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ABSTRACTS OF PAPERS, POSTERS AND FILMS PRESENTED AT THE SECOND INTERNATIONAL NEMATOLOGY CONGRESS, VELDHOVEN, THE NETHERLANDS, 11-17 AUGUST, 1990.

ABAD P., QUILES, C., ABADON, M., CASTAGNONE-SERENO P. & DALMASSO, A. *Distribution and conservation of mobile elements in nematodes.*

Little is known about the origin of transmission, and evolution of mobile elements within the Nematoda. To improve understanding of the evolutionary history of these mobile elements, we examined the distribution of homologues to transposable elements from *Caenorhabditis elegans* (Tc1 to Tc5) in 24 nematode species belonging to different orders. Probes specific for each element were prepared and hybridized to genomic DNA. Filters were washed under conditions of increasing stringency to estimate the degree of similarity between *C. elegans* transposons and their homologues present in other species. Our results show that these transposable elements are restricted to the genus *Rhabditis*. The Tc1 element homologues were only observed in the subgenera *Caenorhabditis* and *Pelodera*. The Tc2 element homologues were only found in *C. elegans* and in the subgenus *Teratorhabditis*. The Tc3 element homologues seem to be widespread in many members of the genus *Rhabditis* while Tc4 and Tc5 homologues showed the most limited distribution of all elements tested, being strictly limited to the *C. elegans* species. *Station de Recherche de Nématologie et de Génétique Moléculaire des Invertébrés, INRA, B.P. 2078, 06606 Antibes, France.*

ABAD, P., TARES, S., BRUGUIER N. & DE GUIRAN G. *Repetitive DNA and hybridization patterns for the differentiation of isolates of the pinewood nematode species complex.*

Pine wilt is the most serious disease of native pines in Japan and potentially the most important nematode disease of conifers in the world. The pinewood nematode *Bursaphelenchus xylophilus* was found to be the causal agent. Difficulties arose with respect to the precise identity of some isolates of *B. xylophilus* and of a similar species *B. mucronatus*. Restriction enzyme analyses of repetitive DNA revealed bands specific for *B. xylophilus* and *B. mucronatus*, and also for different geographic isolates of these two species. Hybridization patterns obtained with *unc-22* gene of *C. elegans*, clearly identified the populations in *B. xylophilus* and *B. mucronatus*. Furthermore, it is possible to precise the phylogenetic relationships between the different populations constituting the "pine wood nematode" complex. *Station de Recherche de Nématologie et de Génétique Moléculaire des Invertébrés, INRA, B.P. 2078, 06606 Antibes, France.*

ABOUL-EID, H.Z., AMEEN, H. H. & SHAFIEE, M.F. *In Vitro studies on the preying capabilities of* Mononchus truncatus *on specimens of* Cephalobus sp. *and* Tylenchulus semipenetrans *in water.*

Predation of adult and first stage juveniles of *M. truncatus* on adults and juveniles of the larger *Cephalobus* sp. in tap water gave a sigmoid-shaped predation curve. A different L-shaped predation curve resulted when the predator fed on the smaller second stage juveniles of the citrus nematode *T. semipenetrans* in tap water. In all preying trials, a rate of preying Rp is adopted and defined as the number of victim nematodes fed upon daily by one predator specimen. Rp could be calculated from a suggested equation. *Nematology Unit, National Research Center, Dokki, Giza, Egypt.*

ABRANTES, I.M. DE O. & SANTOS, M.S.N. DE A. *Effects of temperature on embryogenic development of three populations of* Meloidogyne *spp.*

Laboratory investigations were carried out to study the effect of a range of temperatures on the embryogenic development of *Meloidogyne arenaria* race 2, *M. hispanica* and *M. lusitanica* sp.

n. The rate of embryogenesis of the three species at different temperatures varied considerably. In *M. arenaria* race 2 and *M. hispanica* the embryogenesis was more rapid at 25 and 30°C (about 10 and 7 days, respectively). At 30°C embryogenesis was about twice as rapid at at 20°C (14 days), and about three times as rapid as at 15°C (30 and 27 days, respectiveely). At 10°C embryogenesis did not occur. Embryogenic development of *M. lusitanica* sp. n. was longer than that of *M. arenaria* race 2 and *M. hispanica*. At 25°C embryogenesis was about twice as rapid as at 15°C and five times as rapid as at 10°C. At 30°C embryogenesis did not occur. These studies showed that *M. lusitanica* sp. n. is more adapted to lower temperatures while the other two species are adapted to higher temperatures. *Centro de Sistemática e Ecologia—INIC, Departamento de Zoologia, Universidade de Coimbra, 3049 Coimbra Codex, Portugal.*

AHMAD, W. *A revised classification of the superfamily Dorylaimoidea.*

The superfamily Dorylaimoidea is a very large group comprising over ninety genera. These have been grouped under four families, *viz.*, Dorylaimidae DeMan, 1876 (subfamilies: Dorylaiminae, Mesodorylaiminae, Thornenematinae, Arctidorylaiminae); Qudsianematidae Jairajpuri, 1965 (subfamilies: Qudsianematinae, Thorniinae, Crateronematinae, Discolaiminae, Lordellonematinae, Hulqiinae); Nordiidae Jairajpuri & A.H. Siddiqi, 1964 (subfamilies: Nordiinae, Cephalodorylaiminae, Pungentinae, Helmabinae, Actinolaimoidinae n. subfam.) and Aporcelaimidae Heyns, 1965 (subfamilies: Aporcelaiminae, Paraxonchiinae and Sectonematinae). The families Prodorylaimidae, Thornenematidae, Arctidorylaimidae, Thorniidae, Discolaimidae, Crateronematidae, Chrysonematidae, Pungentidae and Kochinematidae have been considered synonyms. *Section of Nematology, Department of Zoology, Aligarh Muslim University, Aligarh 202 002, India.*

AKHTAR, M. & ALAM, M.M. *Studies on the integrated control of plant-parasitic nematodes on potato with organic amendments/nematicide and mix-cropping with mustard.*

Increase in the population of plant-parasitic nematodes on potato (*Solanum tuberosum* L.) was significantly arrested when mustard (*Brassica juncea* (L,) Czern. & Coss) was also grown with potato in alternate rows. There was further stress on plant-parasitic nematodes when soil was treated with oilseed cakes and leaves of neem/margosa (*Azadirachta indica* A. Juss.) and castor (*Ricinus communis* L.) and a nematicide (carbofuran), however to varying extent. As a consequence of reduction in nematode population there was an increase in the yield of potato. Root exudate of mustard was found to be highly deleterious to plant-parasitic nematodes. The beneficial effects of all the above treatments persisted in the next growing season when okra (*Abelmoschus esculentus* (L.) Moench.) was grown. *Department of Botany, Aligarh Muslim University, Aligarh 202 002, India.*

ALAM M.M. *Control of plant-parasitic nematodes with organic amendments and nematicides in nurseries of annual plants.*

Organic amendments such as bone meal, horn meal and oilseed cakes of mahua, castor, mustard, neem and groundnut, and nematicides such as oxamyl, fensulfothion, phorate, dimethoate and disulfoton significantly reduced populations of plant-parasitic nematodes in nursery beds of some annual vegetables and ornamentals. Root-knot development on tomato, eggplant and chilli was also inhibited. Consequently the seedlings were relatively healthy in different treatments excepting mahua cake which proved to be phytotoxic. *Department of Botany, Aligarh Muslim University, Aligarh 202 002, India.*

AMSING, J.J. *Dispersal, population development and control of* Pratylenchus vulnus *in a culture of roses on an ebb and flow system.*

The relationship between different inoculation sites and the dispersal of *P. vulnus* was investigated in a rose crop, grown in rockwool slabs on an ebb and flow system. Inoculation with *P. vulnus* was carried out by adding either 6,000 nematodes to a tank with 80 liters of recirculating nutrient solution or 1,000 nematodes per plant around the roots of 6 out of 42 plants.

The dispersal of *P. vulnus* to non-inoculated plants was much faster from the inoculated tank than from inoculated plants. In both cases the nematodes were passively dispersed by the nutrient solution.

Population development of *P. vulnus* was influenced by the age of the rose plants. Inoculations of the nutrient solution carried out 7 and 25 weeks after planting, resulted in 4,975 and 202 *P. vulnus* per 10 g roots, respectively, 35 weeks after inoculation.

Nematicides were effective in controlling *P. vulnus*. One application to the nutrient solution in the tanks of either oxamyl (50 ppm a.i.), carbofuran (50 ppm a.i.) or abamectin (9 ppm a.i.) resulted in a maximum reduction of the initial population densities of 95%, 98% and 98%, respectively. *Research Station for Floriculture, Linnaeuslaan 2a, 1431 JV Aalsmeer, The Netherlands.*

ANVER, S. & ALAM, M.M. *Studies on the interaction of* Meloidogyne incognita *and* Rotylenchulus reniformis *on pigeonpea and the resulting effect on growth parameters including bulk density of stem.*

Meloidogyne incognita and *Rotylenchulus reniformis*, singly or concomitantly brought about significant reduction in plant growth (plant weight/length, bulk density of woody stem, number of pods, chlorophyll content) water absorption efficiency of roots, and root nodulation of pigeonpea (*Cajanus cajan*) cv. Prabhat Line. However, the effect was more pronounced in concomitant inoculation. Addition of rhizobia tended to reduce this damage to some extent. *M. incognita* caused more damage than *R. reniformis*. The rate of multiplication of *R. reniformis* was adversely affected by *M. incognita* and the same was also true with respect to root galling. *Department of Botany, Aligarh Muslim University, Aligarh 202 002, India.*

ARNTZEN, F.K. & BAKKER, J. *The level of partial resistance of some Dutch cultivars and breeding lines, determined with various potato cyst nematode populations.*

Seven Dutch cultivars and breeding lines, differing in resistance spectrum, were inoculated with a range of *Globodera rostochiensis* and *G. pallida* populations. The level of resistance was determined by counting the number of newly formed cysts. In most potato genotypes, apart from nearly complete resistance to one or more pathotypes, partial resistance to other pathotypes and/or populations was found. The level of this partial resistance varied not only between pathotypes, but also between different populations from a single pathotype. These results suggest that tests for partial resistance should be carried out with at least several populations of potato cyst nematodes. *Centre for Plant Breeding Research CPO, Postbus 16, 6700 AA Wageningen, and Plant Protection Service PD, Postbus 9102, 6700 HC Wageningen, The Netherlands.*

ATU, U.G. *Nematode problems in cropped reclaimed gully site at Owerri Nigeria*

Pueraria phaseoloides, yam intercropped with (icw) cowpea, cassava icw maize and fallow (mainly *Panicum maximum*) were grown in a reclaimed gully site. Initial soil samples showed the presence of *Meloidogyne incognita, Scutellonema bradys* and *Pratylenchus brachyurus*. Composite random soil samples collected from rhizosperic soil at monthly intervals and nematode extraction from roots at harvest showed that *M. incognita* and *S. bradys* populations significantly ($P = 0.05$) increased in yam icw cowpea and pueraria plots, while *P. brachyurus* was highest in the fallow and cassava icw maize plots. Determination of nematode taxa and planting appropriate non-host crops would stem nematode problems in a crop land. *Crop Production Dept. F.U.T., Owerri, Nigeria.*

AUMANN, J., CLEMENS, C.D. & WYSS, U. *Influence of lectins on female sex pheromone reception by* Heterodera schachtii *males.*

A standardized bioassay was developed in which the chemotactic behaviour of *Heterodera schachtii* males towards the female sex pheromone can be observed and documented at any time. It gives reproducible results within one to two hours. Incubation of males with the lectins from *Canavalia ensiformis, Triticum vulgare, Arachis hypogaea, Helix pomatia,* and *Limax flavus* did not affect chemoattraction to the sex pheromone. *C. ensiformis* lectin binding to the amphidial exudate did not inhibit the passage of fluorescein isothiocyanate into the amphidial canals. Amphidial

exudate synthesis was enhanced during phreomone reception. *Institut für Phytopathologie, Universität Kiel, Olshausenstrasse 40, 2300 Kiel 1, Germany.*

BABATOLA, J.O. *Host-parasite relationship of* Psidium guajava *L. cultivars and* Meloidogyne incognita.

Greenhouse experiments and laboratory studies were carried out to establish the host-parasite relationship between four guava varieties and *Meloidogyne incognita*. Seeds of all four varieties were planted separately in *M. incognita*-infested soil and thirty-day old seedlings were also inoculated with graded levels of *M. incognita* eggs.

All juvenile stages of the nematode developed within the roots of all the guava varieties. Eggs were observed on the roots of cv Webber supreme in 25 days and 31 days in cv Branca respectively after germination. Plant height, number of leaves, wet and dry shoot weights decreased significantly with increasing levels of inoculum in all the guava varieties except cv Allahabad. *Department of Crop Production, University of Ilorin, Ilorin, Nigeria.*

BACKETT, K.D.[1,2]), ATKINSON, H.J.[1]) and FOREST, J.M.S.[2]) *Development of a rapid immunological screen for resistance in the potato to* Globodera pallida.

An immunologically-based screen is under development as an alternative to standard procedures involving nematode reproduction test plants. Stage-specific monoclonal antibodies (MAbs) have been selected from 700 and 640 hybridoma clones prepared using infective juveniles (J2) and feeding females respectively as the immunogens. A hierarchical screen based on an enzyme-linked immunosorbent assay selected those MAbs that were specific to J2 or reactive with just subsequent stages of the nematode. Results establish that the number of J2 and of later stages can be assayed in a small biomass of test roots so providing an index of host status at a time point after expression of known resistance genes. The procedure is complete within 14 days of infection, can be applied non-destructively to plantlets before selection of promising lines for further growth or propagation by plant tissue culture. The approach has potential for resistance programmes involving both conventional and transgenic plants. [1]) *Department of Pure & Applied Biology, The University, Leeds, UK;* [2]) *Department of Zoology, Scottish Crop Research Institute, Invergowrie, UK.*

BAKKER, J., JANSSEN, R., BOUWMAN-SMITS, L., DE BOER, J., OVERMARS, H. ROOSIEN, J., SCHOUTEN, S., & GOMMERS, F.J. *Molecular strategies to study the host-parasite interaction between potato and* Globodera rostochiensis.

Virulent (aa) and avirulent (AA) inbred lines of *G. rostochiensis* for the H1 resistance gene in *Solanum tuberosum* spp. *andigena* CPC 1673 were produced by controlled single matings. Crossing of the inbred lines revealed a 3:1 segregation in the F2 generation, obtained by selfing the F1, showing that virulence is inherited at a single locus and is recessive to avirulence. To study the linkage of molecular markers with the virulence gene, 300 virulent lines were selcted via backcrossing the F1 (Aa) with the virulent (aa) parent line. The 300 lines can be used to study the inheritance of any molecular difference between the virulent and avirulent parent lines and may eventually lead to the virulence gene or to DNA sequences closely linked to the virulence gene to provide a starting point for isolating the virulence gene by e.g. chromosome walking, rare cutting jumping libraries and Pulsed Field Gel Electrophoresis. Molecular differences between the parent lines will be obtained by RFLP analysis, 2-D electrophoresis of proteins and differential screening of complementary DNA libraries synthesized on mRNA populations. *Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

BALDWIN, J.G. & CAP, G.B. *Systematics of* Nacobbus, *the false root-knot nematode.*

Although *Nacobbus* is an important agricultural pest in the Americas, knowledge of its diversity, biology, and control is partly limited by inadequate systematics. Phylogenetic classification of *Nacobbus* may be difficult due to convergent evolution of some classical diagnostic characters,

including the saccate female and single ovary. Since Sher's controversial 1970 revision, two species, *N. dorsalis* and *N. aberrans*, are recognized. *Nacobbus batatiformis, N. serendipiticus*, and *N. serendipiticus bolivianus* are considered junior synonyms of *N. aberrans*. Direct comparison of morphology, biology, biochemistry, and cytogenetics of isolates from throughout the world, will provide a basis for phylogenetic analysis and revision of the genus. *Department of Nematology, University of California, Riverside, CA 92521, USA.*

BANCK, A. PERSMARK, L., JANSSON, H-B. & ANDERSSON, S. *The influence of extraction methods on the recovery of nematodes and nematophagous fungi.*

Nematodes, including the plant-parasitic species *Paratrichodorus pachydermus, Trichodorus viruliferus, Pratylenchus crenatus* and *Tylenchorhynchus dubius* in a sandy agricultural soil were extracted in six ways; elutriation according to Seinhorst, Whitehead's extraction tray method, Cobb's sieving and decanting method and centrifugation with three different media; silica, Mg and sugar. The total number of plant-parasitic nematodes did not differ significantly between the elutriation and the three centrifugation methods, which all gave higher numbers than the other two methods. The recovery of non-parasitic nematodes was highest using centrifugation with silica and lowest using the Cobb method. Four species of endoparasitic fungi were found; *Catenaria anguillulae, Harposporium anguillulae, Nematoctonus* sp. and *Hirsutella* sp. Three of the methods (elutriation and centrifugation with silica and sugar) gave all four species of fungi in equal frequency. The other three methods lacked some of the species or gave a low frequency of infection. *Department of Plant and Forest Protection, Swedish University of Agricultural Sciences, Box 44, S-230 53 Alnarp, Sweden; Department of Microbial Ecology, University of Lund, Helgonavägen 5, S-223 62 Lund, Sweden.*

BARKER, K.R., MELTON, T.A. & KOENNING, S.R. *Differential residual activity of selected nematicides on* Meloidogyne *spp. on tobacco.*

Eight field experiments, four in 1988 and four in 1989, focused on the residual activity of aldicarb, ethoprop, and fenamiphos on varying taxon levels of *Meloidogyne arenaria* and *M. incognita*, and/or *M. javanica* on flue-cured tobacco. Aldicarb was apllied in a 35-cm band at 3.36 kg(ai)/ha; emulsifiable concentrates of ethoprop and fenamiphos were broadcast at 8.75 and 6.72 kg(ai)/ha, respectively. Treated soil was formed in high, wide beds prior to transplanting. Fenamiphos gave greatest residual control of *Meloidogyne* spp., in some cases up to 10 weeks as determined by periodic nematode assays. Suppression of nematode increase by ethoprop was short-lived with numbers sometimes surpassing those of untreated plots within 4 weeks after treatment. Aldicarb gave intermediate control over time as compared to the other compounds. Relative residual activity also varied with site and season. *Department of Plant Pathology, North Carolina State University, Raleigh, NC, USA.*

BARKER, K.R., SCHMITT, D.P., & KOENNING, S.R. *Repeated and subunit sampling to determine the precision in estimating nematode population levels.*

The first phase of this study involved repeated sampling of five fields to determine the precision of nematode assays, using composites of 10, 20, 40, and 80 soil cores. The second phase focused on randomly selecting two and four 2-ha subunits (data on *Medoidogyne* spp.) of some 20 fields ranging from 6 to 40 ha and computing the precision of estimated means for these numbers of subunits versus the general field mean (based on all 2-ha subunits). For the repeated sampling of fields, average numbers of several nematode taxa were within 50% of the overall mean. Coefficients of variation (CV) were lower for 40 soil cores than for 10, 20 and 80 cores per sample. The CV's for all fields were lowest for 40 and 80 cores. These values were greater for *Meloidogyne* spp. than for *Heterodera glycines*. Population estimates of *Meloidogyne* spp. based on four 2-ha subunits generally were closer to field means than were those for two subunits. Sampling precision with these subunits diminished greatly in large fields with variable soils and/or mixed cropping histories. Either two or four subunits gave estimates of nematode numbers within 3 to 50% of the field mean in most instances. *Department of Plant Pathology, North Carolina State University, Raleigh, NC, USA.*

BAUJARD, P.[1]) & MOUNPORT, D.[2]) *Morphology and ultrastructure of epiptygmata in the Hoplolaiminae (Nemata: Tylenchida).*

Studies on epiptygmata in eight species of five genera (*Scutellonema, Hoplolaimus, Aorolaimus, Helicotytenchus, Aphasmatylenchus*) in the Hoplolaiminae show that epiptygmata are always present in these genera. They appear to form a culticular tube that may or may not protrude out of the vagina. Generic differences have been observed between genera of Hoplolaiminae in the insertion level of epipytgmata on the vaginal walls.[1]) *Centre ORSTROM, B.P. 1386, Dakar, Sénégal,* [2]) *Département de Biologie Animale, Université Cheikh Anta Diop, Dakar, Sénégal.*

B'CHIR, M.M.[1]), BEL HADJ SALAH, N.[1]), CHEBIL, A.[2]), & DE VOLDER, F.[2]) *Choice of the best nematicidal control in two different management programmes.*

Fumigant nematicices cannot be effectively used under hot summer conditions before late season crops. Systemics have generally a short retentivity, with a risk of residues when applied during cultivation.

Mode of action and efficiency in vitro and in the field of two "locally penetrating" nematicides (Ethoprop and Ebufos) are compared in the control of *Globodera* spp. on potatoes and *Meloidogyne* spp. under plastic shelters. [1]) *Lab. Nematology I.N.A.T. 43, Av. Charles Nicolle Tunisia;* [2]) *Lab. Phytopharmacie. Ministère de l'Agriculture Tunisia.*

B'CHIR, M.M.[1]); VAN OOSTVELDT, P.[2]), CHIBOUB, T.[1]) & BEN ABDALLAH, S.[1]) *Genetic manipulation induced by* Tylenchulus semipenetrans *in root citrus cells.*

Healthy and infested nuclei of root cortex cells of *Citrus aurantium* were observed with confocal microscopy and scanning microscope photometry. Uninfested tissue contained diploid and tetraploid nuclei corresponding with G1 and G2 phase of mitotic cycle. Nuclear DNA amounts per nucleus reveal an increased popyploidy level in infested cells. The nucleus of these nurse cells is morphologically different from that of healthy ones. The chromatin is spread in vesicles around the nucleolus. The increase of DNA per infested nucleus is not geometric as would be expected for normal endomitotic processes. This should indicate a nuclear degradation in nurse cells which is also observed by the confocal microscopy. This result suggests a specific genetic manipulation in citrus root cells infested by *T. semipenetrans*. The death of the nematode induces tissue necrosis and pertubations in root activity. [1]) *Laboratory of Nematology, I.N.A.T., 43, Av. Charles Nicolle Tunisia;* [2]) *Laboratory of Biochemistry, Fac. Landbouw., Coupure Links 653, 9000 Gent, Belgium.*

BEEN, T.H., BENIERS, J.E. & KNOL, J.B. *Using image analysis for counting juveniles of cyst nematodes.*

One of the most tedious occupations in nematological research is counting cysts, eggs or juveniles. A GOP-302 image analysis system was used to investigate possible solutions for this problem. The primary aim was to automate the counting of large numbers of *Globodera rostochiensis* and *G. pallida* juveniles suspension. The result has been a mouse/menu-driven system that can count up to 64 compartments with suspension without intervention by an operator. The average time used to count one compartment has been reduced by 80% to 1 minute compared with manual labour. At least 95% of the juveniles in a sample are recognized and counted. The program can be adapted easily to count other nematode species or to suit more complicated problems like counting both juveniles and eggs in one suspension. Possibilities of the system will be discussed. *Research Institute for Plant Protextion, P.O. Box 9060, 6700 GW Wageningen, The Netherlands.*

BELAIR, G. & VINCENT, C. *Entomogenous nematodes for the biological control of the apple sawfly,* Hoplocampa testudinea.

Larvae of *H. testudinea* were infected and killed by entomogenous nematodes *Steinernema feltiae* race "DD136" and race "All", *S. bibionis* and *Heterorhabditis heliothidis* under laboratory conditions. Mortality of second and third stage larvae ranged from 90 to 97% after 48 h. Under field

conditions, soil drench applications of *S. feltiae* race "All" at the rate of 25, 50 and 100/cm^2 were effective in controlling the larvae inside fallen fruit. At the 100 nematodes/cm^2 rate, the larval mortality was the highest at 81% while 5% mortality was observed in the control. The survival rate of nematodes in the soil was confirmed by performing *Galleria* biotests. These results show a promising potential of these nematode species as biocontrol agents against the apple sawfly. *Agriculture Canada Research Station, Saint-Jean-sur-Richelieu, Quebec, Canada.*

DEN BELDER, VAN ESCH, J. & BONANTS, P. *Control of nematodes with genetically improved micro-organisms and their gene-products*

Because of increasing concern about environmental pollution caused by intensive use of nematicides, research on alternatives for chemical control has been initiated using micro-organisms and their gene-products. The infection events of the fungus-root knot nematode system and the effects of extracellular enzyme activity have been studied with the light and electron microscope. Biochemical (FPLC, SDS-PAGE) and molecular biological (*in vitro* translation, 2D-gel electrophoresis) methods are used to identify fungal products with antagonistic activity. Some fungi are capable of degrading structural components of the egg shell (e.g. chitin) while others could degrade a structural component in the cuticle of the juvenile (collagen). FPLC-patterns of culture filtrates of *Paecilomyces* sp., the most prominent fungus, show three peaks with chitinase activity. *Instituut voor Plantenziektenk. Onderzoek (IPO), P.O. Box 9060, 6700 GW Wageningen, The Netherlands.*

BERNARD, E.C. GWINN, K.D., & KIMMONS, C.A. *Interrelationships of endophyte-infected tall fescue and plant-parasitic nematodes.*

The ability of *Meloidogyne marylandi, Pratylenchus scribneri*, and *Helicotylenchus pseudorobustus* to develop and reproduce on tall fescue (*Festuca arundinacea*) infected with *Acremonium coenophialum* was investigated. *M. marylandi* reproduced well on endophyte-infected (E-) plants, but did not survive an infected (E+) plants. Resistance of E+ plants to *M. marylandi* was correlated with thick-walled root endodermis. In E- plants endodermal walls were variable but usually much thinner than in E+ roots. *P. scribneri* maintained itself on E- plants but died out on E+ plants. On agar plates, more *P. scribneri* migrated toward E- root segments than toward E+ root segments. *H. pseudorobustus* was not affected by host endophyte status. *Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN 37901-1071, USA.*

BHARATHA, K.S. & KRISHNAPPA, K. *Studies on the management of nematode complex of banana* (Musa accuminata Colla).

Effect of physical (paring and hot water at 55°C for 20 min) cultural (neem cake at the rate of 400 g/plant) and chemical (carbofuran 3G at the rate of 20 g/plant) methods of control individually and in integration in the management of interaction effect induced by *Radopholus similis*, *Helicotylenchus multicinctus* and *Meloidogyne incognita* on banana cv. Robusta were investigated under glasshouse conditions. The plants which received integrated physical, cultural and chemical treatments recorded maximum plant growth and minimum nematode numbers in roots and soil. *Department of Plant Pathology, University of Agricultural Sciences, GKVK, Bangalore 560065, India.*

BHARGAVA, S., YADAV, B.S. & DASHORA, P.K. *Effect of different soils and varieties of cowpea on plant growth and multiplication of* M. incognita

An experiment was conducted to determine the effect of different soils (light, medium, heavy) and varieties of cowpea on plant growth and multiplication of *M. incognita*. Studies on soils and varieties on nodulation and plant growth revealed that var. C-152 (moderately resistant) had significantly higher nodulation and plant growth than Pusabarsati (highly susceptible) in nematode free light soil. However, multiplication of *M. incognita* was found significantly higher in Pusabarsati in light soil in comparison to C-152 (M.R.). *Department of Nematology, Rajasthan College of Agriculture, Udaipur, Rajasthan, 313 001 India.*

BILGRAMI, A.L. *Resistance and susceptibility of prey to prediation and strike rate of the predators* Mononchus aquaticus, Dorylaimus stagnalis *and* Aquatides thornei.

The resistance of *Panagrellus redivivus*, *Cephalobus* sp., *Acrobeloides* sp., *Rhabditis* sp., *Tylenchorhynchus mashhoodi*, *Hirschmanniella oryzae*, *Hoplolaimus indicus*, *Helicotylenchus indicus*, *Scutellonema*, sp., *Hemicriconemoides mangiferae*, *Hemicycliophora* sp., *Meloidogyne incognita* juv., *Anguina tritici* juv., *Xiphinema americanum*, *Paralongidorus citri*, *Longidorus* sp., *Trichodorus* sp. etc., against predation was determined and quantified using methods of Bilgrami & Jairajpuri (1989). Predators attacked all kinds of prey. *M. aquaticus* was a most successful predator with maximum strike rate (SR = 100%) and *A. thornei* less successful with maximum strike rate (SR = 60%) Prey nematodes possess different degrees of resistance (PR = 0-100%) *M. incognita* juv. were highly susceptible to predation besides *A. tritici* juv., *P. redivivus*, *Cephalobus* sp., *Acrobeloides* sp., and *T. mashoodi* (PS = 84-100%). Various physical, chemical and behavioural characteristics have been attributed to differences in resistance to prey nematodes. *Section of Nematology, Department of Zoology, Aligarh Muslim University, Aligarh 202 002, India.*

BIRD, A.F., MCCLURE, S.G. & NICHOLAS, W,L. *Crystalloid bodies in the pseudocoelom of* Eutobrilus heptapapillatus.

