THE TRAINING OF MICROBIOLOGISTS

RECENT advances in pure and applied microbiology have been so rapid that it should not be surprising if the teaching of the subject has lagged behind. There is, in fact, a general impression that existing courses are not always adequate and that the extreme variation in content which they show is confusing alike to student and employer. A discussion on the training of microbiologists, arranged jointly by the Microbiology Group of the Society of Chemical Industry and the Society for Applied Bacteriology, was therefore timely. The meeting took place in the Beveridge Hall, Senate House of the University of London, on the afternoon of January 9, with Dr. M. Ingram and Prof. E. L. Crossley sharing the chairmanship.

Three of the principal speakers considered the general content of courses on microbiology. Prof. B. C. J. G. Knight, dealing with "The Academic Basis", pointed out that the early microbiologists had a broad and integrated view of their subject, which was soon lost as their successors became pre-occupied with practical applications. Microbiology should still be regarded as a single discipline, since all studies involving small and ubiquitous organisms use similar techniques and since most of the effects produced by such organisms are consequences of the same general property of multiplication. In teaching microbiology, the fundamental unity in biochemistry and physiology underlying the diverse activities of micro-organisms should be emphasized and the biology and physiology of the different groups should be treated on a comparative basis. The course for the B.Sc. degree of the University of Reading is based on these general principles. Dr. G. E. Fogg, speaking on "Algae and the Teaching of Microbiology", mentioned that the syllabus for the M.Sc. degree in microbiology of the University of London, although it allows for some measure of specialization, is likewise based on a broad survey of all aspects of microbial activity. His particular concern was that, at present, courses are almost exclusively confined to the study of bacteria and fungi. In justification of his contention that algae should figure more largely in the teaching of microbiology, he pointed out the contributions which the study of these organisms have made to the development of the subject, their dominant role in natural economy, and their growing economic importance. "The Technological Approach" was considered by Dr. B. H. Arnold, speaking in place of Prof. T. K. Walker. With the growing application of microbiology in industry, more postgraduate courses are needed. These should all start from a sound basis of general microbiology, but specialization in at least three main directions, namely, agricultural, food and chemical microbiology, is necessary. In the field of chemical microbiology the new technology of antibiotic manufacture requires knowledge of chemical engineering and economics. Research may be an important part of the training of an industrial microbiologist, and it is important that this should have some relation to fundamental studies.

More factual accounts of existing courses were given by Dr. M. Woodbine and Mr. A. J. Peters. The former described "The 'Common Stem' Course", as given in the School of Agriculture of the University

of Nottingham. Microbiology, which occupies 10 per cent of the teaching time, consists of an elementary introduction covering the classes of bacteria and viruses and the microbiology of water, soil and food, and is given during the first two years of the finals course. This is followed by specialization in subjects such as dairy and food microbiology in the third year. At this stage students must produce a dissertation on some special topic. Mr. Peters's account of "Microbiology Courses in Polytechnics and Technical Colleges" was based on sixty-five replies to a questionnaire sent to ninety-three of the larger colleges. From this it appears that there are few courses which can be classified as 'craft courses'. Most are concerned with training technicians and are related to some particular local industry or activity. Courses of a medical nature predominate in this class, and the others are very varied, being concerned with microbiology as applied in pharmaceuticals, baking, catering, sewage disposal, tanning and so forth. Few courses of this type include any general microbiology or even deal with both pathogens and non-pathogens and perhaps the recently instituted endorsed certificate in biology of the Institute of Biology will provide the best general training at this level. Besides those for the external degrees of certain universities, advanced courses exist as for the diploma in biochemical analysis given by the Pharmaceutical Society, and that in metabolism of micro-organisms held at the Chelsea Polytechnic. At a few colleges microbiological research is carried out. The general impression is that classes are usually small and courses sometimes inadequate. Although expansion is taking place, this lacks direction. If microbiology is to develop in technical colleges, it seems that some sort of common course must be introduced and that there must be more encouragement from employers for students to attend the courses.

A third group of papers gave the views of those employing microbiologists. Dr. A. H. Campbell, speaking on "Training required for Microbiologists recruited to the Microbiological Industries", pointed out that successful work in this field is being carried out by people with extremely varied types of training. Of a small sample questioned, fourteen had qualifications in the physical sciences, five were botanists or zoologists, and one had been trained as a bacteriologist; considering those engaged in research only, the corresponding ratio was 7:4:1 (in the discussion afterwards, the picture presented by this admittedly small sample was confirmed as being a general one). For work on antibiotics it does, in fact, appear that the best training is one in chemistry with the addition of at least a year's study, preferably at the postgraduate-level, of microbiology. Openings are more limited for those whose training is primarily botanical; such people are most useful for specialized work in mycology or physiology of micro-organisms, although it is possible that, with increasing use of antibiotics in agriculture, wider employment for them may be forthcoming. The value of a training in biochemistry for work in industrial microbiology varies greatly according to the school. Mr. T. E. Bashford considered "Training

