claimed is nickel of density one per cent higher than the crystallographic value.

A large amount of work on dispersion-hardened materials was reported, and at present interest is greatest in materials based on aluminium, copper or nickel. It appears that the dispersed phase should be hard and that interfacial energy between it and the matrix should be low: thus thoria particles in titanium alloys have little effect unless the alloys wet the particles. Dispersed particles should be of irregular shape, not rounded, for greatest effect. F. V. Lenel and G. S. Ansell (Rensselaer Polytechnic) stated that the yield stress of these materials is determined by the stress which fractures a dispersed particle, and that it is inversely proportional to the square root of the spacing between particles.

SAP alloys (aluminium strengthened by dispersed oxide) are now known which can be rolled either hot or cold or which can be drawn and pressure-welded.

M. Eudier (Metallurgie Française des Poudres) reported that a controlled oxidation of nickel before sintering raises the density achieved, and he explained that the effect is due to filling of certain pores with oxide and later reduction of this without re-formation of cavities.

The powder metallurgy industry is expanding rapidly. The use of iron powder showed an upsurge during 1954–55, and in 1960 was three times that in 1956. Application of powder methods to beryllium is now important, and the plant to handle a large amount exists. Consolidation of powder in cans by quick blow-forging is important and disks 12 in. in diameter by 1·5 in. thick are made in this way. Beryllium foam made from fine powder, and the production by hot pressing of metal beryllide parts which have high thermal conductivity, are novel developments. Very large pieces can now be manufactured by powder methods: F. Emley (Westinghouse Electric Corp.) noted equipment for hot-pressing beryllium billets up to 60-in. diameter, and the production of molybdenum billets 40 in. × 3·5 in. × 3·5 in.

G. A. Geach

SOIL FAUNA IN RELATION TO SOIL FORMATION AND FERTILITY

THE study of soils has for long been the province of pedologists, chemists and microbiologists, and, apart from isolated instances, it has only been during the past fifteen years or so that the subject has attracted attention from zoologists in Britain. During the 1955 Easter School held by the School of Agriculture, University of Nottingham, many soil zoologists from Europe as well as Britain were brought together. This was succeeded during 1958 by a three-day international colloquium held at Rothamsted Experimental Station and devoted to "Progress in Soil Zoology". These have given new stimulus to the subject, and the recent symposium on "Soil Fauna in Relation to Soil Formation and Fertility", held by the Association of Applied Biologists, indicates the still growing interest which soil zoology is arousing. This symposium was held on October 14 at the British Museum (Natural History), where the new lecture theatre is eminently suitable for such meetings.

The theme was introduced and summarized by G. V. Jacks, director of the Commonwealth Bureau of Soils. He started by giving numerical evidence of the increasing number of publications on soil zoology appearing in *Soils and Fertilizers*: during 1937–40 there were three, during 1953–56 thirty, and during 1956–59 ninety. The part played by biological processes in determining soil fertility was then put in perspective. Under natural conditions soil animals are complementary to plants and necessary for operating the cycle of nutrients effectively. They are important factors in breaking down plant litter, mixing it with the soil and creating the porous texture characteristic of good soils.

The first paper was given by Dr. D. A. Osmond and Mr. P. Bullock, of the Soil Survey of England and Wales, on "Soil Fauna in Relation to Pedology". The condition of a soil is the result of many factors of which the fauna is but one. The influence of animals is difficult to assess in arable land, but may be very great in grassland and forest soils. Their effects range from the burrowing of mammals to the incorporation of quantities of plant material into the soil by the mesofauna. Dr. Osmond then described different soil-types with the aid of photographs of thin sections. Peat represents one end of the scale where plant matter is virtually unattacked by the fauna, and with increasing faunal influence one passes through moder and mull soils, finally culminating in the vermisols possibly found in parts of north England which are the result of intense earthworm activity.

The mechanics of earthworm influence were pursued by Dr. F. Raw, from Rothamsted Experimental Station, by a consideration of leaf burial in apple orchards. Comparisons were made between sprayed and unsprayed orchards, some under arable cultivation and others under grass. For sampling earthworm populations dilute formalin was found more efficient than permanganate, and in the seven orchards investigated six dominant species were found. Of these, pot experiments showed that only *Lumbricus terrestris* was responsible for pulling leaves into its burrows. Quantitative studies showed, moreover, a close relationship in the grass orchards between weight of *Lumbricus terrestris* populations and the percentage disappearance of leaf litter from cages. The rate of disappearance was inversely proportional to the amount of surface vegetation, being greatest in the arable orchards.

In grass orchards which had been sprayed with a copper fungicide for many years, the earthworm fauna was reduced to a single species living in the surface litter. Here leaf decomposition was very slow and the soil profile had typical mor characteristics.

Some aspects of work being carried out at the University College of North Wales, Bangor, were described by J. Hobart and A. J. Hayes. The former gave a paper on the distributional patterns of soil mites in pure and mixed stands of conifers. In the apparently uniform habitat of a Douglas fir plantation (*Pseudotsuga taxifolia* Britt.), only eight out of thirty-two common species of mites (adults) did not show a significantly aggregated distribution. Samples were taken along radiating transects from trees, and several species of mites were found to have very definite and different preferences for particular radial distances. These may be due to differences in the

thickness of the litter layer and in moisture content, and are evidence of very sensitive discrimination.