Light and electron microscope examination of the nematode *Eutobrilus heptapapillatus*, obtained from the mouth of the river Murray, have revealed the presence of oval crystalloid bodies in its pseudocoelom. These structures which contain glycolipids as well as sulphur and phosphorus vary in size up to a maximum of 10μm in length. Associated with these crystalloids are numerous small, regular, densely stained particles which are about 20nm in diameter which occur throughout the nematode's body. *C.S.I.R.O., Division of Soils, P.O. Glen Osmond (Adelaide), South Australia 5064, Australia.*

BIRD, D.M. & KALOSHIAN I. *Isolation of genes encoding* Meloidogyne incognita *stylet exudate proteins.*

DNA sequence has been inferred from a 32 amino acid stretch of a 200 k glycoprotein component of the *M. incognita* stylet exudate, and an oligonucleotide (23-mer; 1, 024 × degenerate) synthesized. Southern blots of *M. incognita* DNA were probed with kinased oligomer and washed at 53°C in 3M TMAC; two *Eco* RI fragments were detected (7 kb and 3.5 kb). A 3.5 kb fragment also was observed in *M. javanica*. Screening with cDNA, Taylor-primed from *M. incognita* total RNA, indicated that the 3.5 kb, but not the 7 kb, fragment lies within the ribosomal repeat. The 7 kb *Eco* RI fragment has been cloned, and found to contain two closely spaced regions of homology with the oligomer. Different *Meloidogyne* spp. vary in their dosage of this sequence. On-going analysis will reveal if this recombinant encodes the 200 k protein. *Department of Nematology, University of California, Riverside, CA 92521, USA.*

BOAG, B. & CRAWFORD, J.W. *Effect of global warming on the geographical distribution of plant-parasitic nematodes.*

The temperature of the world is expected to rise by 1-1.5°C in the next 20 years and 4°C by 2050. The geographical distribution of many important plant-parasitic nematode species is known due to the recent co-operation between nematologists in producing both national and European atlases. A knowledge of the biology and ecology of the nematodes and their existing distribution has been used to predict their potential distribution pattern and forecast future nematode problems. *Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland.*

BOAG, B., WEBSTER, R.[1]), NEILSON, R. & BROWN, D.J.F. *Techniques for investigating the spatial distribution of nematodes.*

The aggregated horizontal distribution of nematodes has been studied using a range of mathematical functions and techniques including the negative binomial, Neyman Type A, Taylor's Power Law and semi-variograms. Detailed examination of the spatial distribution of *Heterodera avenae*, *Globodera rostochiensis* and *Longidorus elongatus* have indicated that the negative

binomial distribution has limitations due to the dependence of k on the mean population size while b', Taylor's Power Law Index of Aggregation, is independent of the size of the population. Both Taylor's Power Law and semi-variograms can be used to develop optimal sampling procedures. *Scottish Crop Research Institute, Dundee DD2 5DA, Scotland;*[1]) *Centre de Géostatistique, École Nationale Supérieure des Mines de Paris, 35 rue Saint-Honoré, 77305 Fontainebleau, France.*

BOERMA, M. & VELEMA, R.A.J. *The relation between root setting of various potato varieties, and their tolerance against an infestation by the potato cyst nematode* Globodera pallida.

Assessing the root mass and root quality of various potato varieties showed that there are significant differences in the mass of the effective root system and the rate at which the root system deteriorates with increasing infestation by the potato cyst nematode *Globodera pallida*. The tolerant potato variety Elles had a large root system, while the rate of browning only slowly increased with increasing infestation by *G. pallida*. With the susceptible varieties Mentor and Darwina the browning of the roots was evident at low inoculation levels. The quality and the mass of the root systems seems to coincide well with the measured damage in the field. *H.L. Hilbrands Laboratory for soil borne pests and diseases, P.O. Box 323, 9400 AH Assen The Netherlands.*

DE BOER, J.M. & OVERMARS, H.A. *Miniature 2D-electrophoresis of parasitic juveniles of* Globodera rostochiensis..

Mini 2D-electrophoresis followed by a silver stain was used to compare the protein composition of nine developmental stages of *G. rostochiensis*. A major change in the protein pattern was observed at the onset of parasitism, when several dominant spots of the preparasitic J2 disappeared, and a new set of sports typical for the parasitic stages appeared. Male juveniles possess a number of abundant proteins that are not observed in female juveniles. Possibly these proteins have a storage function. The change in protein pattern during the metamorphosis of male juveniles into adults is essentially a reversal of the change observed at the onset of parasitism. Our results show that the development of males is characterised by a considerable amount of protein synthesis and breakdown. They confirm the degeneration of body wall muscles in the parasitic stages, and the rebuilding of these muscles in the adult males. *Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

BOLLA, R.I. & BOSCHERT, M. *Chromosomal complement and mating potential of populations of* Bursaphelenchus *spp.*.

"R" forms of *B. xylophilus* from *Pinus* sp. and some "M" forms from fir have identical chromosome complements but these differ from *B. mucronatus* and other "M" forms. This suggests some "M" forms may be closely related to *B. xylophilus*. *B. xylophilus* populations from *P. sylvestris* in the midwestern U.S. have similar mating potential, identical chromosome complements, overlapping ranges, and similar virulence. This suggests these may be sibling populations, possibly founder populations of *B. xylophilus* in the U.S. *Dept. Biology, St. Louis Univ., 3507 Laclede, St. Louis, MO 63103, USA.*

BONGERS, T. *The use of the Maturity Index in biomonitoring terrestrial and aquatic ecosystems.*

Nematodes are suitable organisms to monitor terrestrial and aquatic ecosystems in relation to pollutants or other disturbances at community level as well as in bio-assays. In The Netherlands use of nematodes in environmental studies is increasing. To assess the quality at community level, identification of the Dutch nematode fauna has been brought within reach of the non-specialist, methods have been developed for an efficient analysis at high magnification and a sensitive ecological parameter developed. In this paper the possibilities of the Maturity Index are demonstrated and status of plant feeders is discussed. *Department of Nematology, Wageningen Agricultural University, PB 8123 6700 ES Wageningen, The Netherlands.*.

BOUWMAN, L.A., VAN DE MAAS, C.J., & DE RUITER, P.C. *Effects of nematophagus fungi on the actual production and death-rate of bacterivorous nematodes in arable soil and its consequences for mobilization of bacterial nitrogen.*

In arable fields bacterivorous nematodes dominate the nematode fauna and affect nitrogen-mineralization, directly as consumers of bacteria and indirectly by changing bacterial activity. The size of the direct effect depends on actual nematode production. Production cannot be measured in the field, due to predation of nematodes. In a microcosm-experiment with organically enriched soil, the actual nematode production could be calculated from measurements on net production in fresh (plus predators) soil and on potential production in sterilized soil, inoculated with soil bacteria and nematodes. *Institute for Soil Fertility, P.O. Box 30003, 9751 RA Haren, The Netherlands. Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

BOWEN, S.A. & SPAULL, A.M. *Relationship between numbers of* Heterodera avenae *and yield of spring oats and other cereals.*

Damage assessment trials were designed to take advantage of the heterogeneous distribution of nematode populations in fields, so that yields could be regressed against a range of initial population densities. Twenty paired plots were distributed on a grid pattern and aldicarb (3.36 kg ai/ha) applied to one half of each pair of plots. Initial numbers at spring oat sites ranged from 0.1-15.7 eggs/g soil and the regression of yields against initial numbers suggested a yield loss of 0.75 t/ha for each 10 eggs/g soil (mean of four trials) Significant yield loss occcurred at only one spring barley trial and was less than recorded for oats. No significant yield losses occurred in winter wheat or winter barley.

Nematode multiplication was poor in the trial series and is discussed in relation to numbers of nematode parasitic fungi and predicting future yield losses due to *H. avenae*. *Edinburgh School of Agriculture, West Mains Road, Edinburgh EH9 3JG, Scotland.*

BRIDGE, J., MACHON, J. & DJATMIADI, D. *A new nematode problem of citrus caused by* Radopholus *sp. in Java.*

An undescribed species of *Radopholus* was discovered as a root endoparasite of citrus seedlings and trees in E. Java, Indonesia. Its damaging potential has been established in controlled pathogenicity experiments which have shown that the nematode can cause very serious root necrosis and severe growth reduction of citrus rootstocks. *CAB International Institute of Parasitology, 395a Hatfield Road, St. Albans, AL4 0XU, UK.*

BROWN, D.J.F. & ROBERTSON, W.M. *Factors involved in the acquisition, retention and release of viruses by virus-vector nematodes.*

A characteristic of the relationship between nematode transmitted viruses and their vectors is the specific transmission of serologically distinguishable strains of nepo and tobraviruses by longidorid and trichodorid vector nematode species respectively. Virus transmission depends on the acquisition of the virus from an infected plant host and the specific retention and resultant release of the virus from sites of virus retention within the oesphagus of the nematode during subsequent feeding on a plant host. The recognition between virus and vector may differ between vector genera and possibly also between different viruses transmitted by the same vector species. Recognition between lectin-like molecules associated with the virus protein coat and carbohydrates present in the oesophageal tracts of some *Xiphinema* and *Paratrichodorus* species may account for specificity, and efficiency, of transmission by these vector genera but not by some *Longidorus* vector species. *Zoology Department, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland.*

BURROWS, P.R. *DNA Hybridisation probes to identify pathotypes of* Globodera rostochiensis *and* G. pallida.

The practical identification of pathotypes within *G. rostochiensis* and *G. pallida* is a time consuming and labour intensive process that assesses the reproduction of a PCN population on a range of differential potato cultivars. Unfortunately, pathotype tests of this sort are often inconclusive and the results difficult to interpret.

At Rothamsted DNA hybridisation probes are being developed to address the problems posed by pathotype identification. Initial results using European populations of *G. rostochiensis* Ro1 and Ro4, and *G. pallida* Pa1 which are all defined by major resistance genes are encouraging. DNA probes that are specific for these groups will provide a sensitive and rapid method for differentiating them from the ambiguous polygenically determined pathotypes. *Entomology & Nematology Department, AFRC IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, UK.*

BURROWS, P.R. *Initiation and development of the syncytial feeding sites of cyst nematodes: a molecular view.*

Cyst nematodes are a large group of obligate root endoparasites, many species of which pose a significant threat to agriculture. In order to complete its life cycle a cyst nematode must stimulate the production of a specialised syncytial feeding site within the host roots. Initiation and maintenance of the syncytium by the nematode is characterised by many local physical and molecular changes including enlargement of the plant cell nucleus and nucleolus accompanying an increase in transcription, loss of normal vacuolation, cell wall degradation and proliferation of subcellular organelles.

At the molecular level very little is known about the processes involved in this host response. However, histological observations suggest strongly that the nematode is able to regulate specific host genes. Molecular biology and monoclonal antibody technology now offer us the opportunity to study this complex host/parasite relationship in great detail. A better understanding of the genes regulated by cyst nematodes and the mechanisms by which this is achieved could facilitate the engineering of crop cultivars that possess novel forms of resistance. Such resistance would prevent syncytial initiation or block development of the syncytium soon after its induction by the nematode. *Entomology & Nematology Department, AFRC IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, UK.*

CADET, P., ALBRECHT, A. & GERMANI, G. *Influence of soil factors on the sugarcane plant parasitic nematode community in Martinique.*

In the seventies, hillock levelling was used in Martinique to improve crop mechanization. Deep soil layers (horizon B or C) were carried to the surface and planted with sugarcane during the last 20 years. Despite this long period of cultivation, pedological properties of these ferrisol horizons still remain different. Soil samples were taken between the sugarcane rows, along lines from the reference top soil to the levelled soil. Nematological and pedological analysis were conducted on each sample. The abundance of *Hemicriconemoides cocophilus* showed a positive relationship with pH and a negative relationship with the carbon content. The abundance of *Pratylenchus zeae* seemed to be negatively related to pH. In conclusion, modifications in abiotic factors induced by hillock levelling could influence the balance between species in the nematode community. However, related biotic factors could also be modified and interact with nematode populations. Therefore, by changing the ratio of abiotic factors, it may be possible to modify the nematode community and maybe reduce its pathogenicity, *Laboratory of Nematology and Pedology, ORSTOM, BP 81, 97256 Fort-de-France, Martinique.*

CAMPOS, V.P. & SILVA, J.F.V. *Isolation of endoparasitic and ectoparasitic fungi associated with nematodes in Brazil and "in vitro" tests of parasitic efficacy of* Haptaglossa heterospora *on selected nematodes.*

The six most prevalent endoparasitic species were: *Harposporium anguillulae, H. bysmatosporum, H. crassum, H. helicoides, Catenaria* sp. and *Haptaglossa heterospora*. Among the ectoparasitic fungi, *Arthrobotrys* spp. were the commonest within the samples. The agressivity of *Haptaglossa heterospora* was high on every tested nematode species, showing no specificity among the hosts. Observations were done also on the life cycle of *Haptaglossa heterospora* on the tested nematodes. *Departamento de Fitossanidade, Escola Superior de Agricultura de Lavras, 37200 Lavras, Minas Gerais, Brazil.*

CANTO-SAENZ, M. *Life cycle and pathogenicity of* Nacobbus aberrans *Thorne & Allen, 1944.*

The life cycle of Nacobbus aberrans, from egg to egg, is about 48 days at 25°C but it may take from 35-90 days depending upon the temperature and the host. The second stage juvenile (J2) emerges from the egg, enters the roots and incites the formation of cavities and necrosis. Two juvenile stages (J3 and J4) may become quiescent. The immature adult female is vermiform and may come out of the root tissue attacking adjacent roots or migrate within the roots. Once it penetrates the roots, it incites necrosis as well as the formation of a spindle, heart or irregular shaped syncytium. The infection also causes the formation of individual, round to spindle shaped galls laterally on roots and usually in a rosary beads fashion. This nematode has a wide host range and populations may differ in their reaction to various hosts and cultivars of the same crop. Yield reduction due to the nematode attack may be as high as 90% in some crops. Interactions of this nematode with *Heterodera schachtii, Meloidogyne incognita, Globodera pallida* and *G. rostochiensis* and *Spongospora subterranea* have been observed. *Department of Nematology & Entomology, International Potato Center, P.O. Box 5969 Lima, Peru.*

CAP, G.B., ROBERTS, P.A., THOMASON, I.J. & MURASHIGE, T.[1] *Successful transfer of root-knot nematode* (Meloidogyne) *heat stable resistance from* Lycopersicon peruvianum *into* L. esculentum *genotypes.*

Genotypes of *Lycopersicon peruvianum* and *L. p.* var. *glandulosum*, each with combined resistance to *Meloidogyne hapla* and to *M. incognita* at high soil temperature, were used as male parents in crosses with *L. esculentum* cv. UC82 and *L. esculentum* male sterile line ms-31, respectively. The incongruity barrier characteristic of these broad crosses with members of the *L. peruvianum* group was overcome by embryo culture techniques and F_1 progeny were obtained. Hybridity in the F_1 of each cross was confirmed by leaf and flower morphological characters and growth habitat patterns, and by isozyme phenotypes using PAGE electrophoresis. In greenhouse inoculation experiments the F_1 plants of each cross regenerated through tissue culture were highly resistant to *M. incognita* at 25°C and 30°C soil temperatures. These results confirmed the successful transfer of the *M. incognita* heat stable resistance from the wild genotypes into *L. esculentum* and its expression in the F_1 hybrids at moderate and high temperatures. *Departments of Nematology and Botany and Plant Science*[1], *University of California, Riverside, CA 92521, USA.*

CARES, J.E. & C.S. HUANG: *Environmental factors affecting diversity of plant parasitic nematodes in the Brazilian Amazon.*

A survey of plant parasitic nematodes was carried out in cultivated and natural ecosystems in non-flooding forest ("terra firme") and periodically flooded plains ("varzea") of the Brazilian Amazon. The vertical distribution, and impact of agriculture on diversity of nematode species were evaluated. Correspondence analysis indicated that agriculture had a greater impact on diversity of nematodes, than did the terra firme or varzea ecosystems. *Department of Nematology University of California, Riverside, CA 92521, USA; and Campbell Institute for Research and Technology, Route 1, Box 1314, Davis, CA 95616, USA.*

CAROPPO, S. & AMBROGIONI, L. *Life cycle of a cyst-forming nematode similar to* Heterodera daverti on carnation and white clover.

The results of a study of the life cycle of a cyst-forming nematode very similar to *Heterodera daverti* are reported. The nematode seriously damages carnation in the Naples area. Investigations were undertaken in a greenhouse at 24-26°C on carnation cv "Tanga Lontarion" and on white clover cv "Huya". The time required by the nematode to complete its life cycle from J2 to the newly hatched J2 from the egg-sac was about 35 days on carnation and 40 on white clover. Brown cysts were observed for the first time, respectively 40 and 50 days after the inoculation of J2. The multiplication rate, based on the number of J2 in the soil, was 28 on carnation and only 4 on white clover. The number of generations was difficult to specify because of overlapping, but it may be assumed to be at least 4 in a six months period on both hosts. *Istituto Sperimentale per la Zoologia Agaria, Cascine del Riccio, 50125 Florence, Italy.*

CARPENTER, A.S., HIATT, H.H., LEWIS, S.A. & ABBOTT, A.G.: *Genomic RFLP analysis of* Meloidogyne arenaria *race 2 pathotypes.*

Total genomic DNA was isolated from eggs of three South Carolina (SC), USA *Meloidogyne arenaria* race 2 populations—Govan, Pelion, and Florence; one Florida race 1 population; and one SC *Meloidogyne incognita* race 2 population. These DNAs have been digested with EcoR1 restriction endonuclease and Southern hybridization analyses performed using single copy level and interspersed repeat, cloned probes. Probes have been isolated from a random genomic library of EcoR1 *M. arenaria* DNA fragments cloned into pUC 8. One cloned probe, designated pE1.6A, when hybridized displays an interspersed repetitive pattern and the RFLP's present distinguish the Govan population from the other SC *M. arenaria* race 2 populations, Pelion and Florence. The *M. arenaria* race 2 Govan population has been shown in field, microplot, and greenhouse tests to differ greatly in reproductive rate and aggressiveness on soybean hosts when compared to the *M. arenaria* race 2 Pelion and Florence populations. Traditional methods of *Meloidogyne* identification have been unsuccessful in distinguishing these populations. *Depts. of Plant Pathology and Physiology, Agronomy and Soils, and Biological Sciences, Clemson University, Clemson, SC, USA.*

CASTAGNONE-SERENO, P., ABAD, P., DALMASSO, A. & BONGIOVANNI M. *Isolation of functional mRNAs from the root-knot nematode* Meloidogyne incognita.

Near isogenic lines of *Meloidogyne incognita* avirulent and virulent for the *Mi* resistance gene of tomato were artificially selected from a single female to study the mechanism(s) of acquired virulence in this species. Total cellular RNAs were extracted from virulent and avirulent juveniles using a quanidium/phenol method. Poly(A) rich RNAs were purified from other RNA species by affinity chromatography on oligo(dT) cellulose column, which provided average yields ranging from 1 to 4% of the total RNAs. The translation in rabbit reticulocyte lysate of these mRNAs resulted in proteins of high molecular weight (>100 kd). We plan to use these purified mRNAs to realize a differential screening of the genomic libraries of the two strains in order to identify sequences involved in *Meloidogyne* virulence. *INRA Station de Nématologie et Génétique moléculaire des Invertébrés, BP 2078, 123, bd Francis Meilland 06606 Antibes Cédex, France.*

CASTAGNONE-SERENO, P., PIOTTE, C., ABAD, P., BONGIOVANNI, M. & DALMASSO, A. *Molecular polymorphism in the genus* Meloidogyne.

Genetic variability between *Meloidogyne* species and populations was assessed using 1) two-dimensional gel electrophoresis (2-DGE) followed by a sensitive silver stain and 2) recombinant DNA technology. 2-DGE of soluble protein extracts from white females resulted in highly reproducible patterns which resolved an average of 400 polypeptides. Differential patterns were obtained between the 7 species we compared, but only slight differences could be found between populations belonging to the same species, even when they originated from very distant geographical locations. RFLPs obtained by hybridization of total genomic DNA digests of the same strains with repetitive DNA probes previously isolated at random from a *M. incognita* genomic library showed a clear polymorphism both between species and populations of one single species. These results confirmed the usefulness of molecular biology approaches for fine and accurate identification of root-knot nematodes. *INRA Station de Nématologie et Génétique moléculaire des Invertébrés, BP 2078, 123, bd Francis Meilland, 06606 Antibes Cédex, France.*

CHANNER, A.G., DAUDI, A.T. & GOWEN, S.R. *The potential of* Pasteuria penetrans *for the control of* Meloidogyne javanica: *theory and practice.*

Pasteuria penetrans, an obligate bacterial parasite of nematodes, has potential as a biocontrol agent. Studies on natural levels of nematode infection in Malawi revealed that while *P. penetrans* is widely distributed, it is also highly localised, not just within particular fields, but around particular plants. *P. penetrans* was found in tomato fields on nematode populations which were above economically damaging thresholds. It is concluded that simple introduction of *P. penetrans* is

unlikely to give classical biological control. However, inundation of nematode-infested soil with *P. penetrans* spore inoculum in pots resulted in highly significant control. Where spore dose rates were high, nematode invasion and egg mass production were greatly reduced and the growth of tomato transplants was improved. Lower dose rate of *P. penetrans* applied to lightly infested soil resulted in prolonged crop life and improved yield in a second crop cycle. Artificial augmentation of *P. penetrans* levels in Malawian field soil gave significant reduction in galling and indications of improved yield when dose rates were high. It is suggested that returning dried roots to the soil after harvest will bulk up *P. penetrans* spores *in situ*, and provide nematode control in perpetuity. *Department of Agriculture, University of Reading, Early Gate, PO Box 236, Reading, RG6 2AT, England.*

CHITWOOD, D.J. & FELDLAUFER, M.F. Caenorhabditis elegans *does not biosynthesize significant quantities of ecdysteroids.*

Ecdysteroids (insect molting hormones) from axenically propagated *C. elegans* were chromatographically purified and quantified by radioimmunoassay. Nematodes from semidefined medium contained immunoreactivity equal to that of 460 pg ecdysone per gram dry weight, but the corresponding equivalent of uninoculated culture medium contained 68 times the immunoreactivity found in *C elegans*. Nematodes from ecdysteroids-deficient, defined medium contained 520 pg ecdysone equivalents per gram. When this medium was supplemented with [^{14}C]cholesterol of high specific activity, nematodes did not contain radiolabelled ecdysteroids, nor did they secrete or excrete radiolabelled ecdysteroids into their culture medium. Similarly, we failed to detect radiolabelled polar or apolar ecdysteroid conjugates in *C. elegans* or in exhausted culture medium. *Nematology and Insect Hormone Laboratories, U.S. Department of Agriculture, ARS, Building 467, BARC-East, Beltsville, Maryland 20705, USA.*

CHOLEVA, B., NEDELCHEV, S. & PENEVA, V.G. *Investigation on the morphology and distribution of* Pratylenchoides ritteri, Sher, 1970, *from Bulgaria.*

Additional data on the morphology and distribution of *P. ritteri* from Bulgaria are presented. Bulgarian populations of this species show large limits of intraspecific variability. The status of *P. alkani* is discussed. *Laboratory of Plant Nematology, Faculty of Biology, University "Kl. Ohridski", Bd. Dragan Tzankov 8, 1421 Sofia, Bulgaria & Central Laboratory of Helminthology, Ak. G. Bonchev str. Bl. 25, 1113 Sofia, Bulgaria.*

CHOLEVA, B., PENEVA, V. & NEDELCHEV, S.L. *Observations on* Longidorid *and* Trichodorid *nematodes in Bulgaria.*

A short review of Longidorid and Trichodorid nematodes in Bulgaria is presented. Additional data on the distribution and host plants of the established species are given. *Longidorus macrosoma. Trichodorus similis* and *T. viruliferus* are new for the country's fauna. *Laboratory of Plant Nematology, Faculty of Biology, University "Kl. Ohridski", Bd Dragan Tzankov 8, 1421 Sofia, Bulgaria, & Central Lab. Of Helminthology, Ak.G. Bonchev str., Bl. 25, 1113 Sofia, Bulgaria.*

CIANCIO, A., MANKAU, R. & MUNDO OCAMPO, M. *Dynamics and ultrastructure of a* Pasteuria penetrans *isolate naturally infecting a population of* Helicotylenchus lobus.

Host population dynamics and the level of parasitism in a population of *Helicotylenchus lobus* naturally infected with *Pasteuria penetrans* were determined at monthly intervals in turf grass soil at Riverside, California. The average of infected nematodes showed seasonal variation ranging from a 40% infection rate in July, 1988, to 67.3% in November 1988, and returning to 40% by January 1989. The average and maximum numbers of spores adhering to infected nematodes varied at monthly intervals in an oscillating pattern. Parasite spores adhered to both adult and juvenile *H. lobus* and penetrated, developed within and eventually filled the host body causing death. Mature spores were also observed within living adult and juvenile *H. lobus* individuals without any apparent reduction in their viability and motility. Spore and endospore diameters of this isolate of *P. penetrans* were larger than those reported from the type isolate described in

Meloidogyne incognita, but did not differ in their morphology when examined with transmission and scanning electron microscopy. *M. incognita* second-stage juveniles did not pick up spores when passed through air-dried soil containing the *H. lobus*-infecting parasite population. *Istituto di Nematologia Agraria, C.N.R., 70126 Bari, Italy and Department of Nematology, University of California, Riverside, CA 92521, USA.*

COHEN-NISSAN, S. & GLAZER, I. *Life cycle of the entomopathogenic nematode* Heterorhabditis bacteriophora *strain 'HP88'.*

In order to provide a basis for further genetic studies and manipulations the development of *Heterorhabditis bacteriophora* strain HP88 was studied in detail *in vitro* using dog-food-agar medium and *in vivo* in late instar of the wax moth *Galleria mellonella*. At 25°C, *in vitro* life cycle duration from egg to egg is 96 hours. According to the following scheme: Egg $\rightarrow J_1$ 10h, $J_1 \rightarrow J_2$ 4 h, $J_2 \rightarrow J_3$ 7 h, $J_3 \rightarrow J_4$ 10 h, $J_4 \rightarrow$ adult 15 h. When development is initiated from the IJ stage only hermaphrodites develop in the first generation, males appear only in the second generation (*in vitro* and *in vivo*). However, throughout several generations all the adult "females" were able to reproduce hermaphroditically. Each hermaphrodite produces 90-150 eggs of which 65-85% reach maturation (adult stage or infective juvenile). The initial rate of development *in vitro* is similar to *in vivo*, however induction for infective juvenile development occurred within a shorter period *in vivo* (*in vivo*—160 h, *in vitro*—190 h). *Department of Nematology, Agricultural Research Organization, The Volcani Center, Bet Dagan 50250, Israel.*

CONCEIÇÃO, I.L.P.M. DA, RODRIGUES, A.P.L., SANTOS, M.S.N. DE A. & ABRANTES, I.M. DE O. *Biochemical studies of Portuguese populations of potato cyst-nematodes*

A survey of potato cyst-nematodes in the principal potato growing districts of Trás-os-montes e Alto Douro, northeastern part of Portugal, was initiated in 1984. Potato cyst-nematodes were found in almost all the samples. Agarose and polyacrylamide isoelectric focusing (IEF) allowed the identification of 300 populations from those districts. In some cases, where the identification by biochemical methods was doubtful, those populations were also characterized and identified using morphological and morphometrical data of second stage juveniles and cyst terminal regions. We observed a high morphological variability between populations and within the same population. Densities of the two discriminating protein bands varied according to the composition of the population so they have been quantified by densitometry and integration. We concluded that 152 populations were pure populations of *Globodera rostochiensis*; 137 were mixed populations (*Globodera rostochiensis* + *G. pallida*) and only 11 were pure populations of *G. pallida*. These studies allowed us to plot the distribution of potato cyst-nematodes in the surveyed region (UTM grid). *Centro de Sistemática e Ecologia - INIC, Departmento de Zoologia, Universidade de Coimbra, 3049 Coimbra Codex, Portugal.*

COOSEMANS, J. & FEYAERTS, H. *Effect of thiolcarbamate herbicides on hatching of* Meloidogyne hapla *eggs and on mobility and orientation of the second stage juveniles.*

The thiolcarbamates diallate, trialate, cycloate and Eptam (as formulated products) were tested in petri dishes on water agar to analyse their influence on *Meloidogyne* hatching, mobility and orientation, Cycloate stimulated the hatching of *Meloidogyne* eggs at concentrations lower than 20 µl/l. The effect was temperature dependent as the effect was stronger at 20°C; at 14°C hatching was accelerated, but was not higher in total. Diallate and triallate at lower concentrations (e.g. 46.6 µl/l) attracted nematodes more than root diffusate of a host plant (*Calendula*) and water agar. *Laboratory of Phytopathology and Plant Protection, Katholieke Universiteit Leuven, Kardinaal Mercierlaan 92, 3030 Leuven, Belgium.*

COOK, R. & THOMAS, B.J. *Elemental composition of syncytical feeding cells induced by cyst nematodes.*

Scanning electron microscopy and X-ray analysis of frozen specimens have been used to determine the elemental composition of syncytical feeding cells induced by cyst nematodes. In red and white clover, cyst nematode (*H. trifolii*) syncytia had increased concentrations of Mg

and P, compared with morphologically unmodified cells of the root stele or cortex. In older syncytia associated with egg-filled females, the Mg and P peaks were localised in globular bodies within the syncytial cytoplasm. In wheat roots, cereal cyst nematode (*H. avenae*) syncytia had increased concentrations of P and K and, to a lesser extent S, but Mg levels remained low. Elemental compositions of some meristem cells of clover and wheat were similar to those of syncytia. These observations indicate the utility of the techniques for exploring plant-nematode interactions, and suggest that the metabilism of cyst nematode-induced syncytia reflects that of the host plant. *Institute of Grassland and Environmental Research, Welsh Plant Breeding Station, Aberystwyth, Dyfed SY23 3EB, Wales.*

CORDERO, D.A.[1]), BALDWIN, J.G.[2]), & MUNDO-OCAMPO, M.[2]) *Fine structure of the posterior cone of* Cactodera cacti.

