vitamins, organized by the Vitamin B Committee of Japan, which was attended by about fifty people. This is, of course, a field of intense Japanese activity, and some good Japanese papers were presented.

In Osaka, a one-day meeting on starch and amylases was held under the chairmanship of Dr. Shiro Akabori. At another informal but valuable discussion, on "The Metabolism of Cyclic and Sulphur Amino-acids", also held at Osaka on October 26, the contributors included A. Braunstein, [the late] C. Fromageot, W. E. Knox and K. Ichihara. All three of these meetings served to confirm the strong impression already formed by the visitors of the great energy and numerical strength of biochemists in Japan, and of their often outstanding technical ability which enabled them triumphantly to surmount the rather widespread difficulties due to old equipment and laboratories, many of which were not really adequate as judged by current European and American standards. In spite of these handicaps, to which must be added the low salaries of academic workers and the difficulty experienced by younger scientists in obtaining suitable posts at home and, still more, grants for travel abroad, the visitor could scarcely fail to be filled with admiration on observing the tenacity with which the Japanese workers pursued their researches, undaunted by these somewhat formidable difficulties. I am grateful to my two English colleagues at the symposium for their comments on this necessarily incomplete report. On the whole, this was a most rewarding symposium and a unique experience for most Western visitors.

F. DICKENS

RESTORATION OF AGRICULTURAL AND OTHER SOILS

ONE of the problems in connexion with the restoration of soil that has suffered a major disturbance is the length of time which elapses before full fertility can be restored. Two papers dealing with aspects of this problem were read at a meeting of the Association of Applied Biologists in Leeds on September 19. The first of these was by R. Holliday and D. R. Hodgson on "Restoration of Land covered by Pulverized Fuel Ash". This paper dealt with investigations in progress at the University of Leeds under a research grant from the Central Electricity Authority, which is the main producer of fuel ash of this type.

The ash occurs in lagoons, into which it is washed after separation from the spent gases with which it is discharged. Utilization or disposal of this deposit after the lagoons are full is a major problem; its use for filling quarries involves costly transport, and wide-scale industrial use appears unlikely. Possible agricultural uses are therefore under investigation.

The agronomic problem posed is one of growing plants in material with the following properties: it consists mainly of spherical particles between 0·2 and 0·002 mm. in diameter, chiefly silica but with various metals incorporated; normal soil structure is lacking; it sets hard when dry but can be eroded by wind unless sealed with soil; the *p*H is high, varying between 8·5 and 10·5; it is deficient in plant nutrients and contains toxic ingredients; microbiologically it is completely sterile.

The problem of making it suitable for crop growth at a low cost is being investigated along these lines: reclamation through the use of a soil cover and fertilizer application; amending the ash as a growing medium by making up nutrient deficiencies, correcting toxicities and improving the structure; selection of crop plants tolerant to the adverse conditions.

Results are now available on soil cover trials using depths of up to 2 ft. of subsoil and 1 ft. of surface soil with four different surface concentrations of complete fertilizer. The crop-yield was affected with cover depths of less than 2 ft. of soil plus subsoil, but little beyond this level. The highest yields were obtained with a deep soil cover and a high fertilizer rate. Moderately good yields were obtained, however, from either a deep soil with moderate fertilizer rate or a shallow soil covering with a high fertilizer rate. Soil is often a scarce commodity and transport is costly, therefore the second alternative is more economical. All rates of fertilizer application gave poor results where no soil cover was used. The material was found to be deficient in nitrogen and phosphate, but potash is generally adequate.

Different crop plants have shown marked variation in the degree of root tolerance to the ash, but it is not clear whether this is a toxicity tolerance or a reaction to the physical structure of the growing medium.

Various methods to reduce alkalinity have been tried, in most cases with beneficial results. The question of cost, however, rules them out for large-scale use.

Dilution of the ash by the addition of bulky materials, including neutral and acid organic materials, shales and sewage sludge has given promising results in some cases.

Field trials on the capacity of various crops to grow in the ash have shown some plants of the orders Chenopodiaceae, Cruciferae and Leguminosae to be reasonably tolerant to the adverse growing conditions. Other crucifers and grasses have intermediate tolerance, while a wide range of economic plants, including cereals and pulse crops, are exceedingly sensitive. It has been shown that a period of weathering makes the growing conditions less unfavourable, and allows more of these plants to be grown with reasonable success on the ash.

The second paper, on "Some Biological Aspects of Opencast Coal Working", by H. W. Thompson, dealt with changes which occur in surface soil during opencast operations, resulting in lowered fertility and other undesirable qualities which persist for some years. Many factors are involved, some of which follow upon changes in the fauna of the soil.