required for Microbiologists recruited to the Food Industry". The scope for microbiologists in this field has increased considerably in the past ten years, but it is not true to say that there is a large unsatisfied demand for microbiologists. Newly engaged staff lack the necessary specialized knowledge and require a good deal of training. Courses in microbiology should contain more of the processing, preservation and spoilage of foods. Yeasts and moulds are of considerable importance in the industry and should be studied as well as bacteria. Mr. H. Proom, who spoke on "Training required for Technicians in Microbiological Laboratories", said that there is at present a grave need for microbiological technicians. To improve the supply it seems necessary that (1) the work and responsibilities be defined, (2) qualifications must receive general recognition and be correlated with wage scales, and (3) there must be a sufficiently large total number of posts. Industry must give the lead with respect to (1), but work and responsibilities are difficult to define because of the variety of conditions and opportunities. Some of the technician's work is bound to be routine, and no ambitious scheme of training is necessary. Training at this level in industry itself is wasteful, and courses in technical colleges, such as that included in the City and Guilds scheme, seem satisfactory. Training in highly specialized work, electron micrography, for example, is more appropriately given in the course of employment.

From the discussion which followed these papers, it seemed that there was fairly general agreement

that the primary object of degree courses in microbiology should be to give a broad training in fundamentals. Of course, indications of practical applications should be given, but it is not for the universities to train for specific industrial outlets. Chemistry is undoubtedly a basic subject for the microbiologist, but the idea that the chemist is just as well able to deal with microbiological processes as the microbiologist was repudiated by many speakers. The biological outlook is essential in industrial microbiology, although it is perhaps true to say that the microbiologist is a specialist whose work is utilized most efficiently if he is supported by a team of chemists. Discussion of the suitability of microbiology as a subject for a first degree was inconclusive. Attention was directed to the fact that microbiology now forms a substantial part of degree courses in pharmacy. For the training of microbiological technicians it was agreed that the City and Guilds scheme meets the need for an elementary non-medical training course. There is clearly room for expansion of courses at this level and there remains a lack of general courses of a more advanced kind for technicians which will perhaps be supplied by those for the advanced level endorsed certificate of the Institute of Biology. Classes cannot be started until a demand exists, but employers are unwilling to send technicians to courses which have not been established. The initiative in breaking this vicious circle must surely come from industry.

G. E. Fogg

OBITUARIES

Sir Arthur Bowley, C.B.E., F.B.A.

ARTHUR LYON BOWLEY died on January 21 at the age of eighty-seven. He was the last of the distinguished statisticians and economists practising at the end of the nineteenth century, and the last of the original group of teachers at the London School of Economics. He will be long remembered, both for his teaching during an active life of fifty years and for his many writings on statistics and on economic and social affairs.

At Trinity College, Cambridge, he was bracketed tenth Wrangler in 1891 and stayed on to gain the Cobden Prize in 1892 with his "A Short Account of England's Foreign Trade in the Nineteenth Century" (published 1893, third edition 1922). Later he obtained the Adam Smith Prize (1894) and the Sc.D. (1913); he was also awarded honorary doctorates by Oxford and Manchester.

For nearly twenty-five years from 1895, Bowley was a part-time teacher of mathematics and statistics at the London School of Economics in the University of London, during a period when statistics was not taught as a separate subject at any other university. He combined this with additional teaching, first as a mathematics master at St. John's School, Leatherhead (1893-99), and then as a lecturer in mathematics and economics at the new University College, Reading (1900-19). It was not until 1919 that he had a full-time teaching post; he was then elected to the new chair of statistics in the University of London, held at the London School of Economics.

He retired from this chair in 1936, being made professor emeritus in the University. Afterwards he was called upon to act as director of the Oxford University Institute of Statistics for a war-time period (1940-44).

As a teacher, Bowley was a meticulous expositor and an inspiration to the inquiring mind; but he made few concessions to the weaker students. His influence was greater among postgraduate than undergraduate students, and greater still with mature research workers. Both Lord Stamp in his work on British incomes and property and Lord Beveridge in his Social Insurance Report were greatly indebted to Bowley for technical advice.

He contributed to the advancement of statistical and economic theory, which he translated into his own mathematical terms. But his more important and lasting work was in the application of statistics to economic and social problems. It can be said that recent developments in such fields as market research arose from his pioneering work, from 1910 onwards, on the use of sampling techniques in social surveys. Equally, practitioners of the art of interpreting current economic movements owe a good deal to his work for the London and Cambridge Economic Service, of which he was editor from the beginning in 1923 until 1945.

His advice was much sought after, both in Great Britain and abroad. He was for many years a member of official committees concerned with the cost of living and related matters. He was active in the affairs of the British Association, holding office