Ultrastructure of cone development of monoxenically grown females of *C. cacti* was investigated. The cone is broad and shallow in newly molted adults. There is no appreciable growth as the female ages. In aging females the region surrounding the vulva and anus becomes sunken. The body wall cuticle is modified in the vulval fenestral region by the absence of layer C. No underbridge is formed, and vaginal musculature is reduced relative to that of other Heteroderinae. Remnants of muscle persist as denticles in the cyst. Comparisons with additional Heteroderinae will provide new insight into phylogenetic characters. [1]) *Ciencias Agropecurias, University of Panama.* [2]) *Department of Nematology, University of California, Riverside, CA 92521, USA.*

CURRAN, J. *Influence of application technique on the field efficacy of entomopathogenic nematodes to control black vine weevil larvae* (Otiorhynchus sulcatus) *on strawberries.*

The feasibility of distributing entomopathogenic nematodes through commercial trickle irrigation systems was established in trials to control black vine weevil infesting field grown strawberries grown under plastic mulch. Subsequent comparisons of different nematode application methods demonstrated that greatest weevil mortality was achieved by soil surface spraying (90% dead) and multiple soil injection (80%), lowest with single injection and trickle irrigation techniques (60%) at a dose of 100,000 *Heterorhabditis* sp. T390 per plant. Using *Steinernema* sp. NC513, a negative exponential relationship was found between Weevil mortality and initial level of insect infestation. The minimum effective dose and optimum initial distribution of entomopathogenic nematodes for weevil control are under investigation. *CSIRO Division of Entomology, P.O. Box 1700, Canberra, ACT 2601, Australia.*

CURRAN, J. *Molecular Taxonomy.*

Historically the major focus of molecular analyses has been the diagnosis of economically important species and their infrasubspecific forms. Protein, monoclonal and DNA based techniques have been successfully developed for use in diagnosis e.g. within the genera *Meloidogyne, Globodera* and *Bursaphelenchus*. Recent refinements in procedures now mean that the choice of technique is largely dependent upon the requirements of the end-user, with ease of automation and quantification being important considerations. Currently the use of molecular data in the study of phylogeny is a huge untapped resource. In the past this was in part due to technical limitations, but now there are few such barriers to data acquisition. In the future, molecular data can serve as an independent test of phylogenetic hypotheses derived from comparative morphological analysis. *CSIRO Division of Entomology, P.O. Box 1700, Canberra, ACT 2601, Australia.*

DALMASSO, A., BOUQUET, A., BONGIOVANNI, M., DANGLOT, Y. & CASTAGNONE-SERENO, P. *Resistance in* Vitis vinifera × Muscadinia rotundifolia *hybrids to* Xiphinema index *and the grape fanleaf virus.*

Sixty-five intereneric F_1 and 26 BC_1 hybrids of *V. vinifera* × *M. rotundifolia* were screened for resistance to *X. index* and virus transmission. Experiments were conducted for periods of six or twelve months in 20 l. containers under greenhouse conditions. At termination of the

experiments, numbers of *X. index* had decreased significantly on all but two F_1hybrids and on 17 of the 26 BC_1 hybrids. Numbers were about 10 to 100 times lower than those obtained on susceptible rootstocks and *V. vinifera* and similar to those on unplanted controls. Virus transmission was reduced or delayed in F_1 hybrids grown in containers or in heavily infested vineyards. BC_1 hybrids presently are being tested for resistance to fanleaf transmission. *I.N.R.A., Station de Recherches de Nématologie et de Génétique Moléculaire des Invertébrés, B.P. 2078, 06606 Antibes Cedex; Station de Recherches Viticoles, Domaine du Chapitre, B.P. 13, 34750 Villeneuve les Maguelonne, France.*

DAMADZADEH, M. & AKHYANI, A. *The reaction of potato cultivars to* Meloidogyne javanica *and* Pratylenchus neglectus *in Iran.*

The reaction of 36 potato cultivars to *M. javanica* in two successive years showed that according to Taylor's index the cultivars Frezja × PS1217, Aola, BL 105, Deraga Alpha and 5416-7-1 were placed in group 3 or higher and are moderately resistant to *M. javanica*, The yield of Deraga and Alpha cultivars were above the average of 115 g/plant in 1987 and the yield of Aola and Deraga cultivars were above the average of 304 g/plant in 1988. The reaction of 29 potato cultivars to *P. neglectus* showed that the population of nematodes around the roots and inside the roots in cultivars Diumant, Cosima, Isola, Famoza, B-71-240-2, 5416-7-1, Astarte, CGN-9-1, Alpha, Aola and Dezire was lower than the average for all cultivars. *Plant Pests and Diseases Research Department, P.O. Box 419, Esfahan, Iran.*

DAVIES, K.G., FLYNN, C.A., LAIRD, V. & KERRY, B.R. *A parasite of* Heterodera avenae *similar to* Pasteuria penetrans.

A population of *Pasteuria*, parasitic on *Heterodera avenae* and similar to *Pasteuria penetrans*, is reported. The life-cycle was restricted to *H. avenae* juveiles and prevented infected juveniles from invading plant roots. Between 1 and 5 spores were found adhering to the cuticles of second-stage juveniles extracted from soil between March and July; microcolonies of the bacterium could be seen in the juveniles as early as April. However mature spores were not observed until July. There was no evidence to suggest developing females and cysts were infected by the bacterium. Host specificity studies with spores extracted from the juveniles of *H. avenae* showed that they adhered to the cuticles of *H. glycines, H. schachtii, Globodera rostochiensis, G. pallida* and *Meloidogyne javanica. AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, AL5 2JQ, UK.*

DAVIES, K.G., ROBINSON, M.P. & PERSIDIS, A.[1]) *The characterisation of* Pasteuria penetrans *using a polyclonal antibody and its effect on spore attachment to the second-stage juvenile of* Meloidogyne incognita.

Proteins extracted from the surface of spores of *P. penetrans*, known to exhibit different levels of attachment to *Meloidogyne* spp., were run on SDS-PAGE gels. Silver staining revealed several differences between the populations. A polyclonal antibody, produced from rabbits immunised with *P. penetrans* population PP1, was shown to bind to the surface of spores of *P. penetrans* by immunofluorescence. Western-blotting of an SDS-PAGE gel of spore surface proteins with the antibody also showed differences between the populations of *P. penetrans*. A competitive ELISA showed the different populations of spores had different affinities for the antibody. In attachment assays the antibody was also found to prevent spore attachment. The results suggest that differences in proteins on the surface of spores may account for differences observed in host specificity. *AFRC Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, AL 5 2JQ;* [1]*) Department of Biochemistry, University of Cambridge, Cambridge, CB2 1QW, UK.*

DAVIS, E.L. & KAPLAN, D.T. *Internal and body wall glycoproteins from hatched juveniles of* Meloidogyne *spp.*

Five biotinylated lectins of different sugar-binding specificities were combined with an alkaline phosphatase avidin-biotin complex to probe western blots of SDS-PAGE separations of protein extracts from second-stage juveniles of *Meloidogyne incognita* races 1 and 3 (Mi1 & Mi3),

M. javanica, and *M. arenaria*. Species-specific, lectin-binding protein bands were detected in all extracts examined here. Proteins from isolated juvenile body walls extracted with SDS or cetyltrimethylammonium bromide (CTAB) demonstrated differential binding of the lectins Concanavalin A and soybean agglutinin between Mi1 and Mi3. Differential general protein patterns of CTAB body wall extracts of Mi1 and Mi3 were also observed. *USDA-ARS*, 2120 Camden Rd., Orlando, FL 32803, USA.

DAVIS, E.L. & KAPLAN, D.T. *Initial identification of phytoalexin elicitors from juveniles of* Meloidogyne *spp.*

Soybean cotyledon bioassays suggested that isolated body walls were the most potent glyceollin elicitors derived from homogenates of second-stage juveniles (J2) of *M. incognita* races 1 and 3 and *Meloidogyne javanica*. Aqueous-soluble and insoluble J2 homogenates were relatively moderate elicitors of glyceollin in some experiments. Elicitors extracted from J2 cuticles with cetyltrimethylammonium bromide (CTAB) demonstrated elicitor activity up to 13-fold greater than that of their corresponding control treatment. No specific accumulation of glyceollin with respect to race-cultivar compatibility was observed. *USDA-ARS, 2120 Camden Rd., Orlando, FL 32803, USA.*

DECRAEMER, W. & REAY, F. *The occurrence of* Trichodoridae in Australia.

So far, trichodorids in Australia are only represented by the genus *Paratrichodorus*. Most records are from crop plants, especially horticultural crops and records from bushland soils and uncommon. During a survey of plant parasitic nematodes associated with native vegetation, two new species of *Paratrichodorus* were found which closely resemble *P. grandis*. Five other species of *Paratrichodorus* are known from Australia, of which *P. minor* and *P. lobatus* are the most widespread. Details of the distribution of the Australian species of *Paratrichodorus* is presented, together with information about the new species. *Koninklijk Belgisch Instituut voor Natuurwetenschappen, Section of Recent Invertebrates, B-1040 Brussels, Belgium and The University of Adelaide, Waite Agricultural Research Institute, Department of Plant Pathology, Glen Osmond, 5084 South Australia.*

DE SILVA, P. & GOWEN, S.R. *Internal resistance in* Meloidogyne *spp. to* Pasteuria penetrans.

When juveniles from a population of *Meloidogyne* derived from a single egg mass were encumbered with a single spore of *P. penetrans* and inoculated on to roots of tomato, 27% of the nematodes that successfully invaded the roots were infected by the bacterium. Four out of 40 females with egg masses were found to contain *P. penetrans* suggesting that there may be some internal resistance to the bacterium. The incidence of infection was greater at 30°C than at 20°C and increased with increasing spore burden but some burden but some recovery from infection occurred even when the spore attachment exceeded 30 spores per juvenile. Nematodes in roots of nematode resistant tomato were more susceptible to infection than nematodes in a nematode susceptible variety. The distribution of infected and uninfected nematodes was not random in the root system. Under similar spore burdens, bacterial infection differed between two groups according to whether they had previously been developed under a *P. penetrans* spore burden or not. *Department of Agriculture, University of Reading, Earley Gate, PO Box 236, Reading, RG6 2AT, England.*

DEVIDAS, P., REHBERGER, L.A. & CROVETTI, A. J. *AARC # 0255—a nematicidal composition of microbial origin—discovery and evalution.*

In pursuance of our goal to achieve control of plant nematodes using microorganisms, various biological assays were used to screen microbial metabolites. A fermentation beer from a hyphomycete, originally isolated from nematode cadavers and coded AARC # 0255, showed extremely good activity in laboratory and greenhouse assays. Field evaluations demonstrated that AARC # 0255 can provide acceptable levels of nematode control. Isolation and purification of the activities of AARC # 0255 is in progress. More extensive examination of the practical

application of these materials under field conditions is being considered. *Abbott Laboratories, 6131 RFD, Long Grove, Illinois 60047, USA.*

DICKSON, D.W., OOSTENDORP, M. & MITCHELL, D.J. Pasteuria penetrans, *a biological control agent of nematodes.*

Of the numerous micro-organisms that are antagonists of plant-parasitic nematodes, *Pasteuria* spp. currently appear to offer the greatest potential for biological control of nematodes. The bacteria can survive without major loss of viability in dry, moist, and wet soil and in soil wetted and dried repeatedly over 6 weeks. Endospores moved downward in soil a total of 6.4 cm within 3 days with percolating water. Some isolates of *Pasteuria* appear to be highly host specific, whereas others have a wider host range. After 3 years in microplots, peanut yield increased 64% in *Meloidogyne arenaria* infested plots treated with *P. penetrans* compared with plots containing non-treated nematodes ($P \leq 0.05$). The population density of *P. penetrans* increased from 0.11 endospores attached per second-stage juvenile (J2) of *M. arenaria* in soil in first year to 8.6 endospores/J2 in the third year. In a nematode suppressive field soil, *P. penetrans* appeared to be the main agent that resulted in a reduction of *M. arenaria* root galling and egg mass production compared with autoclaved soil ($P \leq 0.05$). *Paecilomyces lilacinus, Verticillium chlamydosporium, Penicillium* sp., *Neocosmospora* sp., *Fusarium* sp. and *Aspergillus* sp. were isolated from *M arenaria* females, egg masses and individual eggs collected from the suppressive soil. These fungi also play a role in the suppressive nature of the soil. *Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611-0611, USA.*

DIEDERICH, J., FORTUNER, R. & MILTON, J. *NEMISYS, an expert workstation for nematode identification: interactive environment and principal tools.*

Within the NEMISYS International Project (NIP), 70 nematologists are assisting the authors in building the knowledge base for NEMISYS, a NEMatode Identification SYStem for certain microcomputers and workstations. NEMISYS will allow all nematologists to easily, quickly, and accurately identify any plant-parasitic nematode to the species level. The main features of NEMISYS will be presented. Currently a working prototype is being tested with tools for identification, for browsing primary and secondary characters to the genus level, for entering metadata proposed by cooperating nematologists, and for semi-automated data entry of species data from scanned electronic versions of the printed literature. The main features of each tool will be presented, and an update of the progress to date will be given. The final system will be extendible to other groups of nematodes or other organisms. *Department of Mathematics, University of California, Davis, CA 95616, USA; California Department of Food and Agriculture, Analysis & Identification, P.O. Box 942871, Sacramento, CA 94271-0001, USA.*

DOMINGUEZ, H.E. *The creation of the Honduran Nematology Association and its attempt to characterize local nematode fauna.*

Outside of the confidential work done by the banana companies, Honduras is a nation with very little knowledge of its nematode populations. Stimulated by a strong interest on the part of the Plant Protection Department of the Pan American School of Agriculture (Zamorano) a national organization was created. The association is composed of individuals from public and private institutions. Zamorano's large infrastructure, and data storing capacity allow the association to keep its records there. The goal of the association is to characterize the nematodes of six selected crops in the north and central regions of the country. A need for instruction in proper sampling techniques has prompted a workshop. A preliminary report of Zamorano nematode fauna is presented. *P.O. Box 93, Tegucigalpa, Honduras.*

DORHOUT, R.[1,2]), GOMMERS, F.J.[2]) & KOLLÖFFEL, C.[1]) *Locating proton extrusion pumps by use of the fluorescent dye uranin in pea roots infected with* Meloidogyne incognita.

Uranin, an acidic fluorescent dye with a pK of 4.9 is able to pass through cell membranes in its undissociated form. Cells having a high proton extrusion activity, resulting in a low pH

in their walls, accumulate the dye. Surface screening with a fluorescence microscope of infected pea roots showed that the root regions between the root apex and the most apical gall (1-2 cm from the root tip) accumulated uranin, whereas the gall itself and the more basal regions failed to accumulate the dye. The gall thus marked a sharp transition zone between the active and the less active root regions. Acidification of the medium resulted in dye uptake along the whole root. Decreased proton extrusion by infected tissues (galls) may have major consequences for the mobilization and uptake of minerals. [1]) *Transport Physiology Research Group, University of Utrecht, Botanical Laboratory, Lange Nieuwstraat 106, 3512 PN Utrecht, The Netherlands;* [2]) *Department of Nematology, Agricultural University, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

DUBE, B.N. *An integrated biocontrol of Meloidogyne javanica by* Paecilomyces lilacinus, Pasteuria penetrans *and an organic amendment (cattle manure).*

The combined effect of *P. lilacinus, P. penetrans* and manure on *M. javanica* was tested on two field research sites, Mazowe and Harare. At Mazowe the experiment was conducted on microplots and field plots. At Harare (PVC) microtiles were used. *P. lilacinus* on wheat bran was applied at rate of 5g/l soil (5×10^8 cfu/g),*P. penetrans* at 100mg/l soil (IC_{50} = 50mg/l soil) and manure at 1t/ha. Field bean was the nematode host. Nematode counts (Pi, Pm, Pf) were recorded at 0, 35 and 70 days after planting. Root galling, and yield were assessed after 84 days. At Mazowe microplots with either *P. lilacinus*, manure or both manure and *P. lilacinus* controlled *M. javanica* and reduced root galls. Yield from microplots with both *P. lilacinus* and manure increased by 52% compared to 32% or 17% from microplots with either *P. lilacinus* or manure, respectively. At Harare, application of either *P. penetrans* and manure or *P. lilacinus* and manure controlled *M. javanica* and improved yield by 40% and 32% respectively. Single application of either *P. lilacinus*, *P. penetrans* or manure increased yield by 14%, 13% and 8% respectively. *Department of Biological Sciences, University of Zimbabwe, P.O. Box MP167, Mount Pleasant, Harare, Zimbabwe.*

DUNCAN, L.W. & MCSORLEY, R.T. *A conservative aspect of sample size optimization.*

Nematode population levels in the field are frequently estimated from composite samples comprised of several individual cores of soil obtained from a defined area. Formulae used to estimate an optimum number (N) of multiplecore samples require an estimate of the sample standard deviation and assume from the Central Limit Theorem that population estimates from such samples are normally distributed. An optimization method that uses Student's t statistics based on preliminary sample size can result in mean estimates with specified accuracy and precision without reflecting the precision with which N is estimated. An alternative method which iteratively solves for N by using t values corresponding to N-1 degrees of freedom results in less variability of estimated N values but likewise, without a specified level of precision. Further, with the second method, as the preliminary sample size increases, the average derived N approaches 3 units greater than the actual optimum size. Implications of this relationship are greatest in management systems where N is low. *Department of Entomology and Nematology, University of Florida, IFAS, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850, USA.*

DWINELL, L.D. *Heat-treating southern pine lumber to eradicate* Bursaphelenchus xylophilus.

The pine wood nematode (PWN), *Bursaphelenchus xylophilus*, is transmitted during oviposition of pine sawyers (*Monochamus* spp.) into freshly felled logs, including logs piled in mill yards. As a result, the nematode may occasionally be present in green pine lumber. To determine the time required to kill all nematodes in a 71°C kiln, lumber (2 by 4's, 4 by 4's, and 6 by 6's) was sawn from PWN-infested logs of loblolly and shortleaf pines, then placed in the kiln for different time intervals. Wood temperatures were monitored by placing probes in the geometric centers of selected pieces of lumber. Nematodes were extracted from wood samples by the pie-tin technique. A wood temperature of 60°C was sufficient to kill all nematodes. The time required varied with the dimension of the lumber. For example, 1 hour for 2 by 4's, 2 hours for the 4 by 4's, and 4 hours for the 6 by 6's. This length of time did not appreciably change the moisture content

of the lumber. Therefore, it is not necessary to kiln-dry lumber for the sole purpose of eradicating *B. xylophilus. USDA For. Serv., Southeast. For. Expt. Sta., Athens, GA 30602, USA.*

DWINELL, L.D. *Thermal death point of* Bursaphelenchus xylophilus *in southern pine chips.*

The presence of the pine wood nematode (PWN), *Bursaphelenchus xylophilus*, in exported pine chips has caused concern in some importing countries. Heating chips to the nematode's thermal death poiint during transoceanic passage may be a viable control strategy. To determine the thermal death point, PWN-infested southern pine chips were incubated at 35°C for 3 days and then divided into 48 15g subsamples. The samples were incubated at 46, 48, and 50°C for 1 or 3 days, then incubated at 20°C for an additional 7 days. Control samples were incubated at 20°C for 8 or 10 days. Each treatment was replicated 6 times. Nematodes were extracted by the Baermann funnel method. After 1 and 3 days at 50 and 48°C, respectively, no nematodes were extracted from the chips. The control chips averaged 692 PWN/g dry wood wt. The study was repeated with essentially the same results. It would be feasible, with appropriate engineering, to use intrinsic and supplemental heat from the ship's engines to eradicate the PWN in southern pine chips by bringing their temperature to 50°C for at least 1 day during transit. *USDA For. Serv., Southeast. For. Expt. Sta., Athens, GA 30602, USA.*

EHLERS, R.U. *Environmental and biotic factors influencing the control potential of entomopathogenic nematodes of the genus* Steinernema *and* Heterorhabditis.

The characterisation of traits related to the control potential of species (strains) of entomopathogenic nematodes is the key to successful results in biological pest control with *Steinernema* and *Heterorhabditis* spp. For commercialisation of the nematodes accessibility to mass production methods and tolerance towards storage and transportion conditions are required. Aiming for high mortality of noxious insects the genotype of the nematode-bacteria complex and of the insect are opposed to each other within the limits of environmental conditions and nematode quality. Environmental factors influencing nematode activity and host finding capacity are emphasized. The impact of production and storage conditions on the quality of the nematode-bacteria complex and biotic factors influencing the virulence of the host-antagonist relation are discussed. *Institut für Phytopathologie, Universität Kiel, Germany.*

EHLERS, R.-U. & GERWIEN, A. *Evaluation of* Steinernema *spp. for the biological control of crane fly larvae* Tipula paludosa (*Diptera: Nematocera*).

A laboratory bioassay was used to select virulent nematode strains: *Steinernema feltiae* (strain OBS III) killed 65% of the L2 larvae, *S. affinis* (D1) 4.2%, *Heterorhabditis* sp. (NZ) 10% and *S. anomali* 81%. Further tests over the growing period with strain OBS III gave results varying between 13% and 90% mortality. Higher nematode density did not increase their efficiency. Melanization of dauer larvae was observed in the haemocoel of dead and living insects. A field trial with 0.5 and 1 M. *S. feltiae*/m^2 led to a significant reduction (53%) of the population density of *T. paludosa* larvae only at the higher nematode density (control 27%). *Institut für Phytopathologie, Christian-Albrechts-Universität, 2300 Kiel, Germany.*

EHLERS, R.-U.[1]), SMITS, P.H.[3]), KRAUSE, U.[2]) & STACKEBRANDT, E.[2]) *Identification of* Heterorhabditis spp. *by morphometric characters and RELP and of their symbiotic bacteria* Xenorhabdus luminescens *by species-specific DNA probes.*

A comparison of highly repetitive DNA fragments of *Heterorhabditis* spp. and undescribed strains revealed four genotypic groups: 1. *H. bacteriophora*, 2. *H. heliothidis*, 3. North-West european and 4. Irish group. The North-West European isolates can be separated from described *Heterorhabditis* spp. by the tail length and the total length of the dauer juveniles. *Xenorhabdus* symbionts of the third group can be distinguished from other *X. luminescens* by specific sequences of the 16S rNA, which were used for the synthesis of a complementary DNA probe. [1]) *Institut für Phytopathologie and* [2]) *Institut für allgemeine Mikrobiologie, Christian-Albrechts-Universität, 2300 Kiel, Germany;* [3]) *Research Institute for Plant Protection, P.O. Box 9060, 6700 GW Wageningen, The Netherlands.*

EISENBACK, J.D., & MCGAWLEY, E.C. *Teaching identification of the most common genera of plant-parasitic nematodes by video cassette recording.*

Video cassette recordings of the most common genera of plant-parasitic nematodes are useful for teaching beginning students to identify these organisms. Recordings made at low power (25-40 ×) with a dissecting microscope illustrate the overall shape of the nematode body and general morphological features, as well as the type of movement that is typical for the genus in the counting dish. Recordings made at higher magnifications (400-1575 ×) with a compound light microscope show details about the morphology of each genus which are useful for understanding the features seen with the dissecting microscope. The recordings initially eliminate the need for fresh specimens, allow the student to preview the material to be studied, and provide an image for simultaneous observations by teacher and student(s). *Department of Plant Pathology, Physiology, and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, and Department of Plant Pathology and Crop Physiology, Louisiana State University, Baton Rouge, Louisiana 70803, USA.*

EISENBACK, J.D. *The classroom of the future: Computer-assisted instruction for teaching nematology.*

Progress in science is closely associated with the ability to visualize phenomena. Likewise, learning is enhanced with the increased capacity to represent ideas pictorially. The computer is a powerful tool for visualization and, therefore, has great potential in teaching plant nematology. Hypermedia-based teaching integrates text, graphics, sound, animation, color, randomly accessible video segments, and manual interaction. The variety of sensory stimuli allows the development of a novel method of instruction in which the student can interactively peruse a very large assemblage of electonically linked information. Hypermedia-based authoring programs allow users with little or no previous experience in traditional programming languages to integrate various media into educational applications. *Department of Plant Pathology, Physiology, and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, USA.*

ESCUER, M., ARIAS, M. & BELLO, A. *Proposal of a neotype for* Macroposthonia annulata *De Man, 1880.*

The validity of *Macroposthonia annulata* de Man, 1880 is important in the taxonomy of the subfamily *Macroposthoninae* as it is the type species of the genus. The main problem in its validity is due to the lack of a type described by De Man. During several surveys between 1986 and 1988 a population with males, females and juveniles was found in a swampy soil with grasses close to the Viella tunnel (Lérida). A morphological and morphometrical study of population was done and 30 males were studied by optical microscopy and SEM.

Morphological characteristics are in agreement with De Man's (1880/84) description, but the labial region shape differs from the original drawings. Morphometry fits with the De Man measurements, except for male body annules, 163-175 *versus* 148 on the dorsal side of De Man's illustration. Nematodes from Lérida are considered to belong to *M. annulata* as the observed differences based on the drawings of 1884, are not significant. Thus, the male neotype and female of *M. annulata* are described and *Macroposthonia* is considered a valid genus. *Instituto de Edafolgía y Biología Vegetal. CSIC, Serrano, 115 dpdo, 28006 Madrid, Spain.*

ESMENJAUD, D., SCOTTO LA MASSESE, C., MINOT, J.C. & VOISIN, R. *Sources of resistance in the genus* Prunus *to* Meloidogyne arenaria.

In France, more than 300 clones of 14 species of *Prunus* were tested to find new resistance sources to *Meloidogyne arenaria*. Resistant clones were found in all species. Host suitability of *P. cerasifera* clones were highly variable ranging from resistant (non-host) to highly susceptible. Intraspecific hybrids of this self incompatible species were tested to determine the inheritance of resistance. Results suggest that the non-host character is under the control of at least one major dominant gene. *Station de Nématologie, Institut National de la Recherche Agronomique, 123 Bd Francis Meilland, Antibes, France.*

EVANS, K. & WEBB, R.M. *Field trials with cyst nematodes and laboratory studies with* Pratylenchus *spp. on oilseed rape.*

In the UK two species of cyst nematodes (*Heterodera cruciferae* and *H. schachtii*) are able to attack oilseed rape, although only *H. cruciferae* has been shown to cause substantial damage. Field trials with nematicides have quantified the damage and shown that chemical control is effective, if uneconomic. A survey of rape crops showed few to be infected by cyst nematodes but many by *Pratylenchus* spp. The effects of six *Pratylenchus* species on three rape cultivars (one single low, two double lows) have been investigated in sterile conditions. *Department of Entomology and Nematology, IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, UK.*

FARGETTE, M.[1]), TRUDGILL, D.L.[1]), DAVIES, K.[2]) & ROBINSON, M.[2]). *Studies on resistance breaking populations morphologically indistinguishable from* Meloidogyne incognita.

Six populations of *Meloidogyne* able to overcome resistance in several crops to *M. incognita* were studied. Morphology, morphometrics, chromosome behaviour during the prophase of mitotic parthenogenesis and labelling of amphidial exudates with different lectins were as in *M. incognita*. Monoclonal antibodies raised to *M. incognita* indicated these populations were related to *M. incognita*, but also demonstrated some differences. Similarly, although some isozyme phenotypes were as in *M. incognita* others were different. In addition, strains of *Pasteuria penetrans* specific in their parasitism differentially recognised poulations even within the resistance breaking group. [1]) *ORSTOM and Zoology Department, Scottish Crop Research Institute, Dundee:* [2]) *Rothamsted Experimental Station, Harpenden, Herts, both UK.*

FEIL, J.J.[1,2]) PERRY, R.N.[1]) & ATKINSON, H.J.[2]) *Feeding and the accumulation of* Ditylenchus dipsaci.