Biological problems may arise in various ways. Many restored sites suffer from wetness, because permanent drains destroyed by opencast mining cannot be replaced until soil settling has ceased. Crops grown on undrained land frequently lack vigour and so are more liable to suffer pest injury, particularly by such pests as leather-jackets or slugs. Similarly, frit fly attack has often ruined spring oat-crops which, because of adverse soil conditions, have

been slow in establishment, with poor capacity for producing tillers.

Serious loss of crops arising in this way can often be avoided by care in cropping or, where appropriate, by the use of insecticides. The wetness problem may be solved in some cases by mole draining until such time as permanent drains can be replaced.

A different type of problem occasionally arises through the introduction of harmful organisms to an area not previously affected. There is an obvious risk, for example, of cyst-forming eelworms being spread when infested and non-infested soils are stored together and later distributed. Cysts of some of these eelworms can survive for twelve years or more in the soil. This aspect is therefore being studied, particularly in the case of the potato root eelworm.

This problem is not common at opencast sites, but has arisen in Lancashire where opencasting is in progress in an intensive arable area. Potatoes are an important crop and fields free from infestation are therefore particularly valuable. The spread of infestation is being studied at one such site. Samples of all fields to be worked were taken before scraping commenced. These showed some fields to be free from measurable infestation while others yielded high cyst counts. These fields will be re-sampled after restoration has been completed.

It was thought possible that cyst viability falls off more rapidly under spoil heap conditions than it would normally in arable land, especially where storage continues for several years in large heaps. At one site there was a definite indication that this does occur. Hatching tests on cysts collected from the top foot of soil showed moderate viability; samples from 8 ft. depth yielded cysts of very low viability, and those from 3 ft. depth showed intermediate larval emergence. The evidence so far from this, and from other sites where soil from heavily infested fields was stored, shows that the risk of spreading serious eelworm trouble as a result of opencasting is not very great, especially in view of the long rest from potato growing which is involved.

Another factor which is regarded as very important in its effect on soil structure and fertility is the great reduction in numbers of earthworms brought about by opencast working. Work on this aspect was therefore started in 1956. The object is to study the number of earthworms during the operation itself and to continue to do so after restoration until fertility is restored or the earthworm population has reached stability. Earthworm collection is carried out by hand digging because of the unusual conditions prevailing in spoil heaps.

A site near Wigan is being used, the soil being a sandy loam with an earthworm population estimated at 609,800 per acre before stripping commenced in May 1956. Counts on two spoil heaps and on an unworked area alongside have been made at roughly monthly intervals since. One spoil heap with a surface area of 1·2 acres is made up of surface soil from 11 acres, and the second, of 0·61 acres, from 4·8 acres.

Estimates made in August—four months after heaping—showed a low survival of earthworms, but by the following March numbers had increased to an estimated 77,000 in heap 1, and 43,000 in heap 2. Apart from a fall during the hot, dry period in June, numbers have remained at a relatively high level since, the highest estimates in both heaps and in the control area being obtained in March and October. A more complete picture of earthworm survival will be available after restoration has been carried out.

The opportunity was taken to study the earthworm position at a Barnsley site restored in 1952 after opencasting and cropped since then under twelve experimental rotations. Counts made in 1956, that is, four years after soil replacement, indicated that an earthworm population that could be regarded as normal for this type of soil had become re-established. The highest estimates were obtained from grazed leys with a population of 315,800 worms per acre, and nine of the twelve series of plots had counts exceeding 150,000 per acre. The information obtained from this site therefore suggests that re-establishment of earthworms after opencasting can be much more rapid than is generally believed to be the case.

H. W. THOMPSON

THE SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Science Masters' Association, which was held during December 31, 1957–January 3, 1958, in the University of Leeds, was attended by more than five hundred science masters. Among those who came into residence in the University Halls were masters and students from Canada, South Africa, and Tasmania; the Royal Navy also sent its usual numbers from naval educational establishments.

The first evening began with the Association dinner, at which the toast of the Association was proposed by Prof. F. S. Dainton, chairman of the University School of Chemistry; this was responded to by the chairman of the Association, Mr. W. G. Rhodes, education and training officer of Arthur Lee and Sons, Ltd., steelmakers, of Sheffield. The members then assembled in the Parkinson Hall, where the presidential address was given by Sir Charles Morris, vice-chancellor of the University of Leeds.

Sir Charles was concerned with the fact that the external examinations undergone by schoolboys tend to be a test of the schoolmaster rather than of the pupils; a good master can cause indifferent pupils to pass; and he wondered whether science is not being taught too well. He thought also that too many facts are being taught, and that it is more essential to teach fundamental principles: as a philosopher, he thought that over-reliance on the memory is a very grave fault. This over-reliance is due largely to the great mass of facts which modern pupils are expected to assimilate: it is high time that dons and schoolmasters came together to reduce the content of the syllabuses. Sir Charles then dealt with the problem of what science should be taught to those who will not become professional scientists. Whereas the training in arts needed by the scientist is comparatively easily met by giving him a broad education in the use of language and the appreciation