RECENT DEVELOPMENTS IN PLANT NEMATOLOGY

THE Association of Applied Biologists held a symposium on "Recent Developments in Plant Nematology" on January 20 at the British Museum (Natural History). The symposium was well attended and appears to have been appreciated.

Dr. H. C. Gough (National Agricultural Advisory Service, Cambridge), speaking on "The Importance of Plant Parasitic Nematodes in Britain", pointed out that the root nematodes, species of *Heterodera*, are the most serious pests. *H. rostochiensis* infests at a detectable level more than 80 per cent of potato fields in Holland, Lincolnshire, and about 40 per cent in the Isle of Ely; about 10 per cent of the total potato acreage in eastern England is infested badly enough to cause serious crop loss. In the case of glasshouse tomatoes, the pest often has to be controlled by costly steam sterilization. *H. schachtii* infests about 2 per cent of the total beet-growing area, and a sugar beet eelworm order was introduced in 1943 to reduce the spread and build-up of the pest by control of cropping. Pea root eelworm *H. göttingiana* could well become a serious pest in the rapidly expanding vining pea industry. Stem eelworm, *Ditylenchus dipsaci*, is most serious on narcissus and tulips in the bulb-growing areas. On narcissus, it is controlled to a considerable extent by regular hot-water treatment, but on tulips no similar satisfactory treatment has yet been devised. Stem eelworm in oats is fairly widespread, though most prevalent in northern Britain, but losses can be prevented by the use of good resistant varieties of oats. *Aphelenchoides ritzemabosi* on chrysanthemums, always a serious potential pest, is now controlled by parathion dipping of stools and cuttings at a very low cost.

Dr. J. B. Goodey (Rothamsted) chose as his topic "Taxonomic Relatedness", and claimed that the recognition of new species has led to progress in solving some refractory problems in nematology. He illustrated this by referring to the fragmentation of the old taxa *Heterodera schachtii* and *H. marioni* into a number of recognizable species of *Heterodera* and *Meloidogyne* respectively. In *Ditylenchus* less progress has been made, for although the stem nematodes are now split into three species, *D. dipsaci* is still recognized as containing numerous 'biological races'. Work on *Xiphinema diversicaudatum*, a virus vector, shows that the standard monograph, containing the description of this species, appears to err. The variation shown by this nematode is extensive enough to suggest two possible species if only the extremes are taken, indicating the need to treat taxonomy dynamically with the study of plenty of living material. It was suggested that the taxonomist should not regard himself or others as infallible. The adequate description of new species requires the consideration of about 150 aspects of a nematode, and while to others his work might appear intuitive and subjective, his feet are kept firmly on the earth by the necessity to explain unambiguously his conclusions to sceptical colleagues.

In discussing "The Ecology of Soil Migratory Nematodes", Dr. R. D. Winslow (Rothamsted) defined these nematodes as those root-feeding members of the Tylenchida and Dorylaimoidea in which the female does not become cystic. In the soils investigated by him at Rothamsted and elsewhere *Pratylenchus*, *Paratylenchus*, *Tylenchorhynchus*, *Rotylenchus* and *Helicotylenchus* are most common, with *Pratylenchoides*, *Criconemoides*, *Hemicycliophora*, *Trophurus*, *Longidorus*, *Xiphinema* and *Trichodorus* occurring occasionally. In arable crops at Rothamsted and Woburn (Beds.) highest numbers of total nematodes and of total Tylenchida occur in late summer or autumn. Generally at Rothamsted, and in some cases at Woburn, these numbers are well maintained during winter, falling in spring to a minimum in May or June. Other factors greatly affecting nematode numbers are vegetation, soil-type and *p*H. Cereals generally support more plant-parasitic and other nematodes than do potatoes and sugar beet. Spiral nematodes are numerous in the heavy soil at Rothamsted; very rare in the lighter Woburn soil. *Pratylenchus pratensis* is associated with low *p*H on a hay-field at Rothamsted (probably due to *p*H affecting the botanical composition of the sward), whereas the fungivorous *Aphelenchus avenae* is associated with high *p*H. In forest nurseries *Hoplolaimus uniformis*, *Trichodorus pachydermus* and *A. avenae* are associated with relatively high *p*H.