The variation in dorsal oesophageal gland activity of *Ditylenchus dipsaci* was studied as part of an examination of the factors involved in the accumulation of fourth stage juveniles (J4) in senescing tissue. The proportion of J4 in the total population increases towards the centre of stem lesions and those from the necrotic tissue in the centre had significantly smaller dorsal oesophageal gland cell nucleoli than J4 from the periphery. Assays of cellulase activity demonstrated that J4 from the periphery of lesions contained significantly more cellulase than those from the centre. J4 stimulated by exogenous serotonin contained significantly more cellulase than unstimulated nematodes; serotinin stimulated median bulb pumping and stylet thrusting and a concomitant increase in size of the ampulla of the dorsal oesophageal gland duct was also observed. The results are discussed in relation to the feeding of *D. dipsaci* and the accumulation of J4. [1]) *Department of Entomology and Nematology, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, England* and [2]) *Department of Pure and Applied Biology, University of Leeds, England.*

FERRIS, H.[1]), CARLSON, H.L.[2]), VIGLIERCHIO, D.R.[1]), & WESTERDAHL, B.B.[1]) Meloidogyne chitwoodi - *alternate crops for the potato cropping system.*

The Columbia rootknot nematode is a pest of potatoes in the Klamath Basin of California and Oregon. Tuber blemishes, caused by the second and third generation of the nematode in a growing season, reduce crop values. A short growing season and remote location diminish the choice of profitable rotation crops. Several cultivars of oilseed radish, amaranth, safflower, and barley were poor to non-hosts in greenhouse trials. Those adapted to the region were grown in a 1-year rotation with potato in two field trials. The *M. chitwoodi* population declined under safflower, Briggs barley, white lupin, oilseed radish, and rotations involving a summer fallow. The crops varied in their host status to *Pratylenchus neglectus*, another parasite in the system. Industry acceptance of these alternate crops will be explored. [1]) *Department of Nematology, University of California, Davis, CA 95616, USA.* [2]) *University of California Cooperative Extension, Tulelake, CA 96134, USA.*

FERRIS, V.R. & FERRIS, J.M. *Integration of classical and molecular approaches in systematics.*

Data from proteins, DNA and RNA can all be used in conjunction with morphological data for identification, classification and phylogenetic analysis of nematodes. Molecular approaches may prove especially useful for sorting out relationships in those taxa for which morphological data have always presented difficulties. Molecular data have their own problems of interpretation, which will be worked out over time, and this will occupy nematode systematists of the future. Molecular and classical data are both necessary for understanding and they provide different kinds of information about evolution. It is likely that molecular data will enhance our understanding of phylogenetic relationships and will help us produce classifications that will endure. *Department of Entomology, Purdue University, West Lafayette, Indiana, 47907 USA.*

FORGE, T.A. & MACGUIDWIN, A.E. *Effects of soil-water potential and acclimation to low temperature on survival of* Meloidogyne hapla *second-stage juveniles in frozen soil.*

Juveniles were exposed to water potentials ranging from 0 to -3.4 MPa in polyethylene glycol (PEG) and soil and then frozen at -4°C (PEG and soil), -6°C (PEG), or -8°C (PEG). Freezing tolerance (the percentage of juveniles that survived freezing) was increased by prefreeze exposure to low water potentials in both media. At all water potentials tested, freezing tolerance was also increased by prefreeze exposure to non-lethal low temperatures. For juveniles exposed to 4°C, maximal freezing tolerance was attained within ca. 12 hours. Exposure to fluctuating temperatures (12 hr at 4°C/12 hr at 24°C) and long-term exposrure to 4°C did not affect the level of freezing tolerance attained, but decreased the amount of freezing tolerance lost during subsequent warming to 24°C. *Department of Plant Pathology, University of Wisconsin, Madison, WI 53706, USA.*

FORTNUM, B.A., DECOTEAU, D.R. & KASPERBAUER, M.J. *Mulch color affects yield of fresh market tomatoes infected with root-knot nematodes.*

Colored mulches alter the light micro-environment affecting plant growth and development. Light quality has been shown to alter the development of *Meloidogyne incognita*. The effect of upwardly reflected light on tomato yields and the development of root-knot was studied. Fruit Yields were recorded from tomato plants inoculated with *Meloidogyne incognita* at initial populations (Pi) of 0, 10, 50, 100, or 200 (× 1000) eggs per plant, and grown with four colors of plastic mulch in the spring and fall. Tomatoes grown with white mulch had greater yields ($P = 0.05$) in the spring (42%) and fall (36%) than similarly grown plants with black mulch. Tomato yields decreased as Pi increased. The effects of colored mulches on plant growth were more pronounced in the spring than in the fall. Plants grown with red mulch in the spring had the greatest early marketable yields and the greatest number of fruits ($P = 0.05$). Tomato plants inoculated with 200 (× 1000) eggs and grown with white mulch or red mulch yielded (102, and 111% respectively) more than similarly grown plants with black mulch (7.4 kg and 7.7 kg vs. 3.6 kg/plot, respectively). *Department of Plant Pathology, Clemson University, and USDA-ARS, Box 271, Florence, SC 29503, USA.*

FORTUNER, R. *Computer identification: easy, fast, and accurate.*

There is a growing need among nematologists for new accurate and efficient tools for nematode identification, down to the species level. Traditional identification aids (keys) suffer severe limitations and they should be used only by nematologists already familiar with the species to be identified. Molecular genetics can be useful, but the enormous amount of time, personnel, and money necessary for the development of species specific probes limits the practical applications of such methods to a few economically significant species. It is shown how computer identification, using artificial intelligence and other modern computing techniques, can allow all nematologists to easily, quickly, and accurately identify any plant-parasitic nematode to the species level. *California Department of Food and Agriculture, Analysis & Identification, P.O. Box 942871, Sacramento, CA 94271-0001, USA.*

FRANCO, J., MONTECINOS, R. & ORTUÑO, N. *Management strategies of* Nacobbus aberrans.

N. aberrans is widely distributed in the potato growing areas of Bolivia (2000-3800 m.a.s.l.). The host range covers several traditional Andean crops and common weeds which facilitate its establishment, survival, and multiplication. Depending upon nematode population density, potato cultivar and environmental conditions, yield losses can reach 60%. The use of nematode infested seed-tubers aids in dissemination. As no practical and efficent control practices exist for farmers a program on integrated nematode management has been initiated by the Bolivian Institute of Agriculture (IBTA) and the International Potato Center (CIP). Different control tactics (i.e. biological, genetic, chemical and cultural) have been investigated in an integrated strategy to reduce risks of dissemination and field losses, as a result of high nematode population densities. *Nematology Department, Potato Research Program (PROINPA), Casilla 4285, Cochabamba, Bolivia.*

FRECKMAN, D,W[1])., VIRGINIA, R.A.[2]) & FRECKMAN, J.T.[2]) *Nematode community structure in soil ecosystems lacking higher plants: Antarctica.*

The abundance and community structure of soil nematodes in hot deserts of the southwestern USA is closely correlated with plants and soil organic matter. To separate the influences of plants from soil properties on nematodes, soil nematodes were examined in three Antarctic Dry Valleys, desert systems lacking higher plants. No nematodes were extracted from approximately 25% of the samples. Samples were analyzed for nematode density, biomass, trophic structure, microbial numbers and soil physical and chemical characteristics to examine factors potentially controlling nematode distribution and function in the dry valleys. [1]) *Department of Nematology, University of California, Riverside CA 92521;* [2]) *Systems Ecology Research Group, San Diego State University, San Diego, CA 92182, USA.*

FUTAI, K. *Pathogenicity of* Bursaphelenchus xylophilus *and leakage of tannin from infected pine tissues.*

The seedlings of Japanese black pine, *Pine thunbergii*, inoculated with a pathogenic isolate of *B. xylophilus* contained more distilled water-extractable tannin than did non-pathogenic isolate-inoculated and *B. mucronatus*-inoculated seedlings. No difference was found in amounts of methanol-extractable tannin regardless of isolate inoculated. Because distilled water-extractable tannin represents the leaked tannin, the pathogenic isolate seemed to cause much more leakage of tannin than did the non-pathogenic isolate. Cytochemical observation supported this hypothesis. *Laboratory of Applied Botany, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan.*

GAUGLER, R., CAMPBELL, J., & GUPTA, A.P. *The basis for enhanced host-finding in a selected strain of entomopathogenic nematode.*

Despite the generalist nature of entomopathogenic nematodes, selective breeding for host-finding which enhanced ability to locate waxworm larvae, did not extend to all insects. Host-finding ranged from 5% in cockroaches to 55% in crickets. These differences were shown to be significantly correlated with host carbon dioxide production. Nematodes did not respond to any host when $CO_2$was removed from the assay system. These results suggest CO_2 is an important cue for host-finding and is the basis for enhanced chemosensitivity in our genetically improved strains. *Department of Entomology, Rutgers University, New Brunswick, NJ 08903, USA.*

GAUR, H.S.[1]) & PERRY, R.N.[2]) *The role of the moulted cuticles in the survival of* Rotylenchulus reniformis.

R. reniformis retains the moulted cuticles of the juvenile stages until the adult finally sheds the cuticles to become parasitic. The moulted cuticles have an important role in the survival of this species in dry soil. Under experimental conditions, the ensheathed adults are able to control their rate of water loss at 0, 60 and 80% relative humidities for significantly longer periods than exsheathed adults. Successful shedding of the juvenile cuticles appears to be aided by frictional

forces achieved by movement of the active nematode against soil particles. When movement is inhibited, as in very dry soils, the adults are unable to shed these cuticles; they become quiescent and are able to control their rate of water loss and thus survive desiccation. [1]) *Division of Nematology, Indian Agricultural Research Inst., New Delhi 110 021, India and* [2]) *Entomology & Nematology Department, AFRC IACR, Rothamsted Exptl. Stn., Harpenden, Herts., AL5 2JQ, England.*

GEORGIS, R., & MANWEILER, S.A. *Recent development in commercialization of steinernematid entomopathogenic nematodes in the United States.*

Progress in mass rearing through liquid fermentation has enabled the nematodes to become economically used in certain market segments. Substantial improvement in formulation stability and shelf life has been developed by immobilizing or partially desiccating large numbers of nematodes on specific moist carriers such as polyacrylamid and alginate gels. Efforts made to narrow the efficacy gap between chemical pesticides and nematodes have been successful in various agrosystems due largely to adopting a quality control procedure, selecting a suitable target environment and target insects for nematodes and identifying an effective strain and dosage. *Biosys, 1057 East Meadow Circle, Palo Alto, California 94303, USA.*

GERAERT, E. *The structure of the intestine in the tylenchs.*

Elements in the structure of the intestine can be used to evaluate taxonomic differences in tylenchs. These elements are: arrangement of cells, number of cells, number of nuclei, presence/absence of cell walls, presence/absence of microvilli, presence/absence of fasciculi. The absence of well developed microvilli in *Heterodera, Globodera* and *Meloidogyne* indicates that the intestine of these parasites does not produce enzymes, it acts only as a storage organ. *Instituut voor Dierkunde, Rijksuniversiteit Gent, Ledeganckstraat 35, 9000 Gent, Belgium.*

GLAZER, I. *Measures for evaluation of entomopathogenic nematode infectivity to insects.*

There is increasing interest in the practical and commercial uses of the entomopathogenic nematodes from the families Steinernematidae and Heterorhabditidae as biological control agents. Recently many new populations of those species have been found worldwide and pathogenicity studies have shown considerable variation in virulence between different nematode isolates. Furthermore, host susceptibility differs among various insect species. At present the differences in nematode virulence are determined by a variety of assays. Commonly, the pathogenicity tests are based on exposing the target pest to infective juveniles of specific nematode strains on moist filter paper in a petri dish. In other cases the nematodes are forced to pass a physical barrier, such as a sand column, before encountering the target host. In those tests mortality level at a given time is used as the sole criterion. Infectivity is usually expressed in values of LT_{50} or LD_{50}, similar to tests with chemical pesticides, avoiding the complexity of the factors influencing the rate of mortality. There is a need for development of a standard pathogenicity bioassay which will provide a common basis for comparisons of the various nematode isolates. A better understanding of the pathogenic syndrome involved in the nematode-bacteria-host interaction is essential in order to formulate such an assay. Possible approaches for developing new evaluation measures to determine nematode infectivity will be discussed. *Department of Nematology, Agricultural Research Organization, The Volcani Center, Bet Dagan 50250, Israel.*

GLAZER, I.[1]), GAUGLER, R.[2]) & SEGAL, D.[3]) *Genotypic variation of heat, desiccation or ultraviolet tolerance and host-finding ability among a population of* Heterorhabditis bacteriophora *strain 'HP88'.*

The genotypic variation of *H. bacteriophora* strain 'HP88' for heat, desiccation or ultraviolet tolerance and host-finding ability was assessed by comparing the performance of inbred lines of this nematode in laboratory assays. Each line consisted of highly homozygous offspring (>95%) which originated from one individual obtained from a natural population. Considerable variation was detected among the different inbred lines for all four traits. The values of h^2 (= heritability) for heat or ultraviolet tolerance and for host-finding ability were high

($h^2 > 0.50$), indicating that selection should be an efficient way for improving these traits in the population. As for desiccation tolerance, the results varied considerably within each line and heritability value was low ($h^2 < 0.12$), indicating that the results were influenced mainly by environmental variation. [1]) *Department of Nematology, Agricultural Research Organization, The Volcani Center, Bet Dagan 50250, Israel;* [2]) *Department of Entomology, Rutgers University, New Brunswick, New Jersey 08903, USA.;* [3]) *Department of Microbiology, Tel Aviv University, Tel Aviv 69978, Israel.*

GLAZER, I.,[1]) NAVON, A.[2]) & KLEIN, M.[2]) *Use of entomopathogenic nematodes against foliage insect pests.*

Nematode persistence and efficacy against various foliage pests was determined under laboratory and glasshouse conditions. A comparative bioassay for survival of steinernematids and heterorhabditis under glasshouse conditions (50-70% RH, 25°C, natural illumination 14:10 L:D) had indicated that *Steinernema carpocapsae* 'Mexican' and 'Pye' strains had a greater ability to withstand the experimental conditions that the *S. carpocapsae* 'All' strain or *Heterorhabditis bacteriophora* 'HP88' strain. Nematode viability at low RH (50-70%) was enhanced when mixed with chemicals having antievaporation activity such as liquid wax (18% v/v), folicote (6% v/v) or 'Biosys 226' (20% v/v). Application of *S. carpocapsae* 'Mexican' and 'Pye' strains in water suspension mixed with those antidesiccants resulted in 80-95% control of the foliage pests *Heliothis armigera, Spodoptera littoralis* and *Earias insulana* (Lepidoptera: Noctuidae) in glasshouse microplots, simulating field conditions. [1]) *Department of Nematology,* [2]) *Department of Entomology, Agricultural Research Organization, The Volcani Center, Bet Dagan 50250, Israel.*

GOEDE, R.G.M. & KAMERMAN, J.W. *The nematode fauna in a primary forest succession of* Pinus sylvestris.

A field investigation was conducted in the Leuvenum Forest and Hulshorster Sand nature reserves (in the Central Netherlands) to study the relation between nematode fauna and different vegetation stages. The area covered a primary successional sere running from bare sand to a 130-year-old Scots pine forest in a drift landscape. Clear changes in composition of the nematode fauna of the different vegetation stages were observed. Multivariate analysis showed largest difference between the bare sand, the herb and the forest stages. The miscellaneous feeders dominated the early succession. The herb stages and early forest stages were dominated by bacterial feeding nematodes. In the first forest stage (approx. 45 years old) fungal feeding nematodes reached their optimal abundance, whereas in the 130-year-old pine forest plant feeding nematodes dominated. *Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

GOEDE, R.G.M. & DEKKER, H. *Effects of liming and fertilization on the nematode fauna of a Scots pine forst.*

Due to high deposition of nitrogenous compounds sub-optimal nutritional conditions exist for growth of Scots pine. Application of several cations, lime and organic manure are carried out to improve tree growth and vitality. The effects of applications of lime (3 and 9 ton $CaCO_3$ per ha), magnesium (166 kg MgO per ha), potassium (120 kg K_2SO_4 per ha) and duck manure on the nematode fauna were studied three and four years after the onset of the experiment. Significant changes in the composition of the nematode fauna were observed only in those treatments which resulted in an increased soil pH. Liming resulted in an increase of the bacterial feeding taxa *Acrobeloides, Monhystera* and Rhabditidae for both litter and mineral layer, whereas *Wilsonema* decreased after liming. *Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

GONZALEZ, J.A.[1]), RODRIGUEZ, C.M.[2]) & PHILLIPS, M.S.[1]) *Epidemiological aspects of potato-cyst nematodes* (Globodera *spp*) *in the Canary Islands.*

Potatoes were introduced into the Canary Islands as early as the second half of the sixteenth century and with continued trading links with South America it is likely that there could have

been a number of introductions of potato cyst-nematodes (*Globodera* spp.; PCN). This, together with the topography of the Islands which provides a number of ecological barriers against the spread of the pathogen, makes the Canary Islands an interesting area in which to study epidemiological aspects of cyst nematodes in a discrete ecosystem. Comparative morphometric and PAGE-IEF of protein analysis have been applied to thirty-five Canarian populations, Differences between populations in the mean of morphometric values as well as in their variances were found. These and other differences will be discussed in relation to population grouping and origin. [1] *Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, UK.;* [2] *Department of Edafology, University of La Laguna, Tenerife, Spain.*

GRANDISON, G.S. *Nematode virus vectors of New Zealand.*

The virus vector nematode genera *Xiphinema, Longidorus, Trichodorus* and *Paratrichodorus* are present in New Zealand. Their distribution and host range relations will be discussed. In crops, *X. diversicaudatum, L. elongatus, P. minor* and *P. porosus* are the most commonly occuring species. *X. index* has not been found even though grape fan leaf virus is present. *DSIR Plant Protection, Auckland, New Zealand.*

GRANDISON, G.S. *Rye grass* Lolium perenne *decline caused by* Ditylenchus dipsaci *in New Zealand.*

Extensive areas of pasture on the east coast of the North Island of New Zealand have lost the rye grass component due to stem nematode parasitism. This loss is of serious economic concern. Data on chemical and cultural control methods are presented. Screening and selection of agronomically suitable tolerant rye grass cultivars is being investigated. *D.S.I.R. Plant Protection, Private Bag, Auckland, New Zealand.*

GREEFF, M.S., HEYNS, J. & VAN RENSBURG, P.A.J. *Analysis and interpretation of leaf spectral responses to nematode and moisture stress.*

Spectral measurements were taken to assess the effects of nematode and moisture stress on reflectance, transmittance and obsorptance properties of upper and lower leaf surfaces of cotton, tobacco and maize. Various analytical approaches were used to identify wavelength intervals at which responses to the two stresses might be differentiated. The data indicate the possibility of separating the two stresses within the 0.502-0.708 μm (reflectance), 0.392-0.500 μm (transmittance) and 0.752-0.890 μm (absorptance) wavelength regions. *Tobacco and Cotton Research Institute, P/Bag X82075, Rustenburg 0300, Republic of South Africa; Departments of Zoology and Geography, respectively, Rand Afrikaans University P.O. Box 525, Johannesburg 2000, Republic of South Africa.*

GREEN, F.M., DUBE, A.J., & FISHER, J.M. *New sources of resistance and tolerance in wheat to cereal cyst nematode* (Heterodera avenae *and a study on the genetics of resistance.*

There is only one known gene for resistance to cereal cyst nematode (CCN) in wheat in Australia in the line AUS10894 from Afghanistan. From 1985 to 1987 approximately 2000 lines of wheat, mainly from the mediterranean region, were screened for resistance and tolerance for CCN. Seven per cent were very tolerant and seven lines were highly resistant. These lines have been hybridized and genetic analysis is underway to determine if these lines have different resistance genes from AUS10894 and each other. Even if only one line has a different resistance gene it would help overcome the paucity of resistance for this major disease. Crossing was undertaken with the two CCN resistant sources being used in Australian wheat breeding programmes (AUS10894 and Festiguay) to determine the mode of inheritance of their resistance and if they have the same genes for resistance. Parental, F1, F2, F3 and backcross generations were tested for resistance. From the results so far it appears that both AUS10894 and Festiguay have a single dominant gene for CCN resistance and these genes may be different. *Department of Plant Pathology, Waite Agricultural Research Institute, University of Adelaide, PMB 1, Glen Osmond, South Australia, 5064, Australia.*

GREWAL, P.S. *The nature of bacterial attractants affecting migration of* Caenorhabditis elegans.

The migration of *Caenorhabditis elegans* towards bacterial lawns was studied on agar in quadrant plates. All thirteen species of bacteria modified the normal random migration of the nematode to a more precise and directed response. The degree of alteration in nematode migration varied with the bacterial species: *Acinetobacter calco.antitratus, Enterobacter amnigenus, E. cloacae, Pseudomonas maltophilia* and *Serratia liquefaciens* elicited a significantly more vigorous and rapid response when compared with any other bacterium. *Bacillus* spp. (*B. cereus, B. thuringiensis* and *Bacillus* sp.) affected nematode migration least and attracted fewest nematodes. Young bacterial lawns (24h-48h post-inoculation) were more attractive than old ones (96h-192h post-inoculation). Bacterial lawns exposed to choloroform *in-situ* remained attractive. The relative importance of both diffusible and/or volatile attractants was studied. Chemical characterisation of the attractants is in progress. *Entomology and Insect Pathology Section, AFRC Institute Institute of Horticultural Research, Littlehampton, W. Sussex, BN17 6LP UK.*

GREWAL, P. S. & RICHARDSON, P. N. *Role of bacteria in the pathogenicity of* Caenorhabditis elegans *to the mushroom* Agaricus bisporus.

In-vitro laboratory tests of nine species of bacteria associated with a saprobic rhabditid nematode (*Caenorhabditis elegans*) infesting mushrooms (*Agaricus bisporus*) showed that some bacteria enhanced nematode reproduction and that others inhibited it. As some bacteria were shown to inhibit mycelial growth the effects of *Acinetobacter calco.antitratus, Enterobacter cloacae* and *Serratia liquefaciens*, either alone, or in combination with *C. elegans*, on the flushing patterns, quality and yield of *A. bisporus* were studied. Bacteria alone did not affect mushroom production whereas *C. elegans* resulted in more regular occurrence of sporophores. Inoculation with bacteria resulted in a browning of mushrooms that was even more pronounced in *C. elegans* treatments. Characteristic distortion of sporophores was observed only in the presence of *C. elegans*. Significant yield loss occurred; up to 10.8% when bacteria were inoculated, up to 27.6% when *C. elegans* was inoculated, and up to 33.3% with both bacteria and nematodes. It is concluded that bacteria contribute to yield loss and quality deterioration in *A. bisporus* but that *C. elegans* is the most important causal agent. *Entomology and Insect Pathology Section, AFRC Institute of Horticultural Research, Littlehampton, W. Sussex, BN17 6LP U.K.*

HAAN, J. DE, THIJSSEN, L. & WOUDE, G. VAN DER *Impact of fungi and initial population densities on the multiplication of the potato cyst nematode* Globodera pallida *in greenhouse experiments.*

The efficacy of fungi controlling the potato cyst nematode *Globodera pallida* may depend on the population density of this nematode. As known, the population density itself has an effect on the multiplication rate of *G. pallida*. Two greenhouse experiments were conducted to determine the effect of the fungi *Cylindrocarpon destructans, Fusarium oxysporum* and *Plectosphaerella cucumerina* on the multiplication of *G. pallida* at various initial population densisties. Differences between treatments were only observed at the lowest initial population density used. The results obtained indicate that effects of fungi on the multiplication of *G. pallida* can only be measured at low initial population densities, because the decreasing effect of fungi may be present at higher initial population densities, but he overwhelmed by the effect of the initial population density. *H. L. Hilbrands Laboratory for Soilborne Diseases, P.O. Box 323, 9400 AH Assen, The Netherlands.*

HACKENBERG, C. & SIKORA, R. A. *Influence of abiotic and biotic factors on the interrelationship between plant health promoting rhizobacteria and* Globodera pallida *on potato.*

Rhizobacteria applied as a tuber drench reduced *G. pallida* penetration in potato roots. When applied alone the rhizobacteria did not influence plant growth after 20 days and therefore are not considered plant growth promoting. The PHPR, *Agrobacterium radiobacter* (G12), *Bacillus sphaericus* (B43) and *Pseudomonas fluorescens* (F64), significantly reduced penetration 21%, 22% and 30% ($p = 0.05$) after 20 days in unsterilized soil in pot experiments. Variation in biological control was thought to be influenced by environmental factors. In soil with a high moisture con-

tent, G12 caused a 36% ($p = 0.05$) reduction in penetration versus 30% at low moisture levels. The destabilizing affect of biotic factors on efficacy is unknown. The tubers were, therefore, surface sterilized to reduce competition with other rhizobacteria and to increase colonization of the PHPR isolates. Submergence of the tubers in a 1% NaOCl solution for 1 min proved optimum. *Institut für Pflanzenkrankheiten, Universität Bonn, Nussallee 9, 5300 Bonn, Germany.*

HALBRENDT, J. M. & BROWN, D. J. F. *Virus-vector research with the* Xiphinema americanum-*group in North America.*

During the 1960s and 70s *Xiphinema americanum* was identified as the vector of cherry rasp leaf, peach rosette mosaic, tobacco ringspot and tomato ringspot nepoviruses. The publication in 1979 of a taxonomic reappraisal of the *X. americanum*-group, and erection of several new species, resulted in uncertainty about the associations between the viruses and their specific vectors. This has resulted in speculation that seven nominal species may act as virus vectors. Information is presented which indicates that intra- and inter-population/species variability exists in the biology of this group and in their ability to transmit nepoviruses. Uncertainty also exists about the identity of *X. americanum*-group species and their association with nepoviruses in Europe and Asia. *Department of Plant Pathology, The Pennsylvania State University, P.O. Box 309, Biglerville, PA 17307; Zoology Department, Scottish Crop Research Institute, Invergowrie, Dundee, Scotland DD2 5DA.*

HALBRENDT, J. M., SHAFFER, R., & BROWN, D. J. F. *Evidence that some North American populations of* Xiphinema americanum (sensu lato) *have only three juvenile stages.*

Field populations of *Xiphinema californicum, X. rivesi,* and *X. americanum* (sensu stricto) were randomly selected for measurement of stylet, odontophore, odontostyle, and replacement odontostyle lengths. Data were plotted by stylet length without any attempt to establish the developmental stage of individuals. Scattergraphs naturally separated individuals into three juvenile stages and adult females on the basis of stylet, odontostyle, and replacement odontostyle lengths. Odontophore lengths showed a corresponding increase but did not separate individuals into distinct stage related groupings. These findings support observations of Alkemade, J. R. M. and Loof, P. A. A. (1989), that some species of the *X. americanum* group have only three juvenile stages. *Dept. Plant Pathology, The Pennsylvania State University, P.O. Box 309, Biglerville, PA 17307, USA.*

HANDOO, Z. A., ANAND, S. C., WRATHER, J. A., & HALBRENDT, J. M. *Effect of inbreeding in* Heterodera glycines *for pathogenicity on soybeans.*

Heterodera glycines inbreds were developed from a wild population by single male: female matings. After several increases, each population was examined for developmental pattern on four soybean race differentials, Peking, Pickett 71, PI 88788 and PI 90763 along with the susceptible Lee 74. Soybean seedlings (emerging roots) were exposed to a *H. glycines* population for 16 h and transferred to hydroponics. Adult males were counted as they left the roots. After 20 days, immature juveniles (J_2, J_3, J_4) and mature females were recorded from stained roots. All three *H. glycines* populations infected the susceptible variety Lee 74 equally, whereas, the infection on PI 90763 varied considerably. The number of males and females were approximately the same in Lee 74 for all populations. However, in one of the three populations, the proportion of males in Peking was much higher than females. Very few immature juveniles were observed in Lee 74 and Peking, but a large number of J_3 and J_4 were found in PI 90763. The variation in the developmental pattern among the three *H. glycines* populations indicated that inbreeding resulted in segregation for pathogenicity in the wild (heterogeneous) population. *Plant Science Unit, University of Missouri, Delta Center, Portageville, MO 63873. USA.*

HANDOO, Z. A., & ANAND, S. C. *Mode of resistance to* Heterodera glycines *in soybean plant introduction 437654.*

Soybean plant introduction (PI) 437654 is resistant to all known races of *Heterodera glycines* in U.S. The resistance in PI 437654 and another derived variety, S88-2036, were studied from

observations of the developmental stages of the nematode in the plant and compared with susceptible Essex. Soybean seedlings (emerging roots) were exposed to a wild population of *H. glycines* for 16 h and transferred to hydroponics. After 20 days, immature juveniles (J_2, J_3, J_4) and mature females were recorded from stained roots. There was no difference between Essex and PI 437654 for the total number of juveniles which entered the roots, whereas S88-2036 had significantly greater infection. No immature juveniles were observed in susceptible Essex, but a large number of J_3 and a few J_4 were noticed in PI 437654 and S88-2036. No mature females of *H. glycines* developed on either PI 437654 or S88-2036, but the rate of survival of adult males on PI 437654 was almost half of that on susceptible Essex. Complete resistance to female development and a partial resistance to male development operated in both PI 437654 and S88-2036. *Plant Science Unit, University of Missouri, Delta Center, Portageville, MO 63873, USA.*

HASHMI, S. & KRUSBERG, L. R. *Influence of temperature and certain other factors on the emergence from cysts of second-stage juveniles of the corn cyst nematode,* Heterodera zeae.

