up the bird-catching traps and devices for the capture, marking with numbered leg-rings, and release of migratory birds.

In the United States in 1938 the Carnegie Corporation and the American Philosophical Society set up a Committee on Education and Participation in Science which surveyed the activity of more than seven hundred amateur scientists in the Philadelphia region and helped organize a number of research projects in which very many more participated. Out of this came "The Amateur Scientist", a book written by the secretary of the committee, W. Stephen Thomas[35]. At about this time, too, a Committee on Private Research, also supported by the Carnegie Corporation, was set up at Western Reserve University for work in the Cleveland area. Many of the studies of amateurs with which it was concerned were in the sciences. The activities of this committee are described in a book by its director, William S. Dix, entitled "The Amateur Spirit in Scholarship"[36]. The War unfortunately prevented an extension of

these promising experiments. The American point of view is also well indicated in the presidential address to the American Association for the Advancement of Science of E. W. Sinnott, in December 1949 [37]. In that address, entitled "Ten Million Scientists", Dr. Sinnott pointed out that we sometimes forget the vast areas where facts and principles of great scientific value may be discovered with no more complex tools or techniques than are at the command of any intelligent layman. He instanced the exact distribution of plant and animal species, the records of flowering dates, the analysis of tree-ring chronology, the variability of wild species, bird censuses and the records of bird and insect migrations, the study of peat borings, the collection and identification of fossils, the distribution of minerals, detailed local weather observations, records of meteorites and of variable stars, time-lapse photography, and problems of radio transmission, as but a few of the many fields open to study by the amateur scientist, and he added that a fresh point of view and freedom from bias have often led the amateur to discoveries that his more inhibited professional brother had overlooked.

The latest Directory of Natural History Societies lists some 124 such societies in Great Britain. Some societies, such as the Geologists' Association, Geographical Association, Amateur Entomologists' Society, Radio Society of Great Britain and British Astronomical Association, have among their members a considerable proportion of young people. The Amateur Entomologists' Society has some two hundred members in a special category of junior membership, and the Radio Society of Great Britain has about five hundred. The Royal Society for the Protection of Birds, besides having a special subscription for those under twenty-one, organizes a Junior Bird Recorders' Club. This was founded in 1943 and has now three thousand members between eleven and eighteen years of age. Members record observations of birds, which are used in producing an Annual Bird Report. Altogether there are some four hundred societies in Great Britain the interest of which include one or more branches of science, and these have already co-operated in such matters as the Land Utilization Survey; British Museum (Natural History), bird-ringing scheme, insect immigration scheme; London Natural History Society, bird report; Royal Meteorological Society, phenological report; Rothamsted Experimental Station and National Institute for Agricultural Botany, crop experiments.

With the growing dependence of scientific work upon State, or at least public rather than private support, it is more than ever important to secure such a public understanding and favourable climate of opinion if scientific work is not to be liable to continual and frustrating interruptions at every time of financial stringency. A volume of studies and sketches which Prof. J. Simmons published in 1952 under the title "Parish and Empire"[38] constituted an eloquent plea for field research and historical approach over a wide range of what may be termed local studies. He directs attention, for example, to the general neglect of industrial history and shows how parish studies can be linked up with national and imperial history. He indicates how the study of local history can contribute not merely to the clearer understanding of some of our modern problems, but also to redress some of the dangers inherent in specialization to-day. Local studies of this type could make their own contribution to the promotion of a wider general understanding in the community of the nature of scientific work and thus indirectly to the creation and maintenance of the conditions in which scientific activities truly flourish. That, as has been indicated, is one essential element in securing the continuous public support which the effective prosecution of scientific effort under the conditions of to-day demands. It is fostered also by the very existence of the amateur scientist and his wide distribution among all sections of the community. Lastly, as for the past three centuries, the contribution of the amateur is important in itself: even to-day, without the help of the amateur scientist the prosecution of research on the scale desirable into many problems of ornithology, meteorology and other problems embraced in ecology would be impossible. In such fields, with Britain's limited resources of scientific man-power, the co-operation and enthusiastic support of the amateur scientist are indispensable for the most effective deployment of our trained professional scientists.

[23] Gorham, M., "Broadcasting and Television since 1900", 34 (A. Dakers, Ltd., London, 1952).
[24] *Phil. Mag.*, **37** (7), 73 (1946).
[25] Lovell, A. C. B., *Manchester Guardian* (Nov. 10, 1948).
[26] *Analyst*, **77**, 234 (1952); cf. also Mather, K. H., "The Problem of Anti-scientific Trends To-day", *Science*, **115**, 533 (1952).
[27] "Conservation of Nature in England and Wales", Cmd. 7122, 110, 116 (H.M.S.O., 1947).
[28] *Advancement of Science*, **7**, 285 (1950).
[29] *Advancement of Science*, **8**, 279 (1951).
[30] "Conservation of Nature in England and Wales", Cmd. 7122, 13, 19 (H.M.S.O., 1947).
[31] "The Spirit and Significance of Field Work" (C.P.F.S., 1948).
[32] "Education for Field Study" (C.P.F.S., 1947).
[33] cf. also *Nature*, **167**, 712, 757, 801, 886 (1951).
[34] "Birds and Science," *Country Life*, **108**, 367 (1950).
[35] Thomas, W. S., "The Amateur Scientist" (W. W. Norton and Co., New York, 1942).
[36] "The Amateur Spirit in Scholarship" (Western Reserve University Press, Cleveland, 1942).
[37] *Science*, **111**, 123 (1950).
[38] Simmons, J., "Parish and Empire: Studies and Sketches" (Collins, London, 1952).

THE OLDEST DATED MINERALS OF THE RHODESIAN SHIELD

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FOR some years it has been suspected that the Rhodesia–Tanganyika Shield might include some of the oldest rocks of the African continent[1]. This has now been confirmed by the dating of monazites supplied by Dr. A. M. Macgregor and the Director of the Geological Survey of Southern Rhodesia. Through the good offices of Dr. F. H. Burstall, these minerals have been analysed chemically at the Chemical Research Laboratory, Teddington, for lead, uranium and thorium, and samples of pure lead iodide prepared from each. The proportions of the isotopes in the lead of these samples have been determined by Messrs. William C. Erickson and John Hoffmann in the laboratory of Prof. Alfred O. Nier at the University of Minnesota. The generous collaboration of these friends and fellow-workers is gratefully acknowledged.

The analytical data are recorded in Table 1, together with the crude, uncorrected ages, as read from Wickman's graph[2]. The highest uncorrected