Mr. F. G. W. Jones (Rothamsted) first briefly summed up the present state of knowledge of "The Orientation and Host-finding by Soil-inhabiting Plant-parasitic Nematodes" by saying that there appears to be no evidence of nematode response to *p*H gradients, and that tests on response to temperature gradients have not been made. There is evidence of response to moisture gradients, to carbon dioxide, to certain acidic oxidizing and reducing compounds, to root exudations of unknown constitution and possibly to the products of bacterial activity in the rhizosphere. Response to redox potentials and to electric currents is also known. He then described some of his own work on the behaviour of various nematodes, *Turbatrix aceti*, *Heterodera schachtii* larvæ and *Ditylenchus dipsaci*, when exposed to electrical gradients. Nematodes respond to electrical gradients of more than 30 mV./mm., and, as many nematodes are about 1 mm. long, this represents a change of potential from head to tail. In a gradient of 100–200 mV./mm., *D. dipsaci*, which have been moving at random, tend to move more spasmodically and to swing their heads in a wide arc. Often, after this preliminary swinging movement, the head tends to face the cathode, followed by free swimming towards it. When the current is reversed, movement follows, leading to a reversal of the direction of swimming.

Mr. C. C. Doncaster (Rothamsted) showed a film of "Some Nematode Feeding Mechanisms". This illustrated the feeding of spear-bearing nematodes and those with open stomas. In the first group, *Aphelenchus avenae* thrusts the spear repeatedly against a fungal hypha followed by a rapid pumping action of the valve of the median bulb, thus ingesting the contents of the hypha; but in *Aphelenchoides ritzemabosi*, feeding on mesophyll cells of *Stellaria media* in a water mount, the median bulb shows only gentle pulsation while the spear is inside the cell. It was suggested that feeding in *A. ritzemabosi* may be more the tapping of cell sap under pressure. In the second group, *Diplogaster* sp., *Pelodera lambdiensis*

and *Rhabditis oxycerca* are saprophages. In *Diplogaster*, food particles are sucked in by the expansion of the tri-radiate lumen of the corpus (first bulb), which acts rather like a pipette. The lumen through the base of the corpus can be closed completely and acts as a valve. From the first bulb, food is transferred through the isthmus and second bulb by a wave of peristaltic-like action caused by successive contractions of the radial muscles surrounding the tri-radiate lumen of both parts. In *P. lambdiensis* and *R. oxycerca* the second bulb has three equally spaced valve plates which move backwards into a cup-like cavity. The whole process of feeding is very complex, but appears to be divisible into the following stages: (*a*) the procorpus and corpus open, drawing in food and, on closing, food collects in the forepart of the isthmus; (*b*) this food mass is carried further back to the valve by a wave of 'peristalsis'; (*c*) the cup behind the valve dilates, sucking the food through the valve flaps, which then flick back into the cup together with the whole of the anterior part of the valve; (*d*) the cup collapses, forcing the food into the œsophago-intestinal canal behind it, this canal also showing 'peristaltic' dilation and collapse.

Dr. H. R. Wallace (Rothamsted), in discussing "Plant Reaction to Parasitism by Nematodes", listed some of these reactions; he mentioned rounding of cells and loosening from one another, possibly by the action of pectic enzymes in tissues attacked by *Ditylenchus dipsaci*; the formation of giant cells in roots attacked by *Heterodera* spp. and *Meloidogyne* spp., possibly indicating the presence of growth hormones; cell hyperplasia and hypertrophy in roots attacked by *Radopholus similis*, and extensive necrosis associated with the invasion of roots by *Pratylenchus* spp. He went on to describe his work on the attack in chrysanthemum leaves by *Aphelenchoides ritzemabosi*. In susceptible varieties few cells appear to be attacked, the nematodes remain very near their point of entry, and reproduction goes on; but in resistant varieties many cells are attacked, the nematodes move far and wide and there is almost no reproduction. Resistant varieties show rapid and extensive leaf discoloration associated with the enzymic oxidation of plant polyphenols, and it is suggested that there is an absence of some nutritional factor in these leaves. Dr. Wallace ended by stressing the state of our ignorance of the inter-relationships, particularly biochemical ones, of nematode parasite and plant.