The temperature at which the greatest number of second-stage juveniles (J2) of *H. zeae* emerged from cysts incubated in tap water or in certain solutions was 30 C. At 30 C in tap water an average of 18% of the cyst contents emerged as J2 in 8 days, and an average of 40% J2 in 28 days. No J_2 emerged from cysts at either 10 C or 40 C. Freshly collected root leachate from 25-day-old corn plants growing in silty-loam soil or sand increased J2 emergence from cysts by 34% after 28 days incubation over emergence in tap water. However, leachate that had been stored at 4 C for 30 days, and fresh leachate of silty-loam soil or sand without growing corn plants inhibited J2 emergence. Emergence of J2 from cysts in aqueous 4mM zinc chloride was similar to that in tap water. *Department of Botany, University of Maryland, College Park, MD 20742-5815, USA.*

HASHMI, G., HUETTEL, R., HAMMERSCHLAG, F. & KRUSBERG, L. *Determination of optimum inoculation levels of* Meloidogyne incognita *to tomato and peach under* in vitro *culture conditions.*

Efficiency of root penetration by nematodes under *in vitro* culture conditions is seldom optimized. In order to develop genetically modified or selected somaclonal variants with nematode tolerance or resistance under culture conditions optimum nematode inoculum/nematode development levels should be known. The purpose of this study was to compare penetration of second stage juvenile (J2s) of *Meloidogyne incognita* in tomato (*Lycopersicon esculentum*) root explants and *in vitro* propagated peach (*Prunus persica*) plantlets at five levels of inoculum. The levels used were 25, 50, 75, 100, and 200 J2s for tomato and 50, 100, 200, 500, and 1000 J2s for peach, each replicated 5 × . In tomato, the greatest percentage of root penetration was 30% at the 75 J2 level whereas in peach, the maximum penetration was only 8% at the 200 J2 level. In tomato, the penetration declined to 24% and 19% at the 25 and 50 J2 level. In peach, penetration declined to 3%, 6%, 1%, and 1.5% at 50, 100, 500 and 1000 J2s, respectively. This significant difference ($P<0.05$) in penetration rate between host plants and nematode inoculum levels indicates that all plants propagated under *in vitro* culture conditions for nematode studies should be first screened to determine the optimum number of nematodes needed for quantitative studies, *USDA ARS, Nematology Laboratory, Beltsville, MD 20705, USA.*

HAUKELAND, S., GOWEN, S. R. & HAGUE, N. G. M. *Entomopathogenic nematodes in Norway.*

A survey was undertaken in Norway to examine the presence of entomopathogenic nematodes. Ten soil samples were taken randomly from 61 100m^2 plots in the southern region of the country in the autumn of 1989. The samples, collected in 500 cm^3 plastic containers represent soils from cultivated land as well as from forests and pastures. Nematodes were isolated using the *Galleria* (Wax moth)-baiting technique, and of 360 samples analysed 26 nematode isolates of the genus *Steinernema* have been found, some of which appear to be *S. affinis.* Further work includes selecting nematodes for the control of the cabbage root fly (*Delia radicum*), and biological studies of the different nematode isolates. *Department of Agriculture, University of Reading, Earley Gate, P.O. Box 236, Reading, RG6 2AT, England.*

HAYDOCK, P. P. J. *Potato seed tuber physiological age and tolerance of cultivars to the potato cyst nematode* Globodera pallida.

Seed tubers conditioned to 0, 200 or 400 day-degrees above 4°C were grown in land infested with *G. pallida*. Plants from 400 day-degree seed emerged earlier, had larger canopies and greater dry weights early in the growing season than plants from 0 day-degree seed. However, physiological ageing reduced peak percentage ground cover and advanced crop senescence so that similar quantities of solar radiation were intercepted over the whole growth period. Overall, total and ware yields were not affected much by seed tuber physiological age. Partially resistant cultivars were more tolerant of *G. pallida* than non-resistant cultivars but tolerance was not usually affected by physiological age of seed. *Department of Entomology and Nematology, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, UK.*

HEIJBROEK, W. *The effect of homozygous and heterozygous nematode resistant sugar-beet hybrids on the population development of* Heterodera schachtii *and* Heterodera trifolii *f.sp.* betae.

Diploid sugar beets, homozygous for resistance against *Heterodera schachtii* and heterozygous hybrids, developed by pollinating on a susceptible male sterile production line, were tested on their effect on different inoculum levels of juveniles of *H. schachtii* and *H. trifolii* f.sp.*betae* (the yellow beet cyst nematode).

Pollinators homozygous for resistance were derived from crossings with *B. procumbens* and in a later stage also some heterozygous hybrids were produced with resistance from *B. patellaris*. The results of trials in climate cabinets and field plots showed a correlation between Pf and Pi for both hybrids as well as homozygous pollinators. At different initial densities the production capacity of the resistant hybrids was comparable to the susceptible standards. However, sucrose content and juice quality were still too low. *Institute for Sugar-Beet Research, P.O. Box 32, 4600 AA Bergen op Zoom, The Netherlands.*

HEINICKE, D., SCHULTZ, S., KELLER, R. & KRAUS, W. *Studies on the hatching factor of* Globodera rostochiensis.

Unknown components of potato root diffusates induce the hatch of *Globodera rostochiensis* juveniles. Aqueous extracts from the roots of young potato plants were characterized by analysis with medium and high pressure chromatography and included substances of amino acid, alkaloid and nucleic base origin. The compounds and other secondary plant substances, reported from potato or other host plants were screened with a hatch test. Water was used as the absolute control and 0.25 mM picrolonic acid, an artificial hatching agent, as positive control. The glycoalkaloids α-chaconin and α-tomatin showed significant hatch response. Shikimi and china acid as well as the nucleic bases thymin and uracil induced moderate hatch. The amino acids tested alone or in combination gave the same response as water. Chaconin and perhaps solanin but not solanidin and demissidin are also attractants. *Department of Nematology, Plant Protection Service Hannover, Wunstorfer Landstr. 9, D3000 Hannover 91; Institute of Chemistry, University of Hohenheim D7000 Stuttgart 70, Germany.*

HIATT, E., CARPENTER, S., LEWIS, S. & ABBOTT, A. *Molecular genetic studies of cloned sequence components of* Meloidogyne arenaria *DNA.*

Studies have been initiated to characterize components of the *Meloidogyne* genome. A shotgun pUC8 library of total genomic *M. arenaria* DNA has been constructed. An EcoR1 clone, denoted pE1.6A, has been shown to carry an interspersed repeated sequence. Southern blot hybridization experiments were conducted to characterize this nematode probe. It has been found that pE1.6A shares homology with several different, diverse organisms. The homology results in as few as one band in some organisms and as many as seven bands in other organisms. The 1.6kb insert of pE1.6A has as many as 40 bands on *M. arenaria* DNA. A 3.9kb band is present when probed to soybean DNA. This is approximately the same size as the known EcoR1 fragment for the 26S ribosomal subunit in soybean. Ribosomal genes are known to be highly conserved and are generally randomly repeated in most organisms. The cloned insert may carry a portion

of the ribosomal gene and interspersed repeat sequence. *Dept. of Agronomy, Dept. of Biological Sciences, & Dept. of Plant Pathology, Clemson University, Clemson, SC. 29634-1903, USA.*

HODGE, C. H. & RICH, J. R. *Enhanced tomato growth and suppression of* Meloidogyne javanica *in soil amended with blue crab waste compost.*

Two greenhouse pot experiments were conducted to determine the effect of compost made of blue crab (*Callinectes sapidus*) waste and cypress (*Taxodium distichum*) chips on the reproduction of *Meloidogyne javanica*. The tests were designed as a two way factorial with percent crab compost and *M. javanica* level as the factors. Air-dried crab compost at 0, 10, 20, and 100%, by weight, was mixed with a dry fine sand soil (93% sand, 4% silt, 3% clay) and placed in 10 cm pots. *M. javanica* eggs were injected at 0 or 10,000 eggs per pot. A 10 cm high tomato (*Lycopersicon esculentum*) seedling was then transplanted into each pot. Fifty-six days after transplanting, top plant weight, root weight, root galling, and egg mass and egg counts were made. No significant interactive effect on plant growth was observed between crab compost and *M. javanica* presence. Top plant weight and root weight was significantly higher in all levels of crab compost than in the 0% compost level. Also, all levels of crab compost significantly reduced root galling, number of egg masses, and the number of eggs. *Agricultural Research and Education Center, IFAS, University of Florida, Live Oak, FL 32060, USA.*

HOFFMANN, S. & SIKORA, R. A. *Influence of nematode-trapping fungi on* Heterodera schachtii *early root infection.*

Four species of *Arthrobotrys* and one of *Dactylaria* were tested in petri dishes for predacious activity against *H. schachtii* at temperatures existing at sowing. All fungi grew poorly at 10°C and adequately at 15°C. At 10°C only one *Arthrobotrys* species trapped small numbers of juveniles whereas at 15°C and 23°C all fungi tested trapped juveniles, but to different degrees of effectiveness. The fungi did not significantly reduce the penetration of *H. schachtii* into rape roots in pot trials with unsterile soil. Green manure or straw amendments prior to sowing promoted predacious activity. Penetration was reduced 29% ($p = 5\%$) with straw and 30-35% ($p = 5\%$) with mustard, whereas rape did not significantly alter infection. The commercial preparation "Somycel S 350" reduced *H. schachtii* penetration 36% ($p = 5\%$) in unsterile soil. *Institut für Pflanzenkrankheiten, Universität Bonn, Nussallee 9, D-5300 Bonn 1, Germany.*

HÖGGER, C. H. *Distribution of three plant-parasitic nematodes on winter wheat in Switzerland.*

From surveys in the EPIPRE extension programme and direct inquiries in cases of observed damage the occurrences of stem nematodes (*Ditylenchus dipsaci*), root lesion nematodes (*Pratylenchus* spp.) and oat cyst nematodes (*Heterodera avenae*) on winter wheat was mapped by a Macintosh computer. Stem nematodes were the most important nematode pest on the crop. Damage caused by nematodes occur locally in those areas where the rotations, which are mainly determined by climate and soil conditions, favour the build-up of relatively high nematode populations. Stem nematodes cause damage mainly in rotations which include grass-clover mixtures in heavier soils at higher altitudes. Lesion nematodes and oat cyst nematodes occur only rarely in populations above a damage threshold. *Federal Research Station for Agronomy, Reckenholz, 8046-Zürich, Switzerland.*

HUSSEY, R. S. *Secretions of esophageal glands in root-knot nematodes.*

The dorsal and subventral esophageal glands and their secretory granules in root-knot nematodes change during parasitism of plants. The subventral glands shrink and the dorsal gland enlarges in second-stage juveniles during the early stages of parasitism. While secretory granules formed in both types of glands are spherical, membrane-bound, and Golgi derived, the granules differ in morphology and size between the two types of glands. Subventral gland secretory granules of parasitic juveniles and adult females appear degenerate. Monoclonal antibodies have been generated that are specific for secretory components of the granules. Antibodies have been used as probes to localize the secretory components in the nematode and

stylet secretions and to immunoaffinity purify certain secretions. *Department of Plant Pathology, University of Georgia, Athens, GA 30602, USA.*

INSERRA, R. N., O'BANNON, J. H., DOW, R. L. & VOVLAS, N. *Distribution and hosts of* Tylenchulus palustris *in the United States and Bermuda.*

Tylenchulus palustris was found on *Aster elliottii* and *Liquidambar styraciflua* roots in Florida swamp lands. It was detected on *Borrichia arborescens* and *B. frutescens* roots in saline habitats, tidal marshes, and coastal rocklands of Florida and Bermuda. Host tests indicated that *Mikania scandens* is a host of *T. palustris* but not of *T. semipenetrans*. *Tylenchulus palustris* populations from Florida do not infect citrus rootstocks such as *Citrus aurantium, C. limon, Poncirus trifoliata* and *C. paradisi* × *P. trifoliata*. This nematode, which prefers species of the Compositae family, was recently reported infecting peach trees in Alabama, Arkansas and Georgia. *Tylenchulus palustris* Florida populations do not attack peach trees and have different host preference. *Florida Department of Agriculture and Consumer Services, DPI, Box 1269, Gainesville, FL 32602, USA.*

IREHOLM, A.[1]) & RIVOAL, R.[2]). *Comparison of hatching cycles of three populations of* Heterodera avenae *from France and Sweden in their own country and after reciprocal transfer.*

Hatching of Juveniles (J2) was recorded fortnightly from cysts placed at -20cm depth in the soil outside from 1986 and 1987 at Alnarp(S) and Le Rheu(F), respectively. The two populations Vaxtorp(S) and Nuisement/Coole(F) of the northern european ecotype showed the same activity in both countries; they began to hatch when the temperature decreased (autumn) but most activity was synchronized with increasing temperatures (end of winter and spring). The transfer to Sweden strongly delayed the hatching of the southern ecotype (Villasavary, F) which nevertheless hatched earlier (in intensity) than the northern ecotype. This study gives additional and accurate information on thermal thresholds for completion or induction (continuation) of diapause in these two ecotypes. [1])*Division of Plant Protection, Swedish University of Agricultural Sciences, 23053 Alnarp, Sweden;* [2])*Laboratoire de Zoologie, Centre de Recherches de Rennes, 35650 Le Rheu, France.*

IVEZIC, M. SAMOTA, D. & RASPUDIC, E. *Effect of potassium fertilizer on plant parasitic nematodes of maize.*

Experiments with higher potassium fertilizer rates (180 kg/ha, 405 kg/ha and 630 kg/ha K_2O) were carried out on maize in the field on podzolic soil in 1986-1989. Of the plant parasitic nematodes 54% to 93% belong to *Pratylenchus* spp. with predominant species *Pratylenchus thornei*. The experiments showed a reduction (52-60%) of plant parasitic nematodes in 1987 and 1988 at 180 kg and 405 kg of potassium in relation to the standard. In the first and second year after the application of higher potassium rates plant parasitic nematodes were considerably reduced. These results are a contribution to integrated control. *Agricultural Faculty, Department of Plant Protection, Tenjska bb. P.O. Box 117, 54000 Osijek, Yugoslavia.*

JAFFEE, B. A. , MULDOON, A. E., MANGEL, M. & PHILLIPS, R. *Density-dependent parasitism of* Heterodera schachtii *by the nematophagous fungus* Hirsutella rhossiliensis.

Epidemiological theory predicts that the number and activity of obligate parasites (hence, the percentage of the host population that is parasitized) depend temporally on host density. To test and quantify this relationship for *H. rhossiliensis* (the parasite) and second stage juveniles of *H. schachtii* (the host) at 20°C, hosts were added at 3 wk intervals (wk 2, 5, 8 and 11) to soil microcosms (17 cm^3 loamy sand, heated to 60°C for 2 hr) initially seeded with 5700 spores of the parasite. To measure parasitism at wk 14, assay nematodes (*Heterorhabditis bacteriophora*) were added, extracted after 40 hr, and examined for spores. Numbers of hosts added/interval (and percentage ± SD of assay nematodes with spores) were 0 (15 ± 7), 8 (35 ± 14), 16 (43 ± 9), 32 (54 ± 10), 65 (81 ± 8), 133 (94 ± 3), and 266 (99 ± 2). These results demonstrate density-dependent parasitism and provide fundamental information for understanding epidemics of *H. rhossiliensis* in populations of *H. schachtii*. *University of California, Davis, CA 95616. USA.*

JAFFEE, B. A., MULDOON, A. E., MANGEL, M. & PHILLIPS, R. *Acquisition of* Hirsutella rhossiliensis *spores by* Heterodera schachtii *as affected by spore density and soil porosity.*

The nematophagous fungus *H. rhossiliensis* produces non-motile spores that adhere to, and initiate infection of, host nematodes. Acquisition of spores by *H. schachtii* juveniles (J2) was quantified in soil microcosms (17 cm^3, heated to 60°C for 2 hr) containing a range of spore densities (S, in thousands of spores per microcosm) in loamy sand (-60 mbars matric potential) or coarse sand (-20 mbars) at 20°C. Acquistion, measured as the percentage (P) of J2 with at least one spore after 3 days, was much greater in loamy sand, where $P = (105S)/(S + 31)$ ($r^2 = 0.96$), than in coarse sand, where $P = -0.6 + 0.16S$ ($r^2 = 0.88$); the maximum and minimum values of P are 100 and 0. Differences in acquisition were attributed to soil pore diamter. Most pores (87%) in coarse sand were wider than 80 μm and 4% were between 38 and 80 μm. In loamy sand, 44% were wider than 80 μm and 20% were between 38 and 80 μm. Large pores reduce J2 motility and increase the probability of a J2 passing but not contacting a spore. *University of California, Davis, CA 95616, USA.*

JANSSON, H.-B. *Chemotaxis of zoospores of* Catenaria anguillulae *to nematode exudates and other substances.*

Zoospores of the endoparasitic fungus *Catenaria anguillulae* aggregate at natural openings (mouth, excretory pore, anus etc.) of various vermiform nematodes due to chemotaxis towards leaking substances. A method using flat capillary tubes (microslides) to study chemotaxis of the zoospores to various substances were developed. The zoospores showed strong chemotactic responses towards different unspecific attractants, e.g. nematode exudates, yeast extract, liver extract, but were also attracted to serine, glucose, NH_4^+ and high pH. Single compounds appeared to be attractive at concentrations down to about 10^{-6}mg ml^{-1}. *Department of Microbial Ecology, University of Lund, Helgonavägen 5, S-223 62 Lund, Sweden.*

JELIĆ, A. *Root-lesion nematodes in soybean fields.*

The investigation of nematodes in soybean fields was carried out during three years in 18 localities located in Slavonia and Baranja in the northeast of Yugoslavia. Soil samples were taken from soil around the roots. Nematodes were extracted by Seinhorst's Erlenmeyer bottle technique. All samples had mixed populations. The most commonly occurring were root-lesion nematodes. These nematodes have recently become important in soybean production. Eight speces were identified with *Pratylenchus neglectus* and *P. thornei* dominant. *Agricultural Faculty, Institute for Plant Protection, 54000 Osijek, Yugoslavia.*

JELIĆ, A. *Plant-parasitic nematodes in rhizosphere of rape* (Brassica napus *var.* oleifera).

Little is known about the presence of nematodes in rape fields in Yugoslavia. This study was made to determine plant-parasitic nematodes in rhizosphere of rape in 4 localities situated in the regions of Slavonia and Baranja in the northeast of Yugoslavia. Soil samples were taken in autumn and spring during two years. The principal plant-parasitic nematodes of 9 genera identified were: *Ditylenchus dipsaci, Pratylenchus crenatus, P. neglectus, P. thornei* and *Tylenchorhynchus clarus.* The most frequently found were root-lesion nematodes. Significant differences were found in population density. *Agricultural Faculty, Institute for Plant Protection, Osijek, Yugoslavia.*

JIMENEZ MILLAN, F., PEÑA SANTIAGO, R. & OCAÑA, A. *Fine cuticular structure of several species of Nematomorpha and Bunonematidae (Nematoda).*

A comparative study of the cuticular structure of different species was made by optical and/or scanning electron microscopy. The intricate ornamentation of body cuticle was revealed in detail and its value in the taxonomy of these groups is discussed. *Departamento de Biologia Animal, Facultad de Ciencias, Universidad de Granada, Granada, Spain.*

JOHNSON, A. W. & DOWLER, C. C. *Crop rotation with cotton, triticale, and soybean controls* Meloidogyne incognita.

Following a susceptible crop, 'Yellow Jewel' sweet potato, three cropping systems: 1-year triticale 'Beagle 82' - cotton 'McNair 235', 1-year triticale - soybean 'Twiggs', and 2-year triticale-cotton-triticale-soybean suppressed population densities of *M. incognita*. The application of fenamiphos at 6.7 kg a.i./ha did not suppress ($P = 0.05$) *M. incognita* population densities. Numbers of *M. incognita* juveniles declined on triticale and soybean but increased on cotton. Over three years, mean yields of triticale, soybean, and cotton were 5.6, 5.1, and 7.0% greater, respectively, from fenamiphos-treated plots than untreated plots. *Nematodes, Weeds, and Crops Research Unit, USDA-ARS, P.O. Box 748, Tifton, GA 31793, USA.*

JOHNSON, A. W., LEONARD, R. A., KNISEL, W. G. & MARTI, L. R. *Degradation of fenamiphos on sweet corn and pearl millet.*

The experiment was conducted on a 0.34 ha agricultural watershed of Cowarts loamy sand, fine-loamy, siliceous, thermic Typic Hapludult. Fenamiphos was uniformly applied to one-third of the beds at 6.7 kg a.i./ha. Soil samples were collected at various depths immediately after nematicide applications and at selected time intervals thereafter. Fenamiphos, f. sulfoxide, and f. sulfone concentrations were determined after extraction by modified procedures using high performance liquid chromatography. Fenamiphos dissipated rapidly with concurrent formation of f. sulfoxide and f. sulfone metabolites. Concentration of f. sulfoxide was 2.4 kg/ha one month after application and f. sulfone was < 1.0 kg/ha. F. sulfoxide was more persistent in soil than f. sulfone. Concentrations of f. sulfoxide were greater than 1 mg/kg at the 5- and 10-cm soil depth, but concentrations of fenamiphos and f. sulfone were < 1 mg/kg at all soil depths. *USDA-ARS, P.O. Box 748, Tifton, GA 31793, USA.*

JONES, J. T.[1,2]) & AP GWYNN, I.[1]) *A method for rapid fixation and dehydration of nematode tissue for transmission electron microscopy.*

Nematode tissue was fixed in glutaraldehyde and in OsO_4 in approximately 30 seconds by using a modified microwave oven to speed up the process. The tissue was then rapidly dehydrated using acidified 2,2 di-methoxypropane. Using this method, it has been possible to prepare well preserved tissue for examination in the electron microscope far more rapidly than by a conventional method. Details of the methods used, and pictures of nematode tissue prepared by the two methods are presented and compared. [1])*Department of Biological Sciences, University College of Wales Aberystwyth, Penglais, Aberystwyth,* [2])*Entomology & Nematology Department, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts., UK.*

JONES, J. T.[1,2]), PERRY, R. N.[1]) & JOHNSTON, M. R. L.[2]) *Electrophysiological recordings and responses to various stimuli by the potato cyst nematode* Globodera rostochiensis.

Using glass microelectrodes, electrophysiological recordings have been made from the anterior end of adult males of *G. rostochiensis*, the first from a nematode of this size. Individual nematodes were anchored with a suction electrode around the anterior end and a second electrode was inserted into the body; either electrode could be used for recording. It was possible to record spike activity and to monitor changes induced by certain attractants and repellants. In addition, a recording was obtained showing an activity pattern with the characteristics of a pacemaker neurone. The technique may form the basis of a bioassay for screening novel semiochemicals for nematode control. [1])*Entomology & Nematology Department, AFRC, IACR, Rothamsted Experimental Station, Harpenden, Herts;* [2])*Department of Biological Sciences, UCW Aberystwyth, Penglais, Aberystwyth, Dyfed, UK.*

JOVICIC, D. *Effects of industrial water pollution on soil nematodes.*

The study exposes the results of the long-range field and laboratory investigations on terrestrial nematodes affected by pyrites barren soil of surface mine RTB Bor, the results of river

deposits on cultivated soil in the Timok's valley. The changes in qualitative structure, quantitative relations as well as vertical and seasonal distribution of the nematode populations have been observed. Coming closer to the source of pollution, a significant reduction in the qualitative-quantitative structure of the population has been found in relation with the depth of deposited layout (flooding wave of the Timok). It has been reported that representatives of the order *Rhabditida* appear in large numbers unrelated to the distance of the pollution source. Also, it has been noticed with representatives of the order *Dorylaimida*. This suggests that this group of nematodes is most susceptible to polluted soil, and therefore, possible indicator species for environmental quality conditions are to be found within this group. *Institute for Plant Protection, 11001 Belgrade, P.O. Box 936, Yugoslavia.*

KÄMPFE, L. & HENKE, H. *Fitness alterations in nematicide-tolerant strains of* Rhabditis oxycerca.

Populations of *Rhabditis oxycerca* that have become resistant to aldicarb and oxamyl by long-term exposure reveal reduced fitness compared with sensitive strains: body measurements especially tail length, are smaller. The upper temperature limit is lowered. Motility is decreased in media free of active substances, but increased in the presence of nematicides. O_2-consumption is reduced and number of progeny depends on the pretreatment. These symptoms are most obvious in aldicarb-tolerant strains. *Department of Zoology, University of Greifswald, Bachstr. 11/12, DDR-2200 Greifswald, Germany.*

KAPLAN, D. T. & GOTTWALD, T. G. *Characterization of burrowing nematode sibling species and populations with biotinylated lectins.*

Western blots of homogenates and cetyltrimethylammonium bromide (CTAB)-treated cuticle and egg shells of seven populations of *Radopholus citrophilus* and *R. similis* were probed with five biotinylated lectins combined with an alkaline phosphatase avidin-biotin complex. Predictive equations were developed to estimate the molecular weights of bands. Differential band patterns were observed among four *R. citrophilus* and three *R. similis* populations. *Limulus polyphemus* agglutinin (LPA) binding to low molecular weight proteins was competitively inhibited by neuraminic acid. *USDA-ARS, 2120 Camden Rd., Orlando, FL 32803, USA.*

KAPPERS, F. I. & MANGER, R. *Population dynamics of free-living nematodes in oil contaminated soil during the clean-up with a microbiological restoration technique.*

To improve clean-up techniques by landfarming, lysimeters (18 m^2) were filled with an oil contaminated sandy soil obtained from a bus garage site. Soil (in the open air or covered) was manipulated by raining, fertilizing and seeding. In the half year observation period the impact of restoration techniques on nematode fauna was investigated. The lysimeter results were compared with the composition of nematode fauna in the polluted and in the clean reference soil at the garage site. The numbers of nematodes in the polluted soil were 20 times that of the reference soil, and were dominated by *Cuticularia oxycerca*. In the lysimeters bacterial feeders were also dominant at the start, but decreased with time while carnivorous *Odontopharynx longicaudata* increased. At the end of the experiment restoration of nematode fauna was still in progress: species diversity was 3 times lower than in the reference and feeding group ratio's were quite different. *Nat. Inst. Public Health & Environ. Protection, P.O. Box 1, 3720 BA Bilthoven, The Netherlands.*

KAYA, H. K., HARA, A. H. & GAUGLER, R. *Isolation of steinernematid and heterorhabditid nematodes from the Hawaiian Islands.*

Soils from 340 sites from diverse habitats on six of the major Hawaiian Islands were assessed for steinenematid and heterorhabditid nematodes using the *Galleria mellonella* baiting technique. A *Heterorhabditis* species was found at 22 sites from five islands (Kauai, Oahu, Molokai, Maui, and Hawaii) and was isolated from sandy soils usually near sea level. A *Steinernema* species was found at only 2 sites on the island of Maui and was isolated from loamy soils located inland. *Department of Nematology, University of California, Davis, CA 95616, Beaumont Agricultural Experiment*

Station, University of Hawaii, Hilo, Hawaii 96720, and Department of Entomology, Rutgers University, New Brunswick, NJ 08903, USA.

