SOIL MICROBIOLOGY

ANY further advance in our knowledge of the biological events which occur in soil depends upon the development of new techniques to study the activities of soil organisms in various ecological situations. In consequence, a symposium on "Methods of Studying the Microbiology of Soils" was held under the direction of Prof. Paul Simonart at the University Institute of Agronomy, Louvain, Belgium, during June 3–5. The meeting was attended by thirty-nine participants from twelve European countries and was the result of a proposal by Commission III (Soil Biology) made at the Sixth International Congress of Soil Science in Paris, 1956. Each session began with a review of one aspect of the sampling of specific groups of organisms and the determination of their activities in soil, and concluded with detailed discussion of the points raised by the reviewer. The reviewers presented personal views as well as those included in contributions that had been circulated to all participants before the symposium.

In his opening address to the symposium, Prof. Simonart (who took the chair at the first session) welcomed the participants, and then went on to stress the importance of micro-organisms in the maintenance of life on earth. He described the intense interest that was aroused among earlier investigators by the then unique biochemical transformations such as nitrogen fixation and nitrification which certain soil bacteria can bring about. In conclusion, he pointed out that heterotrophic soil microbes are now receiving more attention than they did in the past.

The review paper by Mme. J. Ziemieka (Pulawy, Poland) described how variations in sampling procedure can influence the results of surveys of soil micro-organisms. Mme. J. Golebiowska *et al.* (Pulawy) had made an investigation of the sources of variability of counts of micro-organisms obtained by the dilution plate technique when the plates had been prepared from samples of soil which had received various treatments. The results showed that the number of microbes in soil samples decreased with the duration of the storage period. Variations in treatment had very little influence on the population levels of soils stored for periods of more than one month in either dry or humid conditions or sifted either before or after the storage period. Counts of micro-organisms varied considerably between samples taken from different positions in one field, whereas the variation exhibited by samples taken from the same place at different times of the year was considerably less. It was suggested that soil samples should be investigated immediately after their removal from the field or after storage for a fortnight. Prof. Simonart and Dr. R. Willeman had determined the influence of desiccation on counts of soil bacteria and showed that the moisture content of samples from a waterlogged soil and stored in varying humidity regimes had a considerable influence on counts of bacterial colonies. Counts fell with decreasing moisture content especially when the moisture content was lowered from 100 to 80 per cent saturation, when they fell one thousandfold. Dr. W. G. Harmsen (Groningen) described how the use of a ball mill to homogenize soil samples before the preparation of dilutions gives an increase in the bacterial count because of fragmentation of bacterial colonies but a reduction in the fungal count because of damage to mycelia.

Prof. V. Treccani (Milan) presided at the second session, which began with a general outline given by Prof. E. N. Michoustine (Academy of Sciences, Moscow) of the various methods employed in the U.S.S.R. for determining the biological activity of soils. The potential fertility and classification of Russian soils are assessed with the aid of microbiological analyses. A useful index of potential fertility has been the determination of the ratio of the numbers of soil bacteria which are able to utilize inorganic nitrogen to those which use organic nitrogen as a nitrogen source. Results show that the proportion of soil bacteria which develop on media containing inorganic nitrogen increases with the fertility of the soil. It has also been found that tillage brings about an increase in the proportion of soil bacilli in the total microbial population and that these bacteria are more abundant in warm soils than cold. Drs. A. V. Rybalkina and E. V. Kononenko (U.S.S.R.) described a method to assess the total activity of the soil microflora, in which glass slides covered with thin films of sterile nutrient agar were buried in soil. Prof. A. Imsenecki (Academy of Sciences, Moscow) showed how the elective culture technique has been useful for the isolation of bacteria with specialized nutritional requirements, but its usefulness suffers from several defects and the results are often difficult to interpret. Prof. N. A. Krassilnikov (U.S.S.R.) submitted an account of the microhabitat of species of *Azotobacter* in the soil and rhizosphere, describing also the natural distribution of genetic strains in the soil. An account of the mobilization by micro-organisms of phosphorus contained in certain water-insoluble minerals and the effect of the activity of these organisms on plant growth was given by Dr. G. Laslo (Agricultural Research Institute, Bucharest).

The third session, with Dr. Harmsen in the chair, was devoted to a discussion of methods of counting soil bacteria. Dr. J. Pochon gave a comprehensive review of work carried out at the Department of Soil Microbiology at the Pasteur Institute which has brought about improvements in the methodology of sampling soil bacteria. The microscopic examination of soil suspensions to estimate the total bacterial count has shown that only 1–10 per cent of the organisms counted in soil suspensions develop on counting plates. Drs. J. Augier and J. Pochon have examined the main defects of counting by direct microscopy, among which are the inability of the observer to distinguish with any degree of confidence dead from living bacteria and small inert particles from bacteria. They have made use of the fact that living cells absorb the dye acridine orange and fluoresce green, whereas dead cells and organic matter fluoresce red or red-brown. Soil suspensions prepared with distilled water are generally heterogeneous, but homogeneous suspensions can be obtained by using a 0·1 per cent solution of the dispersing agent sodium pyrophosphate. The choice of medium employed in making the total counts of soil bacteria has to be arbitrary, but Dr. M. A. Chalvignac found that physiological groups isolated by media containing aqueous extracts of soil include ammonifying, denitrifying, proteolytic and amylolytic bacteria. The proportions of these forms isolated by soil extracts were similar to the relative numbers of the different physiological groups isolated