Dr. R. S. Pitcher (East Malling Research Station) spoke on "Nematode Vectors of Virus Diseases", and said that it was the pioneer work of Hewitt and Raski in California that first showed the transmission of virus by nematodes. He stressed that though this work is important in its own right, it should also stimulate study of the complex inter-relationships of nematodes and other 'soil inhabiting' pathogens and their relation to the plant and its environment. Of the 'soil-borne' viruses, those that have been transmitted by nematodes could be classified as having infectivity destroyed by air-drying of soil, and while 'tobacco rattle', which is transmitted by *Trichodorus pachydermus*, has rod-shaped particles, the others have isometric particles, for example, 'fanleaf of grape', 'peach yellow bud mosaic' and 'arabis mosaic' transmitted by *Xiphinema index*, *X. americanum* and *X. diversicaudatum* respectively and 'tomato black ring' transmitted by *Longidorus elongatus*. There is a clear correlation of disease and the presence of nematodes which are all members of the Dorylaimoidea, with relatively long spears when compared with most members of the Tylenchida, none of which is known as a virus vector. The means by which virus transmission takes place is unknown and, as yet, a matter for speculation.

"Practical Problems and Recent Trends in Nematode Control" was the topic chosen by Mr. F. C. Peacock (Plant Protection, Ltd., Jealott's Hill), who said that many of the earliest nematicides which still give good service are halogenated hydrocarbons. They are generally phytotoxic and relatively volatile substances. Methyl bromide and D–D are early examples and 1,2-dibromo-3-chloropropane a more recent one. A second group of nematicides are the organic phosphates: parathion has been used for some years; more recent examples are O-2,4-dichlorophenyl-, O-diethyl phosphorothioate and diethyl pyrazinyl phosphorothioate. This group of compounds is non-volatile and relatively insoluble in water, but has high nematicidal and residual value and low phytotoxicity, albeit high mammalian toxicity. Dithiocarbamates make good soil sterilants but have high phytotoxicity; their action against nematodes is said to be due to the breakdown product methyl *iso*thiocyanate. Various sulphur compounds, such as chlorophenyl methyl rhodanine, have high phytotoxicity which is useful in seed-bed preparation, but the tetrahydrothiophene dioxides and trithiophene (occurring in *Tagetes erecta*) have low phytotoxicity. Recently the use of yellow oxide of mercury incorporated in soil has shown promise. The observation that a glycoside from *Asparagus officinalis* roots inhibits nematode attack has led to an investigation of the systemic use of maleic hydrazide and other substances, applied to leaves to prevent attack on roots either by the exudation of toxic material or the inhibition of attractive diffusates, or theoretically the preferable killing of already established parasitic nematodes. Mr. Peacock finished by stressing the need for good husbandry so that nematicides are only supplementary in function, and the need for recognizing that different nematode diseases need treatment by different nematicides.

J. B. Goodey

AREA OF RESIDENCE OF MENTAL HOSPITAL PATIENTS

ONE of the Registrar General's series of studies on medical and population subjects contains detailed statistics about the areas from which patients were admitted to mental hospitals in England and Wales during 1957. (*Studies on Medical and Population Subjects*, No. 16; "Area of Residence of Mental Hospital Patients", H.M.S.O. 15*s*. 6*d*. net.)

The addresses of patients at the time of admission have been classified according to the administrative areas in which they are situated. Separate tables are given showing, for the first time, the numbers of admissions from each county borough and administrative county and from each metropolitan borough in the County of London. Figures are given separately