KERMARREC, A., SIRJUSINGH, C. & MAULEON, H. *Susceptibility of the banana weevil* (Cosmopolites sordidus, Curculionidae) *to various strains of entomopathogenic nematodes.*

New control strategies are urgently needed to reduce populations of the banana weevil. A large library of strains of the two entomopathogenic nematodes (EN) genera have been bioassayed against the guadeloupean populations of *Cosmopolites sordidus*. A spectrum of pathogenicity appears and the insect resistance (larvae and adults) to penetration of the EN infestive stages has been studied. Results are promising for a further research step with these potential biopesticides in hot and wet ecologies. *INRA Centre des Antilles-Guyane, Station de Zoologie et Lutte Biologique, BP 1232, 97184 Pointe-à-Pitre Cédex. Guadeloupe FWI.*

KHRUSTALEV, A. V. *A useful technique for making stained slides of nematodes.*

A handy technique of mounting of permanent stained slides of nematodes has been developed using an original medium on the basis of chloral hydrate and polyvinilpyrrolidone. This medium does not need previous dehydration of a specimen. A number of fixatives and dyes is offered that help to achieve selective staining of nuclei, nucleoli, glands, spermatozoa, walls of cells etc. in many free living, plant- and zooparasitic nematodes. The described technique can be used for making slides of chromosomes too. *Centre of Bioengineering, Institute of Molecular Biology Ac.Sci. USSR, Vavilov str., 32, 117894 Moscow, USSR.*

KIM, D. G. & RIGGS, R. D. *The natural suppression of* Heterodera glycines *by ARF18 fungus in soybean fields and effects of agrochemicals.*

Natural suppression of soybean-cyst nematode, *Heterodera glycines* (SCN), by Arkansas Fungus 18 (ARF18) was observed for 3 years in soybean fields in Arkansas. Juveniles (J2) in soil reached a maximum (11 J2/g soil) 6 weeks after soybean was planted then declined continuously. The highest percentage (62%) of diseased J2 in soil occurred about 1 month later. ARF18 was isolated from those diseased J2. Suppressive soil in pots treated with formaldehyde or autoclaved and inoculated with SCN eggs, increased SCN populations 560% and 350%, respectively, compared with untreated suppressive soil. Twenty seven agrochemicals were tested for inhibition of ARF18 fungus. Only Banrot, Benlate, Bravo 720-A, Super-Tin, and Top Sin M at 1 ppm in cornmeal agar reduced the growth of ARF 18 by more than 75% of check. Chemical inhibition of growth did not affect the infectivity of the fungus which averaged between 58 and 79%. *Department of plant pathology, University of Arkansas, Fayetteville, AR 72701, USA.*

KINLOCH, R. A. & DUNAVIN, L. S. *Summer crop effects on the abundance of* Meloidogyne arenaria *race 2 and subsequent soybean yields in the second year.*

Replicated (x10) summer plantings of alyceclover and soybean into field soil averaging 23 *M. arenaria* race 2 juveniles / 10 cm^3 increased the abundance of the nematode by factors of 3.7 and 1.2, respectively, when measured in the following spring. All other crops decreased the nematode population. Yields of soybean in the second year were significantly ($P<0.05$) increased following hairy indigo (2305 kg/ha), aeschynomene (2187), peanut (2109), sorghum (2095), and fallow (2082) but not following sorghum-sudangrass (1991), maize (1965), millet (1938), cotton (1912), lespedeza (1886), or alyceclover (1231) over monocultured soybean (1179). Nematode abundance, which averaged 214 juveniles / 10 cm^3 soil following harvest in the second year, was not related to previous cropping history. *University of Florida, IFAS, Box 575, Jay, Florida 32565-9524, USA.*

KOBAYASHI, Y. *Pathogenicity of* Meloidogyne incognita *on netted melon*, Cucumis melo *L.*

The pathogenicity of *M. incognita* on netted melon was demonstrated under greenhouse conditions. Initial populations for five treatments were 0 (steam sterilized), 0(D-D treated), 3.8, 9.4

and 54.5 second-stage juveniles (J2)/10 g soil. The plants inoculated with high populations wilted 2-3 weeks before harvest, and fruit weight, sugar content and net formation were unfavourable. The following equation was obtained between fruit weight (Y) and soil populations of J2 at transplanting (X): $Y = -a \log (X + 1) + b$. *Shizuoka Agr. Exp. Stn., 678-1 Toyoda-cho, Shizuoka-ken, Japan.*

KORNOBIS, S. *Effects of herbicides on population dynamics of four migratory plant parasitic nematodes.*

In sugar beet microplots the population of *Pratylenchus neglectus* decreased with the use of chloridazon (3.25 kg/ha) or cycloate (4.44 kg/ha), by contrast with the increasing population in the control microplots with weeding only. In *Criconemella curvata* and *Tylenchorhynchus dubius* and *Helicotylenchus digonicus* populations there was no difference in population changes between herbicides and control. No differences between herbicides and control were observed in the results of linuron + bentazone (1.0 kg/ha + 1.5 kg/ha) or cyanozinc + bentazone (1.5 kg/ha + 1.5 kg/ha) applications in pea microplots. *Institute for Plant Protection, Miczurina 20, 60-318 Poznań, Poland.*

KOTCON, J. B. *Effect of chitin-urea amendments on nematode population dynamics and nematode biocontrol agent activity in apple orchard soils.*

Chitin-urea amendments (Clandosan) were compared with fertilizer and fenamiphos application on 2-year-old apple cvs. Empire, Northern Spy, and York Imperial on EMLA-7A rootstock. Soil (2.25 m^2) around trees was treated with 1 or 3 t/ha Clandosan, 20 kg/ha fenamiphos, 667 kg NH_4NO_3/ha (equivalent N to 1 t/ha Clandosan), or were untreated during 1988 and 1989. Population densities of *Pratylenchus penetrans* (Pp) in fenamiphos treated plots were consistently lower than in Clandosan or untreated plots. Density of Pp was highest in untreated plots in 1988, but was highest in Clandosan-treated plots in 1989. Laboratory assays of nematode biocontrol activity, based on survival of Pp, showed significantly higher activity in both fenamiphos and Clandosan plots than in untreated plots. Tree growth and population densities of *Xiphinema americanum* were unaffected by any treatment. *Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506, USA.*

KRALL, E. *Plant nematology in Estonia.*

Globodera rostochiensis, pathotype Ro1, and *Ditylenchus destructor* on potatoes, as well as *Bidera (= Heterodera) avenae* on oats and barley are widely distributed and considered to be the most important plant nematode pathogens in the Baltic region. Local problems often arise with *Ditylenchus dipsaci* on red clover and ornamentals, *Aphelenchoides fragariae* on strawberry, *A. ritzemabosi* on ornamentals, *Pratylenchus penetrans* on woody perennials and other cultivated plants. A summary of investigations on taxonomy, ecology and host-plant physiology of cyst nematodes in Estonia is given. *Institute of Zoology and Botany, Estonian Academy of Sciences, Vanemuise 21, 202400 Tartu, Estonia, U.S.S.R.*

KRUGER, J. C. DE W. & HEYNS, J. *Ultrastructure of the spines in the uterus of* Xiphinema coomansi *Kruger & Heyns, 1986.*

The uterine spines of *X. coomansi* were examined *in situ* with TEM. Longitudinal and cross sections of the uterus indicated that the numerous bluntly bi-pointed spines are not individually attached in the muscular wall of the uterus by means of a base, but are in fact more or less symmetrically arranged in a membranous network which appears to be suspended in the lumen of the uterus. Sections through individual spines disclosed an internal solid hexagonal crystalline structure enclosed within a membrane which seems to attach each spine in the network as well as to the uterine wall in a tri-radial fashion. In some cases two spines are enveloped together as a pair. The possible function(s) of these peculiar uterine structures are briefly mentioned. *Department of Zoology, Rand Afrikaans University, P.O. Box 524 Johannesburg, 2000, Republic of South Africa.*

LaMondia, J. A. *The genetics of tobacco resistance to the tobacco cyst nematode*, Globodera tabacum tabacum.

Homozygous tobacco lines resistant (R) or susceptible (S) to the nematode *Globodera tabacum tabacum* were crossed. F1 hybrid progeny were selfed and backcrossed to produce additional progeny (F2 and BC1, respectively) for evaluation of resistance in greenhouse experiments. Plants without visible (10 × magnification) developing female nematodes on the roots were classified as resistant. The segregation ratios for progeny of resistant and susceptible plants were consistent with test ratios of 3:1, and 1:1 for F2 (F1 × F1); and BC1 (F1 × S) lines, respectively using Chi-Square analyses. There were no differences between reciprocal tobacco crosses. These ratios indicate that this resistance to *G.t. tabacum* is conferred by a single dominant gene. *Department of Plant Pathology and Ecology, Connecticut Agricultural Experiment Station, P.O. Box 248, Windsor, CT 06095 USA.*

Lemos, R. M.[1]) Almeida, M. T. M. de[2]), Santos, M. S. N. de A.[3]), Abrantes, I M. de O.[3]), Martins, A. I. T.[3]) & Relvas, J. C. B. de M.[3]) *Studies on Portuguese populations of Longidorids and Trichodorids.*

Longidorids were found in soil samples collected from the rhizosphere of vineyards of the Douro region. The species most commonly present was *Xiphinema americanum*. *Xiphinema index* was also found associated with severe symptoms of grapevine fanleaf virus (GFLV). Populations of *Xiphinema* sp. and *Longidorus* sp. were found in a vineyard where the grapevine enations disease (GED) was spreading. Trichodorids were found in 100 of the 370 soil samples collected from the rhizosphere of several plants in various localities. Thirty-two percent were mixed populations of *Trichodorus* spp. and *Paratrichodorus* spp. and 68% were single populations of *Trichodorus* or *Paratrichodorus* species. Seven species were identified: *T. beirensis, T. lusitanicus, T. primitivus* and *P. allius, P. anemones, P. minor* and *P. pachydermus*. Further studies are in progress in order to characterize and to identify the nematodes and to get more information about their distribution and the associated viruses. [1])*Centro de Estudos Vitivinícolas do Dão, EVN-INIA, 3520 Nelas, Portugal;* [2])*Departamento de Biologia, Universidade do Minho, 4719 Braga Codex, Portugal;* [3])*Centro de Sistemática e Ecologia — INIC, Universidade de Coimbra, 3049 Coimbra Codex, Portugal.*

Lewis, S. A., Ibrahim, I. K. A., & Harshman, D. C. *Host suitability of selected graminaceous plants for populations of* Meloidogyne arenaria.

Twenty-two graminaceous plant cultivars were evaluated in greenhouse tests for resistance to three South Carolina populations of *M. arenaria* race 2 (Ma-R2) and a Florida population of race 1 (Ma-R1). Host suitability was determined by calculating egg mass index, reproduction factor (RF), and number of eggs per gram of root. Corn hybrids Pioneer 3147 and Northrup King 508, corn inbred South Carolina 60, and oat cv. Florida 502 were highly resistant to all nematode populations. Oat cv. Coker 716 and grain sorghum cvs. Cherokee, Northrup King 2660 and Pioneer 8333 failed to maintain populations at the initial level. Barley cvs. Boone, Keowee, and Redhill; corn hybrid Pioneer 3389; oat cvs. Brooks and Coker 820; rye cvs. Bonel, Florida 401 and Wrens Abruzzi; Triticale cvs. Beagle 82 and Florida 201; and wheat cvs. Coker 983, Florida 302 and Williams were either good (RF 1.1-5.0) or excellent (RF > 5.0) hosts for all populations. *Department of Plant Pathology & Physiology, Clemson University, Clemson, South Carolina, 29634-0377, USA.*

Lewis, S. A., Drye, C. E., Saunders, J. A., Halbrendt, J. M., & Shipe, E. R. *Races of* Heterodera glycines *in South Carolina.*

Selected soybean fields in the middle Coastal Plains of South Carolina were assayed for plant-parasitic nematodes. *H. glycines* was found in seventy-two (14%) of the 500 fields sampled. Thirty-nine race determinations were made. Seventeen (43%) of the fields contained race 14, eleven (28%) race 3, five race 9, two race 6, two race 10, and two race 9 or 14 (different results were obtained in two tests). Seventy-one percent of the fields with *H. glycines* had either race

3 or race 14. Race 14 does not reproduce on PI 88788 which is the source of resistance to race 4 in commercial cultivars. *Department of Plant Pathology & Physiology, Clemson University, Clemson, South Carolina, 29634-0377, USA.*

LEIJ DE, F. A. A. M. & KERRY, B. R. *Influence of temperature and nematode species on the efficacy of the fungus,* Verticillium chlamydosporium, *as a biological control agent of root-knot nematodes.*

A selected isolate of *Verticillium chlamydosporium* significantly reduced (>90%) populations of *Meloidogyne incognita, M. arenaria, M. javanica,* and *M. hapla* on tomato plants when 2,000 propagules/g of the fungus were added to soil in pot tests. Eggs of the four root-knot nematodes were similar in their susceptibility to the fungus. Rate of nematode development and the susceptibility of the host plant to individual nematode species were shown to be key factors affecting the efficacy of *V. chlamydosporium* as a biological agent. In general, temperatures <25°C increased the development rate of the nematode more than that of the fungus and resulted in less effective control. Isolates of the fungus differ in their temperature optima for growth and sporulation and could be selected to suit soil conditions. *Entomology & Nematology Department, AFRC/IACR Rothamsted Experimental Station, Harpenden, Hertfordshire, AL5 2JQ, England.*

LOOTS, G. C. *Induced anhydrobiosis in* Pratylenchus zeae *(Nematoda)*

Two methods for inducing anhydrobiosis in *P. zeae* were evaluated and the influence of these on the external morphology of the nematodes was studied with the SEM. The agar-desiccated method which resulted in a significantly higher survival rate of nematodes than the relative humidity chambers, was used to study the influence of maize roots on the survival rate of *P. zeae.* Nematodes desiccated on agar retained their expanded shape and those anhydrobionts inside maize roots survived much higher and lower temperatures than those on agar. *Dept of Zoology, PU for CHE, Potchefstroom 2520, RSA.*

MACCULLOCH, L. A., ROBERTSON, W. M. & FORREST, J. M. S. *Effect of pH on control by the lectin concanavalin A of* Meloidogyne javanica *and* Globodera rostochiensis.

Initial attempts failed to repeat the work of Marban Mendoza *et al.*, (*J. Nématol.* 19, 331-335, 1987) who found that the lectin concanavalin A (con A) applied as a soil drench to tomato plants (*Lycopersicon esculentum*) could control galling by *M. incognita.* However, because con A forms different isomers dependent on the pH of the medium the effect of a range of pHs and two different buffers on the numbers of *Meloidogyne* galls and the development of *G. rostochiensis* females was examined. Con A applied at a concentration of 200 ppm in 10 mM phosphate buffer at pH 6.4 significantly reduced galling of tomato roots by *M. javanica* and cyst formation on potato roots by *G. rostochiensis.* No significant reduction of galls or cysts was found at pHs 5.6 and 7.2 in phosphate buffer or pH 7.2 in 10 mM TRIS-HCl buffer. Succinylated con A made up in either phosphate or TRIS buffers at pH 7.2 also failed to affect galling by *M. javanica. Zoology Department, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland.*

MACCULLOCH, L. A.[1]), ROBERTSON, W. M.[1]) & GOW, N. A. R.[2]) *Response of* Longidorus elongatus, Xiphinema index *and* Rotylenchus robustus *to electrical fields.*

Nematodes were exposed to electrical fields generated through an agarose gel. A peristaltic pump was used to mix the buffer reservoirs containing the electrodes to preventing the formation of gradients from electrolytic by-products. *L. elongatus* and *X. index* moved towards the cathode at gradients of 3 V cm^{-1} and above whereas *R. robustus* orientated towards the anode at 1 and 2 v cm^{-1}. These field strengths were 1-2,000 times greater than those generated at plant root tips. [1])*Zoology Department, Scottish Crop Research Institute, Invergowrie, Dundee, Scotland DD2 5DA and* [2])*Department of Molecular and Cell Biology, Marischal College, University of Aberdeen, Aberdeen, Scotland AB9 1AS.*

MACIEJCZYK, M. Teratocephalidae *of coniferous forests in Poland.*

Investigations were made of nematode communities (*Teratocephalidae*) in the coniferous forests of Poland: Peucedano-Pinetum and Leucobryo-Pinetum. Seven species of Teratocephalidae are recorded. Data on their biometry and distribution in microhabitats (moss, litter and mineral soil layer) are given. The main abundance of Teratocephalidae per square meter was found to be $107,895 \times 10^3$ in moss, $10,526 \times 10^3$ in litter and $2,631 \times 10^3$ in soil mineral layer. *Institute of Zoology, Polish Academy of Sciences, Warszawa, ul. Wilcza 64, Poland.*

MAGNUSSON, C. *Interactions of plant parasitic nematodes and* Verticillium dahliae *on root weight and yield parameters of oilseed rape.*

Effects of *Heterodera schachtii* (1.5, 5 and 50 ind./ml soil) and *Pratylenchus penetrans* (1000, 2000 and 3000 ind./plant), alone and combined, in the presence or absence of the wilt fungus *Verticillium dahliae* (16×10^6 microconidia/plant) were studied in the greenhouse at 11-20°C for 39 weeks. The fungus alone did not cause a statistically significant reduction in root weight, but in the presence of *H. schachtii* alone or together with *P. penetrans*, synergistic reductions of 52-83% were recorded. Both the fungus and the nematodes affected the seed number primarily by reducing the number of pods developed. Seed weights were reduced by 13% by the fungus alone and by 12-35% by the nematodes. Synergistic interactions with the fungus caused substantial reductions in seed numbers (72-85%), pod numbers (65-79%), seed content of pods (29-38%) and in the 1000-seed weights (25-50%). Reductions due to second-order interactions between all three pathogens were most prevalent at higher densities of *H. schachtii*, while at lower densities antagonism occurred irrespective of the population levels of *P. penetrans*. *Department of Plant and Forest Protection, Swedish University of Agricultural Sciences, Box 7044, S-750 07 Uppsala, Sweden.*

MAGNUSSON, C. *The pinewood nematode in a North European perspective.*

The importance of the forest resource has caused concern in Nordic countries about the potential danger of the pinewood nematode, *Bursaphelenchus xylophilus* (PWN). Due to its absence from Europe, its damaging potential on pine and its transmission in trade, PWN is recognized as an A_1 quarantine pest organism. The presence of PWN in soft wood exports from infested areas is universally agreed upon, but its absence from Europe and its damaging potential has been questioned. So far, European isolates of the Pinewood Nematode Species Complex, tested with recombinant DNA-technology, have all belonged to the *B. mucronatus* sub-group of the complex. This supports European surveys which have all failed to detect PWN in forests and European trade products. While the establishment of PWN in the "saprobic food chain" needs further study, the transmission of Swedish *B. mucronatus* to conifers by native pine sawyers indicates the existence of a potential transmission system for PWN. Future studies to evaluate the damaging potential of PWN in northern areas must consider local day fluctuations in temperature and humidity as well as seasonal changes in day lengths, all possible stress factors at high latitudes. *Department of Plant and Forest Protection, Swedish University of Agricultural Sciences, Box 7044, S-750 07 Uppsala, Sweden.*

MANKAU, R. & CIANCIO, A. *Nematode antagonists in a southern California soil developing suppressiveness to* Heterodera schachtii.

A field inoculated with *H. schachtii* about 12 years ago and continuously cropped with host plants exhibited a gradual decline in sugar-beet cyst nematode damage. After a decade of cultivation, significant differences could no longer be obtained between control plots and those treated with nematicides. Soil analysis revealed a remarkable variety of fungal antagonists including parasites of females and eggs; and at least 6 spp of nematode-trapping fungi. Three *Arthrobotrys* spp were present at high densities and one or more could be isolated from any 0.5 g of soil. An average of 44% of all cysts recovered following a cabbage crop were infected by fungi and 57% of the eggs within these cysts were parasitized. Several predacious nematode spp. were abundant and a large *Aporcelaimellus* sp. prominent in the fauna in both numbers and biomass, was observed feeding on the eggs within cysts. Predacious mites and tardigrades were

also observed. Substantial circumstantial evidence of biological control was apparent. *Department of Nematology, University of California, Riverside, CA 92521, and Instituto de Nematologia Agraria, C.N.R., 70126 Bari, Italy.*

MARSHALL, J. W. *Variation in restriction fragment length differences patterns in* Globodera rostochiensis *and* G. pallida *populations in New Zealand*

Populations of potato cyst nematode from geographically isolated populations throughout New Zealand were compared by restriction fragment length differences. The results of the restriction digests were transferred by Southern Blot and probed with recombinant DNA probes derived from *G. pallida* (Pa_3) and *G. rostochiensis* (Ro_1).
Two consistent patterns for *G. pallida* populations were produced when probed with the *G. pallida* probe. The patterns for *G. rostochiensis* populations were less clear. The relationship between reproductive potential of each populations when grown on *Solanum vernei* (VTN)[2] 62 33.3 to restriction patterns will be discussed. *DSIR Plant Protection, Canterbury Agriculture and Science Centre, Private Bag, Christchurch, New Zealand.*

MARULL, J., PINOCHET, J. & VERDEJO, S. *Reaction of five almond varieties* (Prunus amygdalus) *to four species of root lesion nematodes.*

Five almond varieties used as rootstocks in Spain were tested for their resistance to root lesion nematodes. Almond seedlings of Atocha, Garrigues, Marcona, Larqueta and Texas were inoculated with 1000 individuals of *Pratylenchus vulnus, P. neglectus, P. thornei* and *Zygotylenchus guevarai* and maintained for 120 days in a greenhouse. All almond varieties reacted similarly to each of the four root lesion nematodes tested. *Pratylenchus vulnus* reproduced well, reaching the highest population density, 15825 nematodes/plant on Garrigues. Final population levels of *P. neglectus* were only slightly higher than the initial levels suggesting that these varieties are poor hosts of the nematode. Marcona and Larqueta roots were not invaded by *P. thornei* but nematodes were recovered from soil. Some eggs and juveniles of *Z. guevarai* were found in roots although apparently this nematode does not multiply on almond. Atocha and Garrigues, used as rootstocks because of their vigor, developed more root mass than the other varieties regardless of the nematode species inoculated. *Dpto. Patología Vegetal, IRTA, Crta. de Cabrils s/n, 08348 Cabrils (Barcelona), Spain.*

MARULL, J., PINOCHET, J., VERDEJO, S. & SOLER, A.: *Reaction of 12* Prunus *rootstocks to* Meloidogyne arenaria *in Spain.*

Twelve *Prunus* rootstocks were evaluated for their reaction to *M. arenaria* at 120 days following inoculation with 5,000 nematodes per plant under greenhouse conditions. The majority of these materials were composed of peach × almond hybrids of Spanish origin. In a first experiment, the rootstock G × N No 1 was immune, GF-305 resitant and the six remaining rootstocks, Fermoselle, Bergasa, GF-677, Garrigues, Moncayo and Adafuel, showed different degrees of susceptibility. In a second experiment, G × N No 9 was immune, Hansen-5 resistant and the three remaining hybrids, MB 1-35, GF-677 and MB 2-2, susceptible. The root-knot nematode resistant peach, Nemared, used as a parent in the two G × N selections, was found to provide immunity to *M. arenaria. Departamento de Patología Vegetal, Institut de Recerca i Tecnología Agroalimentàries (IRTA), Crta de Cabrils s/n, 08348 Cabrils, Barcelona, Spain.*

MCGAWLEY, E. C. FISCHER, N. H., FLORES, H. E., HJORTSO, M. A. & WINCHELL, K. L. *Influence of root extracts from plants in the Heliantheae and the African marigold on nematodes.*

Viability of eggs of *Meloidogyne incognita* race 2 (*Mi2*), and *Rotylenchulus reniformis* (*Rr*) and infectivity of juveniles of *Mi2*, as influenced by extracts from roots of plants in the Heliantheae and from "hairy" root cultures of *Tagetus patula*, were tested. Egg hatch, infection and post-infection biology of *Mi2* were influenced by the root extracts. Eight compounds from roots of plants in the Heliantheae were tested. Damsin and dihydroparthenolide have activity against *Rr*. In 2 tests, marigold root extracts increased galling by *Mi2. Deparment of Plant Path. & Crop Phys., L.S.U., BR, LA, USA.*

McInnis, T., Kluepfel, D. & Zehr, E. *Suppression of* Criconemella xenoplax *on peach by rhizosphere bacteria.*

The ring nematode *C. xenoplax* is associated with severe injury to fine roots and early mortality of peach trees. Some peach orchard sites usually conductive to large *C. xenoplax* populations and premature death of peach have exhibited low nematode populations and little tree mortality. Soil collected from these sites was inhibitory to *C. xenoplax* population increases in greenhouse tests when Nemaguard seedlings were planted and additional nematodes were added. Treatment with aerated steam (65°C) removed the inhibitory factor(s) and resulted in a 9-fold increase in nematode numbers during a 12-15 week period. *Pseudomonas aureofaciens* was isolated from the rhizosphere of trees on the suppressive sites. After 12-15 weeks, *C. xenoplax* increased slightly or declined when peach seedlings had been dipped in bacterial suspensions (10^8 bacteria/ml) prior to planting in steamed river sand or nonsuppressive field soil. Increases of 4-10 fold occurred on control plants. These results suggest that rhizosphere bacteria may contribute to the suppression of *C. xenoplax* on peach. *Department of Biological Sciences and Department of Plant Pathology and Physiology, Clemson University, Clemson, South Carolina, 29634, USA.*

McSorley, R. *Applied population modeling.*

Models forecasting population buildup have received much attention in nematology. In agricultural systems, relatively simple models estimating final densities (Pf) from initial densities (Pi) have been useful in practice. These critical point models can be linked in sequence to forecast population fluctuations over a series of crops, since Pf on a previous crop becomes Pi for the next. Computer models can be used to compare population projections from a variety of potential crop combinations and to estimate economic returns for selected sequences when population models are linked with plant damage functions. Sources of error can be perpetuated and compounded by crop sequence models, however, increasing ranges in final estimates. Major factors contributing to error in models forecasting popuplation buildup and crop loss include sampling error in obtaining Pi, confidence limits associated with derivation of regression equations, and seasonal variation in the relationship of Pf to Pi. Of these, seasonal variation in the model relationships appears to be the most substantial source of error, and is ignored if relationships are derived from data pooled across several seasons. Probabilities of various outcomes can be estimated by simulation if error terms are carried, providing a rationale for forecasting likely ranges in predicted populations. *Nematology Lab., Building 78, 0611-IFAS, University of Florida, Gainesville, Fl 32611, USA.*

McSorley, R., Dickson, D. W., Hewlett, T. E., & Frederick, J. J.: *Damage threshold studies of* Meloidogyne arenaria *on* Arachis hypogaea.

Microplots, 76 cm in diameter and 50 cm deep, in an Arredondo fine sand were inoculated with 0, 0.5, 1, 5, 10, 30, 50, 100, or 200 eggs of *M. arenaria* race 1 per 100 cm^3 soil. Each treatment was replicated 10 times, and plots were planted with three pregerminated seeds of 'Florunner' peanut, *Arachis hypogaea.* Ten days later, densities of 1.0 juvenile/100 cm^3 soil were found in plots inoculated with 30 or more eggs/100 cm^3, but only 0.1 juvenile in plots with 1-10 eggs/100 cm^3. At 60 days after planting, the size of plants was reduced in plots receiving the highest inoculum levels, resulting in lower midseason densities of juveniles in soil in plots receiving 100 or 200 eggs/100 cm^3 compared to plots receiving 10-30 eggs/100 cm^3. The same trend occurred in densities observed at harvest. Foliage weights and pod weights were inversely related to inoculum density ($r = 0.822$ and $r = 0.846$, respectively; $P \leq 0.01$, 88 d.f.). Both relationships showed best fits to Seinhorst's models with tolerance limits of 1.0 egg/100 cm^3 soil. Pod weights in plots inoculated with ≥ 50 eggs/100 cm^3 soil averaged < 25 g/plot, compared to 246 g/plot in uninoculated control plots. The results confirm field observations that the damage threshold of *M. arenaria* on peanut is at or near detection. *Nematology Lab., Building 78, 0611-IFAS, University of Florida, Gainesville, Fl 32611, USA.*

MELAKEBERHAN, H. & WEBSTER, J. M. *Is food consumption by* Bursaphelenchus xylophilus *significant in the death of* Pinus sylvestris?

We examined the relationship between the size of *Bursaphelenchus xylophilus*, and pine death and dry matter accumulation by 8-month-old *Pinus sylvestris* over a period of 5 weeks. Nematode fresh weights, calculated as a function of length and width were 0.02-0.5 μg, equivalent to 0.000043-0.0011 calories per nematode. Pines were treated with either wound, wound + water, wound + *B. xylophilus* culture filtrate, or wound + 400, 4,000 or 40,000 *B. xylophilus*. Whenever pines died, the number of dead pines and 3-4 symptomless pines from all treatments were harvested and dry weights determined. Number of nematodes in plant tissue were estimated from 0.2 g fresh weight samples. The medium and high nematode treatments resulted in 30% and 50% pine death, respectively, but nematodes accounted for <4 calories of food consumption. Whether the pines were dead or symptomless at the time of harvest, treatments did not differ in dry weights with or without nematodes. The data suggest that in the process of pine death food consumption by nematodes may not be significant but the effect of the nematode on host physiology is. *Department of Biological Sciences, Simon Fraser University, Vancouver, B.C., V5A 1S6 Canada.*

MELAKEBERHAN, H. & WEBSTER, J. M.: *Is starvation a factor in the death of* Bursaphelenchus xylophilus-*infected* Pinus sylvestris?

As part of our study of physiological changes associated with the pine tree's response to *Bursaphelenchus xylophilus*, we examined the effect of wound, wound + water, wound + *B. xylophilus* culture filtrate, or wound + lethal *B. xylophilus* doses on the assimilation and translocation of ^{14}C in eight-month-old *Pinus sylvestris*. Pines were exposed to 28.35μCi of $^{14}CO_2$ for 20 minutes either above (pine shoot leader) or below the point of nematode inoculation at 3 and 7 days after inoculation, respectively. At 4 and 2 hours after exposure to $^{14}CO_2$, nematode infection decreased ($P = 0.05$) ^{14}C assimilation, and translocation of ^{14}C by 10-55%. Relative to the amount of ^{14}C fixed per gram of exposed tissue, however, infected pines translocated more than controls. The data suggest that the effect on photoassimilation and translocation of photoassimilates probably results in decreased host maintenance activities of *B. xylophilus*-infected pines, and could be one of the key factors that lead to pine death through starvation. Further studies indicate that the effect on photosynthesis is preceded by an effect on water uptake. *Department of Biological Sciences, Simon Fraser University, Vancouver, B.C., V5A 1S6 Canada.*

MERCER, C. F.*, VAN DEN BOSCH, J.△, GRANT, J. L.* & BLACK, I. K.△, *Breeding* Trifolium repens *for resistance to* Meloidogyne hapla *and* Heterodera trifolii.