by selective media. Dr. Pochon described different aspects of the use of a quantitative method of measuring the activity of physiological groups of aerobic and anaerobic micro-organisms. Liquid media containing test substrates are dispensed into tubes to which are added a known series of soil dilutions and then incubated (Dr. J. Pochon *et al.*). The tubes are examined daily for the disappearance of the substrate and for the appearance of metabolites. An example of a precise test for cellulolytic activity employing a suspension of cellulose fibres as a test substrate was given by Dr. H. de Barjac. The results can be expressed as the number of organisms per gram of soil or graphically as an activity curve (Dr. D. Lavergne) by employing a new method of calculating results of dilution tube analyses (Drs. J. Augier and D. Lavergne). Thermophilic bacteria are not very abundant in soil, but besides cellulolytic forms, amylolytic, denitrifying and sulphate-reducing thermophils can be isolated from the soil by variations of the dilution tube technique (Dr. J. Lajudie).

Methods of sampling soil fungi were discussed in the penultimate session, which was presided over by J. S. Waid (Nature Conservancy, Great Britain) and began with a paper given by Prof. Simonart, written in collaboration with Prof. O. Verona (Pisa). The review described the important part that fungi play in the carbon and nitrogen cycles and in plant nutrition even though their biochemical activities as a group are more restricted than those of the bacteria. Soil fungi are difficult to count because of their filamentous habit of growth, and during the preparation of soil suspensions mycelia fragment and colony structure are lost. Fungal colonies which develop on sampling plates may have arisen either from active hyphæ or from inactive propagules. Even though many groups of fungi are known to be active in the soil, for example, Basidiomycetes, they may never be seen on isolation plates because they are not selected by the conditions of isolation and culture. Another difficulty is to find a suitable means of expressing fungal activity which truly reflects events which occur in the soil.

J. S. Waid and M. J. Woodman submitted a method of estimating hyphal activity which partially overcomes some of the defects of the Rossi–Cholodny contact slide method. In place of glass slides, nylon gauze is buried in soil and left for several months. Fungal activity is estimated by counting the number of hyphæ per mesh, and the technique reveals differences in activity in contrasting soil types. Dr. D. Parkinson (University of Liverpool) described new methods for the qualitative and quantitative study of fungi in the rhizosphere. A soil box technique has been devised to isolate mycelia active in the rhizosphere of various parts of a root system. A direct method can also be employed to estimate the amount of fungal development in the rhizosphere by preparing slides by a soil impression technique. The results demonstrate the existence of well-defined microfloras in various parts of the rhizosphere at different stages of plant development. A paper by J. S. Waid, C. K. Capstick and D. C. Twinn argued that fungal infections of free-living nematodes can only be accurately estimated with efficient methods of sampling soil nematodes. Using a method with an extraction-rate of 97 per cent it was found that 45 per cent of a sample of nematodes was infected by either saprophytic or predacious fungi, but it is not known how many of the infected nematodes were dead at the time of sampling.

During the final session, which was presided over by Dr. J. Duche (Gif-sur-Yvette, France), the possibility of developing standard methods for sampling soil micro-organisms was criticized by Dr. T. K. Wieringa (Wageningen). While agreeing that microbial, chemical and physical analyses are complementary when determining the economic potentialities of soils, Dr. Wieringa emphasized that the characterization of soils by routine microbiological methods is laborious and limited by practical considerations. He described various ways of measuring soil activity which had not been considered in detail by the symposium, such as the measurement of carbon dioxide production, carbohydrate decomposition, the measurement of mineral deficiencies with microbial growth assays and the effect of adding various substrates to soils such as urea or glutamine.

During the discussion of Dr. Wieringa's paper several participants stated that it is nearly impossible to obtain uniform counts of soil micro-organisms from one sample analysed by separate laboratories, and this fact makes the biological characterization of soils difficult. Dr. Pochon then proposed a scheme by which all participants of the symposium were invited to take part in carrying out a limited number of microbiological analyses and tests of biological activity upon two soil types bearing characteristic vegetation. The results obtained from widely scattered laboratories could then be compared to determine if soils could be characterized by a standard microbiological procedure.

It is a pleasure to record the excellence of the organization and arrangements for the symposium made by the University of Louvain and the International Society of Soil Science. The success of the meeting was due to the good humour, patience and hospitality of Prof. Simonart and his colleagues, under whose supervision the full proceedings of the symposium are now being prepared for publication.

J. S. Waid
D. Parkinson

BIOLOGY OF HAIR GROWTH

A SYMPOSIUM on the biology of hair growth, organized by Prof. W. Montagna (Providence) and Prof. W. S. Bullough (Birkbeck College, London) under the auspices of the British Society for Research on Ageing, was held in London at the Royal College of Surgeons during August 7–9. The symposium secretary was Dr. G. Bourne (St. Bartholomew's Hospital Medical College, London). The very large audience from Europe and the United States was welcomed by Sir Francis Fraser (British Postgraduate Medical Federation, London), and introductory addresses were also given by Prof. Montagna and Prof. S. Rothman (Chicago), who both referred to the great advances made during the past decade in our knowledge of the structure and physiology of mammalian skin.

The first day was devoted to the structure of the hair and the hair follicle. In the opening address Dr. E. Van Scott (Bethesda) dealt with the anatomy of the human hair follicle, describing in particular the changes which occur with age. He was followed by