In mixed plantations, again, distinct populations were found in relation to spruce (*Picca* sp.), Scots pine (*Pinus sylvestris* L.), larch (*Larix* sp.) and silver fir (*Abies alba* Mill.). The numbers under spruce were generally lowest, and a few species showed definite preferences for larch or silver fir.

Hayes described some work on feeding behaviour of Oribatid mites using mainly *Hoploderma magnum*. Colonies were kept at constant temperature maintained at three different humidities and fed on weighed quantities of needles from three species of conifer. These needles were graded into three categories of age and condition. After 72 hr. the remains were re-weighed and the number of fæcal pellets counted. Measurements were made on eight replicates of fifty individuals for each treatment. Production of fæcal pellets for all three species appeared to be greatest for fallen but still entire needles and least for fresh green needles. Analysis of variance showed, however, that few of the differences between humidities, tree species or conditions of needles were significant. Preliminary results indicated that there was no correlation between loss in dry weight and the number of fæcal pellets produced, and loss in dry weight of needles did not appear to give a satisfactory index of feeding.

As part of the concerted work on woodland soils by the Nature Conservancy at Merlewood Research Station, K. L. Bocock described some work concerned specifically with the comparative rates of disappearance of oak (*Quercus petraea* Liebl.) and ash (*Fraxinus excelsior* L.) leaves on contrasting sites. Weighed quantities of leaves were placed on the ground in nylon hair-nets and sampled periodically over 14 months. As a result of earthworm activity ash leaves on a mull soil disappeared most rapidly, with loss in nitrogen following closely the trends of loss in dry weight. On a moder soil the loss of nitrogen was relatively less rapid. Oak leaves on mull showed an actual increase in nitrogen content; possible explanations were the presence of nitrogen-fixing micro-organisms, absorption of nitrogen compounds from the rain or contamination with slime and droppings from soil animals.

Feeding experiments with *Glomeris* (Diplopoda) on hazel leaves (*Corylus avellana* L.) showed that the amount of water-soluble nitrogen was larger in the fæces than in the food, largely due to an increased ammonia content.

The symposium ended with a synoptic point of view of invertebrate metabolism and its effect on soil fertility. With the aid of diagrams, A. Macfadyen depicted the main paths of energy-flow in a typical grassland soil as a result of the direct metabolic effects of the fauna. Calories entering the system from sunlight pass through various levels (corresponding to successive links in food chains) at each of which some energy is dissipated in respiration. The proportions received and passed on by different groups of organisms and, in the case of agricultural exploitation of the grassland, the amount finally available to man were calculated.

Indirectly the fauna has catalytic effects on other organisms which are probably much more important: the feeding of animals on fungi eliminates senescent growths, effects the dispersal of spores and overcomes 'stasis', and their fæces provide food sources for other organisms. All such activities increase the rate of energy-flow which ultimately determines the soil fertility.

B. N. K. Davis

AGRICULTURAL HISTORY

THE joint winter conference of the Agricultural History Society and the Association of Agriculture was held on December 3, at the Institute of Education, University of London, under the chairmanship of Sir Keith Murray. Before lunch, Mr. Michael Havinden, research assistant, Museum of English Rural Life, read a paper on "Agricultural Progress in Open Field Oxfordshire". Modern research has suggested that the open field system was more flexible than was formerly believed. Mr. Havinden's researches among college documents and seventeenth-century Oxfordshire farmers' inventories has confirmed this still further. He is convinced that the introduction of improved rotations by agreement among the tenants or imposed by manorial lords was a major factor in delaying enclosure in Oxfordshire and possibly elsewhere. The improvement was mainly towards the introduction of fodder crops, the growing of more peas and beans and vetches, and the new legumes clover, sainfoin and lucern as well as some rye grass. In places a group of strips was enclosed by agreement and these crops were grown. He described the mechanism of this process very definitely. In other places fodder was grown and consumed by hitching the grazing animal on the strip. It has, of course, for long been known that sainfoin was grown on the chalk escarpment in the seventeenth century, but only vaguely. Mr. Havinden's researches have revealed places where this and other fodder crops were actually grown in the open fields, and he has thus made specific what was formerly only a general impression derived from remarks in the didactic treatises and propagandist literature of the time.

In the afternoon Mr. John Saville, senior lecturer in economic history, University of Hull, discussed "Public Opinion and Agricultural Depression, 1880–1900". He showed how the current difficulties of the landed interest had led reformers to demand the restoration of a peasant proprietary without any very clear perception of the methods by which the plan could be put into effect. Despite some ameliorative legislation, giving the farm worker the vote, the setting up of parish councils, some small-holding acts, etc., the ideas were in the main quite ineffective. These measures had been supported by liberal reformers in the first place, but afterwards received the backing of the great landlords, Henry Chaplin for example. In spite of that, somewhat less than 1,000 acres of small holdings were created before 1914.

The programme was closed by the showing of a film made by Imperial Chemical Industries in 1942, "The Harvest Shall Come", which is a moving history of the wretched conditions of employment in agriculture before 1914, the comparative prosperity of the workers during the two Wars, and their submersion in poverty in the interval between them, conditions that will never again be imposed.