T. repens seedlings were raised individually in pots for 3 weeks then inoculated with a suspension of eggs of *M. hapla* or *H. trifolii*. At 5 weeks from inoculation, *M. hapla* galls or *H. trifolii* females/cysts were counted, roots weighed, and stolon tip cuttings taken from all resistant plants and some susceptible plants as a comparison. The F_1 progeny means of galls per gram root dry weight of pair crossed and open crossed plants more resistant to *M. hapla* were 76% and 81%, respectively, of the susceptible plants. Response to *H. trifolii* resistance selection was greater; the mean females/cysts per gram root dry weight of pair crossed resistant plants was 37% of susceptible plants. **DSIR Plant Protection and* △*DSIR Grasslands, Private Bag, Palmerston North, New Zealand.*

MERCER, C. F., GREENWOOD, D. R., & GRANT, J. L. *Effect of chitinase on* Meloidogyne hapla *eggs and juveniles, - a potential resistance factor?*

Chitinases from *Serratia marcescens* and *Streptomyces griseus* were prepared in 0.05 M potassium phosphate buffer at pH 7.0. *M. hapla* eggs and juveniles were added to serial dilutions from each chitinase source as well as controls of water, buffer, and boiled chitinase. Numbers of eggs, live and dead juveniles were counted at 11 days. Eggs became spherical and hatched prematurely in chitinase at 0.5% and 0.05% thereby increasing numbers of live and dead juveniles. The *S. marcescens* preparation tended to be more active. Chitinase solutions showed no apparent effect on juveniles. *DSIR Plant Protection, Private Bag, Palmerston North, New Zealand.*

MEYER, A. J. *Observations on annual ryegrass toxicity in South Africa.*

Annual ryegrass toxicity (ARGT) is a complex disease that kills sheep and cattle grazing on infected reygrass. The disease occurs when the nematode *Anguina agrostis* and a bacterium (*Corynebacterium rathayi*) invade annual reygrass and cause the seed heads to become toxic. The disease has been known in Australia since 1956 and was discovered in the Western Cape Province in 1979. Observations made on the development cycle, toxicity and spread in South Africa will be described. *University of Stellenbosch, Dept. of Entomology & Nematology, Stellenbosch 7600, RSA.*

MILLER, L. I. *Morphological comparisons of one isolate each of* Heterodera schachtii, H. cruciferae *and one of their hybrids.*

Comparisons were made of 21 specimens each of second-stage juveniles and males of the Salinas isolate (S) of *Heterodera schachtii* cultured on 'US75' sugarbeet, the Cabrillo isolate (C) of *H. cruciferae* cultured on 'Market Prize' cabbage and one of their hybrids (SC) cultured on 'US75' sugarbeet. Mean dimensions in μm were as follows — [juveniles] stylet length: S 25.1, C 24.4, SC 26.7; breadth of stylet knobs in lateral view: S 5.2, C 4.5, SC 4.9; stylet knobs to dorsal gland orifice: S 4.8, C 6.7, SC 5.3; [males] length: S 1235, C 1094, SC 1377; stylet knobs to dorsal gland orifice: S 4.7, C 4.3, SC 3.6; head tip to ventral pore: S 163, C 127, SC 170. S, C, and SC measurements were significantly different ($P > 0.05$) for all juvenile and male characters compared. 'Maxi' white mustard and 'Pegletta' and 'Nemex' fodder radish are highly resistant to reproduction of S, C, and SC hybrid. Cabbage was a good host of S, C, and SC. Sugarbeet was not a host of C but was a good host of S and SC. *Department of Plant Pathology, Physiology, and Weed Science, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, USA.*

MOENS, M., MOERMANS, R. & HENDRICKX, G.: *Spread of nematodes by recirculating nutrient solutions in gullies of hydroponic-like systems.*

Plant parasitic nematodes, liberated from ornamental pot plants grown on hydroponic-like systems, were detected in the nutrient solution. The influence of some physical parameters on the spread of nematodes in the nutrient solution was examined in laboratory conditions. 'Response surface methodology' was used for the description and interpretation of the experimental data. It can be concluded that: (a) a steeper slope and a higher flow-rate enhance the nematode spread; (b) the influence of the slope is more important than the flow-rate; (c) the pots present in the gullies slow down the spread and (d) nematodes liberated from pots move over a shorter distance than those introduced at the top of the gully. *State Research Station for Nematology and Entomology, C.L.O.-Gent, Burg. Van Gansberghelaan, 96, 9220 Merelbeke, Belgium.*

MOTA, M. M., & EISENBACK, J. D.: *Morphological comparisons among one isolate each of second-stage juveniles of* Globodera tabacum *sspp.* tabacum, virginiae *and* solanacearum.

Morphological comparisons using light microscopy (LM) and scanning electron microscopy (SEM) were made between one isolate each of second-stage juveniles of *Globodera tabacum tabacum*, Hazardville isolate (GTT), *G.t.virginiae*, Horton isolate (GTV), and *G.t.solanacearum*, Fisher isolate (GTS), reared on 'Rutgers' tomato plants. Observations focused on the stylet morphology (LM and SEM), lip region (SEM) and tail region (LM). No major differences were found between isolates of the three subspecies. Morphometric data, in μm, refer to mean and standard deviation (n = 30): stylet length (GTT = 23.1 ± 1.1, GTV = 23.7 ± 0.7, GTS = 24.8 ± 1.1); DEGO (GTT = 5.8 ± 0.7, GTV = 5.8 ± 0.8, GTS = 6.1 ± 0.6); stylet shaft length (GTT = 9.9 ± 0.7, GTV = 10.3 ± 0.7, GTS = 10.8 ± 0.6); shaft length/stylet length (GTT = 0.43 ± 0.02, GTV = 0.43 ± 0.03, GTS = 0.44 ± 0.02); width of stylet knobs (GTT = 4.6 ± 0.4, GTV = 4.9 ± 0.3, GTS = 5.1 ± 0.3); height of knobs (GTT = 2.9 ± 0.3, GTV = 3.2 ± 0.3, GTS = 3.1 ± 0.3); width/height of knobs (GTT = 1.58 ± 0.19, GTV = 1.54 ± 0.16, GTS = 1.67 ± 0.21). Stylet-related characters were very reliable and stable. Complementary observations of males and females may help clarify the status of this species complex. *Dept. Plant Pathol., Physiol. & Weed Sci., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, USA.*

MOUNPORT, D.[1]) & BAUJARD, P[2]): *Cuticle ultrastructure in the Tylenchina (Nemata: Diplogasteria).*

The fine structure of the cuticle of twelve species belonging to the Tylenchidae, Belonolaimidae, Hoplolaimidae, Pratylenchidae and Criconematidae is presented. The simplest anatomy has been observed in Tylenchidae and the most complicated in Hoplolaimidae. The cuticle, outside the lateral fields, may be subdivided into three zones in all the families studied except in Hoplolaimidae; intrageneric differences in cuticle anatomy occur in *Criconemella* species; intergeneric differences in the cuticle layers have been observed in Hoplolaiminae resulting in three groups of genera.[1]) *Département de Biologie Animale, Université Cheikh Anta Diop, Dakar, Sénégal;* [2])*Centre ORSTOM, B.P. 1386, Dakar, Sénégal.*

MOUSA, E. M., GAAFAR, A. A. & EL-SHENNAWY: *The influence of root-knot nematodes on damping-off and wilt fungi of cotton.*

Four cotton cultivars, resistant to *Fusarium oxysporum* f. sp. *vasinfectum* and *Rhizoctonia solani* and four other cotton cultivars susceptible to both these fungi, all of which were susceptible to root-knot nematode *Meloidogyne javanica*, were used to investigate the nematode-fungi interrelationships. More *F. oxysporum f. vasinfectum* was found in the vascular tissues of roots and stems of plants inoculated with the fungus and nematodes than in plants exposed to the fungus alone. Similarly, much more *R. solani* was obtained from roots exposed to the nematode, than from roots infected with the fungus alone. Giant cells were strongly invaded by the fungal elements. Root-galling in plants infected with fungi was greatly reduced compared to plants infected with nematode alone. Severe wilt and damping-off occurred in the resistant cultivars to both fungi. *Department of Plant Sciences, Faculty of Agriculture, Menoufiya University, Egypt.*

MÜLLER, J. *Investigations on the occurrence of pathotypes in* Heterodera schachtii.

Different resistance genes from *Beta procumbens*, *B. webbiana* and *B. patellaris* have been transferred into *B. vulgaris*, and several *Beta*-genotypes are used for breeding *Heterodera schachtii*-resistant sugar beet. However, almost nothing is known about the virulence of different nematode populations. We collected soil containing *H. schachtii* from 146 locations and tested nematode multiplication rates on *Beta*-hybrids with resistance genes from the three wild *Beta*-species. When young beet seedlings were infested with *H. schachtii* juveniles and evaluated after four weeks, only a few nematode populations had produced slightly higher cyst numbers than the mean. However, pronounced differences became visible after about three nematode generations had developed; multiplication rates ranging from 0.1 to 40 were determined. Virulence in certain nematode populations was restricted to specific *Beta*-genotypes. It is supposed that qualitatively different resistance genes have been transferred from wild *Beta*-species to the breeding lines. In this investigation they have successfully been used to differentiate pathotypes in *H. schachtii*. *Biologische Bundesanstalt, Institut für Nematologie und Wirbeltierkunde, D-4400 Münster, Deutschland.*

MÜLLER, J. *The effect of nematode-resistant sugar-beet hybrids on the population dynamics of* Heterodera schachtii *under field conditions.*

Five different *Beta*-genotypes with genes for resistance to *Heterodera schachtii* from *Beta procumbens* or *B. webbiana* were used to study their effect on the population dynamics of beet cyst nematode. The plants were hybrids derived from crossings of resistant monosomic addition lines or translocation lines with sugar beet. The young seedlings were first tested for their resistance and then planted in April/May under field conditions in soil with different population levels (Pi) of *H. schachtii*. Final population densities (Pf) were determined in November. Multiplication rates were expressed as Pf/Pi-quotients and their correlation with initial population densities (Pi) was calculated. A good correlation between multiplication rate and Pi was obtained in all years (1986-1989) with susceptible varieties as control plants. Resistant genotypes gave different regression lines. It is concluded that different resistance genes have been transferred to the tested genotypes. *Biologische Bundesanstalt, Institut für Nematologie und Wirbeltierkunde, D-4400 Münster, Deutschland.*

MUELLER, J. D., FORTNUM, B. A., & LEWIS, S. A. *Host suitability and yield response of corn hybrids and a South Carolina composite to* Hoplolaimus columbus.

Host range studies indicate that corn (*Zea mays*) is a host of *Hoplolaimus columbus* but there is little evidence that plant yield is affected. Five corn hybrids and one South Carolina composite were planted at the Pee Dee and the Edisto Research and Education Centers in fields infested with an average of 98 and 50, respectively, *Hoplolaimus columbus*/100 cm^3 of soil to assess their host suitability and the effects of soil fumigation with 1,3-D. Each hybrid or composite was planted in a paired plot of 2 rows (12.2 m long on 96-cm centers) untreated and two rows treated with 56 liters/ha (6.7 ml/m) 1,3-D. *Hoplolaimus columbus* reproduced on all six corn hybrids tested and large numbers of nematodes were found within the roots. Yields were significantly increased ($P = 0.01$) with the application of 1,3-D and were 16-86% and 5-52% greater at the two sites, respectively than in the untreated plots. The number of nematodes in roots at anthesis was lower in fumigated plots ($P = 0.01$) than in non-fumigated plots. Populations of nematodes in roots ranged from 202-493 (Pee Dee) and 277-983 (Edisto)/gram dry weight. A hybrid × nematicide interaction was not observed. Corn appears to support a high level of *H. columbus* reproduction and may be a poor rotation crop for fields infested with this nematode. *Clemson University, P.O. Box 247, Blackville, SC 29817, USA.*

MUGNIERY, D. & BALANDRAS, C. *Assessment of potatoes for resistance to potato cyst nematodes (PCN),* G. rostochiensis and G. pallida (GRo & GPa).

In the seventies the only gene of resistance carried by potatoes was H1, conferring a total resistance to GRol. Whatever the test and the GRol population, results were clear. Now selected genotypes have complex backgrounds and may act on PCN against hatching, development and sex-determination whatever the species and pathotypes. Moreover some have a type of induced resistance against GRol which may act against GPa3.

Potatoes have to be cultivated under ranges of climatic conditions, cultural methods and different virulence populations. For the breeder it's not possible to take account of all these parameters and they need to know with which standard populations and with which test methods they have to work in order to know the mechanisms and the level of resistance of the selected genotypes.

In breeding programs: a) progeny tests are available mainly against GRo2/3/5 and GPa2/3 in order to identify the most promising crosses. The test may be done in pot or in Petri dish; b) individual tests which have to be severe in the first instance are done generally in pots or in Foot containers. With advanced material, hatching tests and resistance tests in Petri dishes are recommended to determine the mechanisms of resistance.

For regulation purposes, both tests, pot and Petri dish are preferable to one test only, whatever the test is. Instead of seeking absolute resistance which is unrealistic with partially resistant genotypes, a relative scale of resistance, using reference clones, must be used. Checks have to be made under particular climatic conditions with local populations by national and local plant protection services. *Laboratoire de Zoologie, INRA, 35650 Le Rheu, France.*

MULDER, A. *Effect of pH on the tolerance of potatoes against* Globodera pallida.

In field trials on sandy and sandy peat soils in the northeastern part of the Netherlands the pH of the soil proved to be of major importance in the severity of damage to potatoes by *Globodera pallida.* At pH = 4.8 no decrease in yield is detected at infestation levels below 200 living juveniles (lj) per 100 g soil. At higher pH-values and infestation levels above 200 lj per 100 g soil, damage results in yield reductions up to 25%. At increasing pH-values, the susceptibility to damage of all potato varieties tested (10) increased, resulting in higher yield reduction. At a pH = 6 damage is restricted to approx. 5%, at low infestation levels, but increases to yield reductions of up to 50% at population densities of more than 2000 lj per 100 gr soil. *H. L. Hilbrands Laboratorium voor Bodemziekten, Mr. P. J. Troelstralaan 1a, 9402 BA Assen, The Netherlands.*

MULDER, A. & JELLEMA, P. *On the nature of resistance to* G. pallida *of potato varieties derived from* Solanum vernei.

On eight Pa- infested fields (sandy and sandy peat soils) experiments were carried out with potato varieties with resistance to Ro_1, $Ro_{1,3}$ and $Ro_{1,3}/Pa_2$, and susceptible ones. At low initial population densities multiplication was observed on all cultivars. On the Pa_2 resistant varieties (cvs Darwina and Atrela) multiplication was about 50% lower compared to the other cultivars. Higher initial population densities (>2000 lj/100 g soil) were decreased by a maximum of about 50% of the initial population. The results indicate that these (so-called) Pa_2 resistant varieties should be considered as "bad hosts" to *G. pallida. H. L. Hilbrands Laboratorium voor Bodemziekten, Mr. P. J. Troelstralaan 1a, 9402 BA Assen, resp. Plant Protection Service, Geertjesweg 15, 6706 EA Wageningen, The Netherlands.*

MULDER, A., ROOSJEN, J. & SMELT, J. H. *A new and improved technique for a still better application of soil fumigants.*

With a share-injector (Rumpstad CombiJet and Climax) fumigants are applied as a liquid at a depth of 18-20 cm. From there the gases penetrate through the soil. The achieved CT-products in the upper 5-8 cm of the tillage layer are mostly too low for a high kill of the nematodes. On the other hand, in many cases, the fumes penetrate, by diffusion and leaching, so deep, that small amounts of residues can be detected in the shallow (1-2 meters deep) ground water. Experiments on sandy soils, with a new application technique (Rotary Spading Injector) showed that a near optimal distribution of the compounds through the soil resulted in very good nematicidal effects in the whole depth of the tillage layer. Also deep penetration, and contamination of the shallow ground water is highly reduced. *H. L. Hilbrands Laboratorium voor Bodemziekten, Mr. P. J. Troelstralaan 1a, 9402 BA Assen, resp. Staring Centre, Marijkeweg 22, 8709 PD Wageningen, The Netherlands.*

MULDER, J. G. & VROOM-WOLF, A. W. *Periodicity in hatching response of vintage cysts of* Globodera rostochiensis.

Vintage cysts, *G. rostochiensis*, (Ro_1), originating from population Mierenbos, were multiplied in the greenhouse in different seasons in one year. Their hatching response, both spontaneous and induced by potato root diffusate (PRD) was followed during a two year period. A periodicity in hatching response was observed, independent of the growing season, in which the cysts were multiplied in the greenhouse. This periodicity was most prominent in spontaneous hatch, whereas, when hatch was induced by PRD, periodicity seemed to disappear at prolonged exposure of the cysts to PRD. *H. L. Hilbrands Laboratory for Soil-borne Pests and Diseases, P. O. Box 323, 9400 AH Assen, The Netherlands.*

MUNDO-OCAMPO, M. & BALDWIN, J. G. *Comparison of host parasite relations of* Ekphymatodera thomasoni *with other Heteroderinae.*

Light microscopy, SEM, and TEM indicate that the nurse cell induced by *Ekphymatodera thomasoni* on *Juncus effusus* is a small syncytium within the stele which resembles that of *Verutus* spp. Unlike those of *Globodera, Heterodera* and *Cactodera*, the syncytium lacks wall ingrowths, has poorly defined boundaries, and is associated with little hypertrophy. Each unit of the syncytium apparently has one cluster of nuclei or a single mutilobed nucleus. The thickened wall adjacent to the nematode head is similar to that of the single uninucleate giant cell of *Sarisodera*. The syncytium of *E. thomasoni* is compared with that of *Punctodera chalcoensis* which, contrary to previous reports, also lacks wall ingrowths. *Department of Nematology, University of California, Riverside, CA 92521, USA.*

NAVAS, A., BARRIOS, L., NOMBELA, G. & HERRERO, P. *Phylogenetic and biogeographical relationship of genus* Longidorus *in the Euromediterranean area.*

An approach to the historical biogeography of genus *Longidorus* in the Euromediterranean area is carried out. The most commonly accepted chorological units of the area were considered

and compared from a geographical and faunistic point of view, to determine in which species the apocoric compounds are more important. Graph theory is applied to define the connexions between areas as well as the congruence degree with different cladograms. A method to infer multistate character polarity of species and consequently a phylogeny of the group is proposed. *Instituto de Edafología y Biología Vegetal (CSIC), Serrano 115 dpdo, 28006 Madrid, Spain.*

NAVAS, A., ESPARRAGO, G., MARTINEZ, J. L. & CUADRA, L. *Parasitic and pathogenic differences among populations of* Meloidogyne incognita *Race 1.*

After continuous cropping in greenhouse of 20 populations of *M. incognita*, three isolated from tomato, *Chenopodium* sp., and almond tree, identified as Race 1 were selected as showing quantitative differences in their biological potential (galls and egg production). Intra-racial parasitic variability and interaction with five tomato cultivars, considered as resistant (Nema 1401, Alphapeel and Zenith) and susceptible (Hypeel 244 and Rio Fuego) were analyzed. Interaction is defined by: a) weight of the aerial part of the plant; b) nematode reproduction (galls and egg-mass numbers, and total number of females and second stage juveniles in roots); c) percentage of phenols in the roots, and d) changes in root respiration owing to infection. Results suggest selection of a virulent population able to reproduce on a resistant cultivar and presence of differential interaction *sensu* Robinson (1980). Populations of *M. incognita* R1 could be defined at an intra-racial level according to the conclusions and results of Powers and Sandall (1988) about genetic distance. *Instituto de Edafología y Biología Vegetal (CSIC), Serrano 115 dpdo, 28006 Madrid, Spain.*

NAVAS, A., NOMBELA, G. & ZACHEO, G. *Reproductive behaviour and respiration rate of* Aphelenchus avenae *isolates.*

Population structure and respiration rate after their adaptation for more than 6 months to the same host (*Rhizoctonia solani*) are studied for 5 geographically separated *A. avenae* isolates. Four mature females were inoculated and cultured for 45 days on the fungi *R. solani, Verticillium dahliae, Phytophthora parasitica, Ph. capsici, Fusarium oxysporum* f.sp. *lycopersici, F. oxysporum* f.sp. *pini* and *F. solani*. Taking into account the possibility of selecting populations adapted to environmental demands of phyto-pathogenic fungi, respiratory behaviour in different pH (5, 6, 7 and 8) was also studied as well as inhibition percentages of total respiration with inhibitors CNK, Sham and Antimicine A. Results suggest a clear discrimination among nematode isolates depending on hosts and physiological behaviour, mainly determinated by structure (and origin) of populations. Such hypothesis is also confirmed with the same analysis in another ubiquitous nematode species, such as *Cephalobus persignis*. *Instituto de Edafología y Biología Vegetal (CSIC), Serrano 115 dpdo, 28006 Madrid, Spain.*

NIBLACK, T. L., BAKER, N. K., & SMITH, G. S. *Quantification of the* Heterodera glycines-Glycine max *association in Iowa and Missouri*

During the 1980's the soybean cyst nematode (*Heterodera glycines* Ichinohe) was recognized as the most economically important soybean pathogen in the midwestern United States. Field and microplot studies were conducted in the north/central regions of Iowa (1986-87) and Missouri (1988-89) to assess yield losses due to the nematode and to identify damage thresholds for advisory purposes. Field plot studies were conducted in 16 different environments with natural infestations of *H. glycines*, with combinations of susceptible and resistant cultivars adapted to the environments in which they were grown. Plots were 6 m long, with 4 rows spaced 76 cm apart; each study included plots treated with aldicarb at 1.12 kg ha^{-1}. Plots were sampled at planting, midseason (R3) and harvest for cyst and egg densities/250 cm^3 soil. Field microplots of 1 m^2 were established in fields with low natural infestations (less than 10 eggs/250 cm^3 soil) and infested to a depth of 15 cm with from 0 to 100 eggs/cm^3. In all field plot locations, soybean cyst nematode egg density/250 cm^3 soil was better than cyst density as a predictor of seed yield. The relationship was subject to significant soybean genotype × environment interaction, but a density of 2 eggs/cm^3 soil caused significant reductions in seed yield of most susceptible cultivars in all locations. Mean seed yields of resistant soybean cultivars were -3% to +96%

of yields of susceptible cultivars. Microplot data suggested that egg densities in field plots are underestimated. *Department of Plant Pathology, University of Missouri, 108 Waters Hall, Columbia, Missouri, 65211, USA.*

DEN NIJS, L. J. M. F. *Assessing the effect of concomitant infections of* G. rostochiensis *and* G. pallida *on their reproduction.*

Mixtures of the two potato cyst nematode species *G. rostochiensis* (Ro1) and *G. pallida* (Pa3) were reared on susceptible, resistant and species-specific resistant potato varieties. Species composition of the newly formed cysts was determined by analysing the species specific thermostable proteins by way of separation and subsequent quantification on SDS-PAGE. Reproduction of each species in the mixture was calculated and compared to the single species population. This analysis revealed that in the mixtures the two species interacted. A decrease in reproduction could be significantly proved for *G. rostochiensis* and almost significantly for *G. pallida* in the situation where one of the species is in excess of the other (<25%). This phenomenon was established on all cultivars used. *Research Institute for Plant Protection, P.O. Box 9060, 6700 GW Wageningen, The Netherlands.*

NICOLAS, H., RIVOAL, R., DUCHESNE, J. & LILI, Z. *Thermal infrared remote sensing of winter wheat infested by* Heterodera avenae *Woll.*

Experiments were conducted on two rows with different infestation levels to determine the potentialities of thermal infrared remote sensing techniques for the detection of *H. avenae.* Crop canopy temperature was measured with portable radiothermometers and a thermal infrared camera. The presence of *H. avenae* in the root system increased canopy temperature as a consequence of an increase of stomatal resistance in infested plants; the temperature difference was about 1 to 1.5 degrees Celsius at midday. Thermal images made it possible to identify clearly defined areas of both rows with moderate and low infestation, and should be extensively applied to the detection of nematode attacks by remote sensing in large wheat fields. *Ecole Nationale Supérieure Agronomique de Rennes, 65, rue de Saint-Brieuc, 35042, Rennes cédex, France.*

NISHIZAWA, T. *Comparative experiments on spore-attachment to host nematodes by two isolates of* Pasteuria penetrans.

In the case of the isolate of *P. penetrans* parasitic only on cyst nematodes, desiccation of the spore suspension or exposure of the spores to high frequency sound waves (sonication) for a few minutes were highly effective in increasing spore-attachment to the body surface of the host nematode juveniles. Mechanical disruption of the sporangial wall might be the causal mechanism of this phenomenon. Treatment of the spores with high (60°C for 1 hr) or low (-20°C for 1 hr) temperatures was not effective in increasing to this capacity. Shaking treatment of the incubating medium strikingly inhibited spore-attachment. By contrast, similar phenomena were barely recognized in the isolate of *P. penetrans* parasitic only to root-knot nematodes. *Department of Environmental Biology, National Institute of Agro-Environmental Sciences, Tsukuba, Ibaraki 305, Japan.*

NOBBS, J. M. *Distribution of nematodes within a small area of native vegetation in the arid region of South Australia.*

A 25 metre square area of vegetation, consisting of *Acacia papyrocarpa* and mixed Chenopods (*Atriplex vesicaria* and *Maireana sedifolia*), was separated into 25 5-metre square quadrats and soil sampled randomly within each quadrat to a depth of 25 cm. The nematode fauna was extracted and separated into the four major trophic groups: omnivores/predators (Dorylaims); bacterial feeders (Rhabditids); fungal feeders (Aphelenchs and Tylenchids) and plant parasites (Tylenchids). The plant parasitic nematodes were identified as *Tylenchorhynchus tobari* Sauer & Annells, 1981; *Tylenchorhynchus siccus* Nobbs, 1990 and *Morulaimus* sp. There was no significant correlation between any particular plant species and trophic groups, except plant parasites. The distribution of *T. tobari* was positively correlated with the distribution of *Atriplex vesicaria* and *T.*

siccus was positively correlated with *Acacia papyrocarpa/Maireana sedifolia. Department of Plant Nematology, CAB International Institute of Parasitology, 395A Hatfield Rd., St Albans, Herts., England AL4 OXU.*

NOLING, J. W. *Methyl bromide soil fumigation for multiple pest control in Florida citrus replant sites.*

Preplant soil fumigation experiments with methyl bromide (MBC) were conducted at nine Florida locations to evaluate control of citrus root suckers, weeds, nematodes, and fungi. MBC was applied at three rates (0.45, 0.68, and 0.91 kg MBC/site) and dispensed through 1-6 injection points around a tree stump or a future citrus tree replant site. Depending on dosage and placement pattern, use of MBC resulted in 35-90% reductions ($P = 0.05$) in root suckering. The average radius of weed control from the point of injection increased ($P = 0.05$) from 71 cm at the 0.45 kg rate to 90 cm at the 0.9 kg rate of MBC application. At one location, recolonization by *Phytophthora parasitica* occurred in 24% of the fumigated plots within 7 months after fumigation. All MBC treatments effectively controlled citrus nematode, *Tylenchulus semipenetrans*, for a period of 18 months within the fumigated soil zone. However, citrus tree root growth into nonfumigated, citrus nematode infested soil was observed 16 months postfumigation. Increased tree growth was not apparent 12 months postfumigation at any location. *Department of Entomology and Nematology, University of Florida, IFAS, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850, USA.*

NOMBELA, G., NAVAS, A. & BELLO, A. *Ecological structure of soil nematofauna in agro-oecosystems representative for Central Spain.*

The structure of the nematofauna of the most representative soils of the cereal agrosystems of the Spanish southern plateau has been studied. The trophic groups of nematodes, their reproductive strategy (r or k), type of use, cultural practices and physical and chemical parameters of the studied soils were estimated as structural elements to consider. The trophic groups (saprophagous, predators and omnivorous) define concrete associations with phytoparasitic according to their behaviour (sedentary/migratory, endoparasitic/ectoparasitic). As a whole the ecological structure is simple, limited by low diversity, but stable, and knowledge of which makes the use of cultural methods in the control of pathogenic nematodes possible. The indicative value of genus *Paratylenchus* and *Tylenchus*, representative for uncultivated and rotational system areas resp., is pointed out as well as the value of clay as regulator element of this system, considered as one of the most characteristic in the mediterranean area. *Instituto de Edafologia y Biologia Vegetal (CSIC), Serrano 115 dpdo, 28006 Madrid, Spain.*

NORDMEYER, D. *The search for novel nematicidal compounds*

Toxicological and environmental concerns have led to a marked reduction in the availability of efficient market nematicides within the past 10 years. No new nematicides with novel mode of action or favorable environmental characteristics have been brought to the market. In the future it is unlikely that further fumigants or cholinesterase-inhibitors will be developed. We can use our knowledge of modes of action and fate of nematicides to find novel compounds and develop innovative nematode management strategies with the objective of producing an efficient and environmentally satisfactory solution. Selected examples of known and potential biochemical targets will be discussed as well as the impact of the compounds fate in soil and nematodes on their efficacy. Critical issues for the development of novel compounds as well as possible use strategies will be outlined. *CIBA-GEIGY Limited, Agro Division, Research and Development, CH-4002 Basle, Switzerland.*

NYCZEPIR, A. P. & BERTRAND, P. F. *Suppression of* Criconemella xenoplax *with selected small grains.*

Field and greenhouse studies were conducted to access the susceptibility of some small grain and/or row crops commonly planted in the southeastern United States as a host for *Criconemella xenoplax*. Small grain cultivars and cotton tested were either poor hosts or nonhosts for *C.*

xenoplax, whereas soybean and sorghum cultivars were suitable hosts. Stacy winter wheat appears to be a nonhost and antagonistic to the nematode since no *C. xenoplax* were detected in the field and greenhouse studies. Incorporating Stacy wheat into an integrated control management plan may prove to be an alternative preplant control method for *C. xenoplax* on land having a history of peach tree short life. *USDA, ARS, S.E. Fruit and Tree Nut Research Laboratory, Byron, GA 31008 and University of Georgia, Tifton, GA 31793, USA.*

OCAÑA, A., PICAZO, J. & PEÑA, R. *The influence specific physicochemical parameters have on specimens from the order* Dorylaimida.

Using the Pearson coefficient of correlation the relationship between 13 physico-chemical parameters (temperature, pH, oxygen, Cl, SO_4, CO_3H, Ca, Mg, Na, K and Fe) and organic sediment material was studied for 24 species from order *Dorylaimida*, representing some of the nematode fauna reported from 38 mineral-medicinal springs in the province of Granada (Spain). On the basis of the resulting correlation matrix, we found that of the variables analyzed, oxygen and iron were found to be statistically significant for many species, and that none of the species studied (with the exception of *Proleptonchus* sp.) showed positive correlations when compared to conductivity, a parameter which is determined by ions which are for the most part dissolved in natural water environments. *Departamento de Biología Animal, Ecología y Genética. Fac. Ciencias. Univ. Granada 18071 Granada, Spain.*

OLTHOF, Th. H. A., & BROADBENT, A. B. *Control of a chrysanthemum leafminer,* Liriomyza trifolii, *with the entomophilic nematode,* Heterorhabditis heliothidis.

Foliar sprays of *Heterorhabditis heliothidis* (PheroTech SC 88) in water containing 0.02% sticker (Agral 90), applied at 100,000 nematodes/10 ml/plant to 10-15-cm potted chrysanthemums (cv. Manatee Iceberg) 3 days after oviposition by *Liriomyza trifolii* were very effective. Based on 7 laboratory experiments the average mortality of leafminer larvae was 93.5% as compared to 10.0% in the water control. In several dosage studies to date the average mortality at 100,000, 50,000, and 25,000 nematodes/plant was 90.0%, 82.9%, and 76.2%, respectively. Soil applications of nematodes, both pre- and post introduction of leafminer prepupae, were ineffective. *Research Branch, Agriculture Canada, Research Station, Vineland Station, Ontario LOR 2EO, Canada.*

OLTHOF, Th. H. A., & RINKER, D. L. *Efficacy of entomophilic nematodes in the control of a mushroom fly,* Lycoriella mali (*Diptera: Sciaridae*).

In a 10× -replicated trial, 100-g quantities of spawned compost in glass jars were inoculated with 10,000, 20,000, 40,000, and 80,000 *Heterorhabditis heliothidis*, delivered in 20 ml water, followed immediately by the introduction of 10 gravid females of the sciarid mushroom fly, *Lycoriella mali*. No difference was observed in the number of adult flies caught on sticky traps after 37 days in the dark at 25°C. In a second trial when 60,000 *H. heliothidis* were applied to spawned compost immediately after the introduction of 10 gravid *Lycoriella mali* or after 3, 6, 10, 13, or 18 days, highest mortality was achieved at 10 days and lowest at day 0. In three experiments to date involving 9 strains of entomophilic nematodes, purchased commercially or laboratory-reared on *Galleria mellonella* larvae (6 *Steinernema feltiae*, 2 *H. heliothidis*, 1 *H. bacteriophora*), applied at 100,000/100 g compost at 5-10 days after introducing *L. mali*, *H. heliothidis* caused highest overall mortality. *Research Branch, Agriculture Canada, Research Station*; and *Horticultural Research Institute of Ontario, Ontario Ministry of Agriculture and Food; Vineland Station, Ontario LOR 2EO, Canada.*

OMWEGA, C. O. & ROBERTS, P. A. *Genetics of resistance to* Meloidogyne incognita *in common bean.*

Resistance to *Meloidogyne incognita* was studied in the common bean line PI 165426. Reciprocal crosses were made between the resistant line and susceptible cultivar Kentucky Wonder (KW) to obtain F1 generation. The F1, F2, F3, and backcross populations of the cross PI 165426 × KW were screened for resistance to *M. incognita* races 2 and 3. The F1 plants were found to be

resistant to both races, suggesting that the resistance is dominant. In the F2 generation, segregation of 3 resistant: 1 susceptible was obtained when plants were assayed for resistance using 1000 second stage juveniles (J2) of *M. incognita* race 2 as the inoculum. In a test of four F2 families inoculated with 2000 J2 of *M. incognita* race 3, segregation in three of the four families had a good fit to a 3:1 ratio. Results in most of the F3 families were consistent with a single dominant gene model, but a few families did not conform to this conclusion. Our tentative explanation is that resistance in PI 165426 is controlled by a single dominant gene but the expression of this gene is influenced by other genetic factors. *Department of Nematology, University of California, Riverside, CA 92521, USA.*

OPPERMAN, C. H. *Molecular basis of differential nematode sensitivity to nematicides.*

Non-fumigant carbamate and organophosphate nematicides act by inhibiting nematode acetylcholinesterase at the neuromuscular junction, resulting in paralysis. The effects of non-fumigant nematicides are readily reversible if the nematicide exposure is reduced or eliminated. Plant-parasitic nematodes display large variations between genera in regard to sensitivity to non-fumigant nematicides. In addition, there is often no correlation between observed behavioral effects of applied nematicide and the in vitro enzyme inhibition on crude acetylcholinesterase preparations. Nematode acetylcholinesterase exists in multiple molecular forms within the neuroanatomy. These forms comprise three discrete classes, A, B, and C, which vary in their physical and biochemical properties, and are encoded by separate genes. Classes A and B resemble acetylcholinesterases isolated from other animals with respect to their kinetic parameters and response to enzyme inhibitors. Class C acetylcholinesterase is unique to nematodes: it has a very high affinity for acetylcholine, but is relatively insensitive to carbamate and organophosphate inhibitors. This form of acetylcholinesterase is relatively abundant in *Meloidogyne* species. The responses of plant-parasitic nematodes to nematicides are a result of the relative abundance and localization of the various molecular forms of acetylcholinesterase. *Department of Plant Pathology, North Carolina State University, Raleigh, N.C., USA.*

ORION, D.[1]) & KRITZMAN, G.[2]) *Antimicrobial activity of* Meloidogyne javanica *gelatinous matrix*

Young egg masses obtained from monoxenic cultures of the root knot nematode *Meloidogyne javanica* were placed in a suspension of *Pseudomonas syringae* pv. *tomato* (PS), *Bacillus subtilis* (BS) or *Saccharomyces* sp. (SS). The population growth rates of BS and SS were significantly reduced in the presence of the egg masses while PS was not affected at all. Microscope observation showed strong agglutination of both BS and SS cells in the vicintiy of the gelatinous matrix. It is concluded that the GM has antimicrobial properties probably for the protection of the nematode eggs. [1])*Department of Nematology and* [2])*Department of Plant Pathology, Agricultural Research Organization, Volcani Center, Bet Dagan 50250, Israel.*

OSBORNE, W. W. *Severity of the Osborne's cyst nematode (OCN) on tobacco, tomato, and eggplant.*

Data show that the Osborne's cyst nematode (OCN), *Globodera solanacearum* (Miller & Gray, 1972) Behrens, 1975, causes crop loss in excess of 40 percent in field grown tobacco (*Nicotiana tabacum* L.) and tomato (*Lycopersicon esculentum* Mill). The OCN also causes crop failure in eggplant (*Solanum melongena* L.) by severely stunting plants, curtailing fruit yield and weight in excess of 45 percent, and delaying fruit maturity. *IAI, Inc., South Boston, Virginia 24592, USA.*

OSBORNE, W. W. & ADAMS, H. S. *Differences in the pathogenicity, geographic distribution, and control of the Osborne's cyst nematode (OCN) and the tobacco cyst nematode (TCN).*

Recent studies show that the OCN will lessen flue-cured tobacco (*Nicotiana tabacum* L.), tomato (*Lycopersicon esculentum* Mill.), and eggplant (*Solanum melongena* L.) yield more than 50%, 45%, and 50% respectively. The TCN alone is reported to cause a 22% loss in Connecticut broadleaf tobacco. The TCN alone is not economically important in tomato or eggplant production. Pepper (*Capsium frutescens* L.) is a host to the TCN but is not a host to the OCN.

The OCN occurs on economic crops only in Virginia. The TCN occurs only in Connecticut and Massachusetts in the USA and in Bulgaria.

In Connecticut, the TCN contributes to a disease complex of TCN-*Fusarium* wilt on tobacco and TCN-*Verticillium* wilt on tomato. No OCN disease complex interactions with other pathogens have been demonstrated in Virginia on field grown crops. Therefore, OCN and TCN control measures differ greatly. *IAI, Inc., South Boston, Virginia 24592, and Dabney S. Lancaster College, Clifton Forge, Virginia 24422 USA.*

OU, X. & WATSON A. K. *In vitro mass rearing of Russian knapweed nematode,* Subanguina picridis.

Russian knapweed nematode, *Subanguina picridis* has been cultured monoxenically *in vitro.* A shoot culture system, initiated from shoot tip culture, is used as plant tissue culture system for *S. picridis* culture. The surface sterile nematodes are applied to young shoots growing on the artificial medium, and then incubated at 20°C and 16 hour photoperiod. Six days after infestation, the galls can be observed on the leaf, shoot apex and the petiole parts of the shoots. The nematodes developed and reproduced inside the galls. Three months after infestation, the number of nematodes increased from 50 initial infestation number to 7,000-10,000. These cultured nematodes are virulent on greenhouse grown plants and the optimization of this mass production system will significantly enhance the biocontrol program on the economically important weed, Russian knapweed (*Acroptilon repens* (L.) DC.). *Department of Plant Science, Macdonald College of McGill University, Montreal, H9X 1CO, Canada.*

OVERSTREET, C., MCGAWLEY, E. C., RUSSIN J. S. & WINCHELL, K. L. *Interactions between* Calonectria crotolariae *and* Heterodera glycines *on soybean.*

The interactions of *H. glycines* (*H.g.*) at 0,10^2, 10^3, & 10^4 eggs/pot and 0,100, & 200 cysts/pot and *C. crotolariae* (*C.c.*) at 500, 5000, & 50,000 microsclerotia/pot were evaluated. At 10^4 eggs/pot, nematode reproduction is increased at each microsclerotial level. *H.g.* × *C.c.* interactions were significant and antagonistic to soybean growth. Use of *C.c.*-infected *H.g.* race differentials did not alter the analysis of the nematode population as race 3. *Department of Plant Path. & Crop Phys., L.S.U., B.R., LA, USA.*

PARNITZKI, P. F.[1]), TREVERROW, N.[2]), BEDDING, R. A.[3]) & SIKORA, R. A.[1]) *Susceptibility of adults of the banana weevil borer* Cosmopolites sordidus *to 32 species and strains of* Heterorhabditis *and* Neoaplectana.

The susceptibility of adults of the banana weevil borer *C. sordidus* in vermiculite to 32 species and strains of *Heterorhabditis* and *Neoaplectana* has been compared in laboratory trials. Tests were carried out simultaneously in the Kingdom of Tonga, and in NSW, Australia to examine possible differences in the susceptibility to nematodes of Tongan and NSW derived weevils. Results show that there is high variation in susceptibility between strains and species. Effective strains were characterized by consistent results, while marginal strains were either clearly ineffective or highly variable. [1])*Institut für Pflanzenkrankheiten der Universität Bonn, Nussallee 9, 5300 Bonn, Germany;* [2])*Dept. of Agr. Inst., Wollongbar 2480, Australia;* [3])*C.S.I.R.O., Div. Entomology, Clunnies Ross St., Canberra, ACT. 2800, Australia.*

PASHA, M. J., KHAN, M. W. & SIDDIQUI, Z. A. *Effect of soil amendment with flyash of thermal power plant origin on root-knot nematode on cucumber.*

Amendment of soil with flyash (10 and 25%) of thermal power plant origin improved the plant growth, yield and chlorophyll content of leaves of uninoculated cucumber plants. These parameters of plants inoculated with *Meloidogyne javanica* and grown in amended soil (10-25%) were also greater than inoculated plants grown in unamended soil. But the juvenile penetration, root galling and eggmass production were greater in amended soil. At higher levels (50-100%), flyash became toxic and suppressed all the parameters of plants studied as well as juvenile penetration, root galling and eggmass production on cucumber. *Section Plant Pathology & Nematology, Department of Botany, Aligarh Muslim University, Aligarh 202 002, India.*

PAUL, H., DEELEN, J. E. M. VAN, HENKEN, B., BOCK, Th. S. M. DE, LANGE, W. & KRENS, F. A. *Expression of resistance to* Heterodera schachtii *in hairy roots of a nematode-resistant monotelosomic addition plant of beet* (Beta vulgaris).

Hairy roots were induced by *Agrobacterium rhizogenes* on beet plants (*Beta vulgaris* L.) susceptible to the beet cyst nematode, *Heterodera schachtii*, and on the nematode-resistant monotelosomic addition AN5, carrying a telosome from *B. patellaris*. After inoculation of the root cultures with L2 larvae of *H. schachtii*, significantly less cysts developed on the roots of AN5 than on the other root cultures. This result indicates that resistance to the beet cyst nematode is expressed after transformation. The in-vitro assay will be used for evaluating beet material obtained in a research programme aimed at the isolation of gene(s) for resistance to the beet cyst nematode. *Centre for Plant Breeding Research CPO, P.O. Box 16, 6700 AA Wageningen, The Netherlands.*

PENEVA, V. & s'JACOB, J. J.[1]) *Host suitability of some cultivars to* Meloidogyne hapla.

Eleven plant cultivars: lupin cv. Barpine and cv. N 85 Bitter, borage cv. Nickelson-Zwaan and cv. Royal-Sluis, radish cv. N 1019, cv. N 1034 and cv. N 1035 and evening primrose (proposed as rotational crops) were tested as host plants for *M. hapla* in greenhouse conditions. Lupin, borage, radish and mustard cultivars were good hosts for *M. hapla*. Oil flax cultivars and evening primrose were poor hosts. Total egg production was a good indicator for host suitability while the number of galls was not. *Central Laboratory of Helminthology, Ac. G. Bonchev Str., Bl. 25, 1113 Sofia, Bulgaria;* [1])*Department of Nematology, Agricultural University Wageningen, Binnenhaven 10, 6709 PD Wageningen, The Netherlands.*

PERALTA, M. & PEÑA SANTIAGO, R. *Taxonomy and distribution of species of* Tylencholaimellus *in the Province of Jaén, Spain.*

No previous record exists of species of the genus *Tylencholaimellus* in Spain. In the present study more than two hundred soil samples collected from natural areas in the Province of Jaén (Spain) during 1982 and 1983 were examined. At least seven different species have been found and their spatial distribution in relation to nine native plant communities (oak forest, brushwood, meadows, etc.) and three geographical areas was analysed. Species of *Tylencholaimellus* are very frequent and abundant in the studied region, especially in association with non-forest plant communities. The possible importance of these species as bio-indicators is discussed. *Escuela Universitaria de Formación del Profesorado de EGB, Virgen de la Cabeza n° 2, 23008-Jaén, Spain.*

PERRY, R. N.[1]) & WRIGHT, K.[2]) *Moulting of* Aphelenchoides hamatus.

Detailed observations were made on changes during the moult from J4 to adult of *A. hamatus*. The process took 12-13 h to complete. Initial changes included the loss of knobs and shaft of the stylet as the head began to pull away from the old conus. The nematode volume and water content decreased enabling it to retract within and away from the old cuticle. The oesophagus then became active and there was a rapid increase in water content as the adult expanded to burst the old cuticle. [1])*Entomology & Nematology Dept., AFRC IACR, Rothamsted Experimental Station, Harpenden, Herts., AL5 2JQ, England;* [2])*Dept. Zoology, Univ. Toronto, Toronto, Ontario, M5S1A1, Canada.*

PERSMARK, L. BANCK, A., ANDERSSON, S. & JANSSON, H.-B. *Vertical distribution of nematodes and nematophagous fungi in a sandy soil.*

In a sandy agricultural field in southern Sweden soil samples were taken at 10 cm intervals to a depth of 60 cm. Soil moisture was registered for each level. Nematodes were extracted using Seinhorst's elutriation-method. Total numbers and numbers of Trichodorid nematodes were counted. The Trichodorids were most abundant in the upper 30 cm and decreased markedly from 30 to 40 cm depth to very low numbers in the layer 40-60 cm. Soil moisture decreased by half from the upper 20 to 40 cm. *Catenaria anguillulae* was the endoparasitic fungus most fre-

quently found, especially in the upper 30 cm, and rarely below 40 cm. Different kinds of predatory nematophagous fungi, mainly network forming species of *Arthrobotrys*, were also found in the upper soil layers. *Department of Microbial Ecology, University of Lund, Helgonavägen 5, S-223 62 Lund, Sweden; Department of Plant and Forest Protection, Swedish University of Agricultural Science, Box 44, S-230 53 Alnarp, Sweden.*

PICKUP, J. *Cold hardiness studies on free-living Antarctic nematodes*

Knowledge of the cold-hardiness of terrestrial invertebrates has largely been derived from studies on insects and microarthropods. Recent work on Antarctic nematodes has drawn out several interesting comparisons. Seasonal variation in the ability of hydrated nematodes to supercool to sub-zero temperatures may occur in field populations, and can be influenced by recent feeding activity. The ability to survive freezing depends upon the temperature at which ice formation occurs, with the probability of survival decreasing at lower freezing temperatures. Exogenous ice-nucleation and dehydration as a result of the freeze concentration of external solutes may be very important to nematode survival at low temperatures. *British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge, CB3 OET, UK.* Present address: *Agricultural Scientific Services, Dept of Agriculture and Fisheries for Scotland, East Craigs, Edinburgh, EH12 8NJ, UK.*

PINOCHET, J. *Breeding bananas for resistance against lesion forming nematodes.*

Control of *Radopholus similis* and some *Pratylenchus* species is a priority in banana production throughout the world. Few attempts have been made to incorporate resistance in *Musa* against lesion forming nematodes because of the difficulty in working with a genetically complex plant. The high cost of a breeding program, the time required for its development and the adoption of adequate screening methods have also been major obstacles in obtaining resistant commercial cultivars. Resistance to *R. similis* is found in the Pisang Jari Buaya diploids, although in some cases difficult to transmit. Resistance appears to be dominant and controlled by a few genes. Some progenies of PJB clones also have resistance against Black Sigatoka and Panama disease. Resistance mechanisms are suspected to be associated with mechanical barriers. An interesting PJB clone (SH-3142), highly resistant to *R. similis* has proved to be susceptible to *Pratylenchus coffeae. Dpto. de Patologia Vegetal, IRTA, Crta. de Cabrils s/n, 08348 Cabrils, Barcelona, Spain.*

PLASTERK, R. H. A. Regulation and mechanism of DNA transposition in the free living nematode *Caenorhabditis elegans.*

The main cause of spontaneous mutations in the soil nematode *Caenorhabditis elegans* is the jumping of transposon Tc1. All natural isolates of the nematode contain several copies of this DNA element in their genome; the element is mobile in some but not all strains. Genetic analysis of the difference between strains that are and strains that are not permissive for Tc1 activity points to the factors that determine the level of "mutator" activity in nematodes. DNA transposition is not only interesting per se, but may also be used as a tool for the molecular analysis of *Caenorhabditis elegans*; recent experiments in this direction will be described. *Department of molecular biology, Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, The Netherlands.*

PLOEG, A. T., BROWN, D. J. F. & ASJES, C. *Occurrence of trichodorid nematodes and tobacco rattle tobravirus (TRV) in flower bulb fields in the Netherlands.*

Tobacco rattle tobravirus (TRV) can cause serious diseases in flower bulb crops (leaf malformation, colour break) and potatoes (spraing disease). In order to assess infection of soil with both the nematode vector species and TRV, soil samples from the flower bulb region of Holland were taken and analysed for presence of nematodes and virus. In 35 out of 38 samples taken, trichodorid nematodes were found. Virus was recovered from 22 out of the 35 samples containing trichodorids. These initial results indicate that trichodorids are widespread throughout the

region and that many of these populations were capable of transmitting virus. *Zoology Department, Scottish Crop Research Institute, Dundee DD2 5DA, Scotland and Flowerbulb Research Centre, Vennestraat 22, 2160 AB Lisse, The Netherlands.*

PLOEG, A. T., BROWN, D. J. F. & ASJES, C. *Trichodorid nematodes as vectors of tobacco rattle virus (TRV) in Dutch bulb fields.*

During May and November 1989 soil samples were collected from the Dutch bulb area in order to examine the occurrence of trichodorid nematodes and TRV. Seven trichodorid species were found: *Paratrichodorus pachydermus, P. teres, P. nanus, Trichodorus similis, T. viruliferus, T. cylindricus* and *T. sparsus*. By letting single hand-picked nematodes feed on *Petunia hybrida* seedlings and subsequently testing the root system for infection with virus, it could be established that *P. pachydermus, T. viruliferus* and *T. similis* acted as virus vectors, each species transmitting serologically distinct strains of TRV. *Department of Zoology, Scottish Crop Research Institute, Dundee DD2 5DA, Scotland and Flowerbulb Research Centre, Vennestraat 22, 2160 AB Lisse, The Netherlands.*

POPOVICI, I. *Structure and dynamics of nematode populations in different ecosystems in the Retezat Mountains of Romania.*

The specific and trophic structure of soil nematode populations were investigated in 25 forests and grasslands. Species diversity is more pronounced in beech, grassland and *Mugo*-shrub ecosystems situated on limestone as compared to those on acid rocks. The affinity of nematode communities (by Soerensen's index) reveals the importance of edaphic and climatic factors on the structure of nematofauna. A pattern of population dynamics and energetic parameters in three coniferous ecosystems is illustrated. *Biological Research Centre, 48 Republicii Street, 3400-Cluj, Romania.*

POTTER, J. W., SAUNDERS, J.[1]), & WAINMAN, L. I. *Soil solarization for nematode and disease control in conifer nurseries.*

Soil solarization (solar heating of soil under plastic film) was tested for control of *Paratrichodorus pachydermis* and *Cylindrocladium* root-rot in three trials at St. Williams tree nursery. In 1987, significant reductions of fungus and stubby-root nematode were achieved under clear film with maximum soil temperatures exceeding 40°C; clear plastic was preferable to black. A second trial (1988) with one- and two-ply clear film with and without irrigation also resulted in maximum temperatures over 40°C, significant reductions in fungus level, and elimination of the nematode to 20 cm depth under two-ply film with irrigation. In 1989, spruce seedlings planted into 1988-solarized plots showed better % survival, greater weight, and better color than in check-plots. Data from plots solarized in 1989 again show nematodes eliminated to 10 cm deep and greatly reduced to 20 cm. *Agriculture Canada, Research Station, Vineland Station, Ontario, LOR 2EO;* [1])*Pest Management Section, OMNR, c/o Great Lakes Forestry Center, Box 1000, 1219 Queen St. E, Sault Ste. Marie, Ontario, P6A 5N5, Canada.*

POWERS, T. O., HARRIS, T. S., & SANDALL, L. J. *Phylogenetic relationships among* Meloidogyne *species derived from nucleotide sequence analysis.*

Approximately 1,750 base pairs of mitochondrial DNA have been sequenced from *Meloidogyne incognita* to serve as a basis for phylogenetic comparisons of five species. This DNA contains the gene coding for the large ribosomal RNA. Using sets of amplification primers and polymerase chain reaction (PCR) we have examined over 30 geographic isolates of *Meloidogyne*. DNA from single juveniles was compared to a computer generated fine-scale restriction map. To date, three distinct lineages as defined by restriction site polymorphism, have been identified. These lineages correspond to species as determined by host differential tests. *Department of Plant Pathology, University of Nebraska, 406 Plant Sciences Hall, Lincoln, Nebraska 68583-0722, USA.*

PROT, J.-C., MATIAS, D. M. & AUNG, T. Pratylenchus zeae *a pest on upland rice.*

Experiments were conducted under greenhouse and field conditions to estimate the pathogenicity of *P. zeae* on rice cv. UPL Ri-5 and its effect on yield. In the greenhouse experiment, yield, number of panicles, grain weight per panicle, panicle length, and plant height were significantly reduced at all inoculum levels (250, 500, 1000, 2500, and 5000 *P. zeae*/plant). Maximum yield and panicle number reductions were 69% and 54%, respectively. In a naturally infested field, the yield of a rice crop was negatively correlated with the population density of *P. zeae* detected at sowing and at harvest. When the average initial soil population density was above 4000/dm^3, the yield was 37% lower than when the initial soil population density was below 30/dm^3. *Division of Plant Pathology, International Rice Research Institute, P.O. Box 933, Manila, Philippines.*

RADEWALD, J. D. & SHIBUYA, F. *Increases in grape yields following multiple low dosage drip irrigation applications of phenamiphos for control of root-knot and citrus nematode in California.*

Yields of 2 cultivars of *Vitis vinifera* L. infected with *Tylenchulus semipenetrans* and *Meloidogyne incognita* increased in quantity and quality when multiple 100ppm applications of phenamiphos were made in drip irrigation water. Applications were made the first year 3 times, 3-5 days apart in spring and fall. Timing of application coincided with population dynamics curves for the citrus and root-knot nematode. By considering concentration necessary for nematode kill (100ppm); amount of water needed to wet the effective root zone; the population dynamics and root flush, we were able to attain better results in control and yields with 33% of the toxicant registered for usage in the grower vineyards. *Department of Nematology, University of California, Riverside, CA 92521, USA.*

REIS, L. G. L. *Occurrence and distribution of phytoparasitic nematodes associated with "Burley" tobacco in Portugal.*

In a survey of phytoparasitic nematodes associated with "Burley" tobacco in Portugal, carried out from 1984 to 1989, 197 soil and root samples were collected. Of the 24 genera found the most abundant were *Tylenchorhynchus s.l.* (61.9% of the soil samples), *Pratylenchus* (61.4%), *Helicotylenchus* (40.6%), *Meloidogyne* (34.0%) and *Trichodorus s.l.* (26.4%). *Meloidogyne* spp. (mainly *M. javanica* and *M. incognita*) and *Pratylenchus* spp. were the most frequent endoparasitic nematodes recovered from roots. The *Meloidogyne* species caused severe destruction of the root system, galling on all types of root as well as wilt symptoms, leaf chlorosis and dwarfing of the tobacco plants. *Departamento de Fitopatologia, Estação Agronómica Nacional, 2780 Oeiras, Portugal.*

REIS, L. G. L. & FARIA, A. *Plant-parasitic nematodes associated with bananas in Madeira Island.*

A survey of plant-parasitic nematodes was carried out from 1987 to 1989 in the major banana producing regions of Madeira Island and 144 soil and root samples were collected and analysed. Nematodes belonging to nine genera were identified from the soil samples *viz. Helicotylenchus* (100% of the samples), *Paratylenchus* (87%), *Meloidogyne* (80%), *Hemicycliophora* (71%), *Criconemoides s.l.* (55%), *Rotylenchulus* (48%), *Paratrichodorus* (43%), *Pratylenchus* (22%) and *Scutellonema* (13%). *Meloidogyne* spp., *Rotylenchulus reniformis, Helicotylenchus* spp., *Paratylenchus* sp. and *Pratylenchus* sp. were the only nematodes recovered from banana roots. *Departamento de Fitopatologia, Estação Agronómica Nacional, 2780 Oeiras, Portugal & Secção de Nematologia, Laboratório Agrícola da Madeira, 9135 Camacha, Madeira.*

REUTER, G.[1]), AUMANN, J.[2]), WYSS, U.[2]), JANSSON, H.-B.[3]) & SCHAUER, R.[1]): *Investigations on the occurrence and biosynthesis of sialic acids in the nematode* Panagrellus redivivus.

The occurrence of sialic acids in the free-living nematode *Panagrellus redivivus* was studied by periodate oxidation/[^{3}H]sodium borohydride reduction of about 10^7 nematodes. In parallel, the capability of sialic acid biosynthesis was examined by metabolic labelling of the same number of nematodes with [^{3}H] N-acetylmannosamine. In both experiments radioactivity was incor-

porated into the nematodes. Mild acid hydrolysis, however, did not release radioactively labelled sialic acids as tested by thin layer chromatography, indicating that *P. redivivus* does not contain or synthesize sialic acids. [1])*Biochemisches Institut and* [2])*Institut für Phytopathologie der Universität Kiel, D-2300 Kiel, Germany, and* [3])*Department of Microbial Ecology, Lund University, Helgonavägen 5, S-223 62 Lund, Sweden.*

RICHARDSON, P. N., GREWAL, P. S. & COLLINS, G. *Potential of rhabditid nematodes for the biological control of mushroom sciarid flies.*

Insect-parasitic rhabditid nematodes (*Steinernema* spp.; *Heterorhabditis* spp.) have been shown to parasitise the larvae of mushroom sciarid flies (*Lycoriella auripila*) in laboratory tests. Recent research has concentrated on their potential as biological control agents in commercial mushroom farm conditions. Mass-produced infective nematode larvae were mixed with mushroom compost at spawning and/or two weeks later with casing (moss peat + chalk). A single application, at casing, was almost as effective as the standard chemical control for sciarids, diflubenzuron. An additional application at spawning provided no extra benefit and application only at spawning was totally ineffective. Insecticide treatments significantly reduced mushrooms yields; nematode treatments significantly increased them. *Entomology and Insect Pathology Section, AFRC Institute of Horticultural Research, Littlehampton, W. Sussex, BN17 6LP, U.K.*

RIGA, E. & WEBSTER, J. M. *Contemporary and traditional approaches of differentiating members of the Pinewood Nematode Species Complex.*

Four approaches were used to study the taxonomic and biological relationships of *Bursaphelenchus mucronatus* isolates from Europe and Asia and *B. xylophilus* isolates from North America and Japan. These isolates from pines are morphologically and biologically similar. Pathogenicity studies showed that *B. xylophilus* isolates killed more Scots pines than did *B. mucronatus* isolates. Chemical communication studies showed that *B. xylophilus* isolates are not attracted to chemicals released by *B. mucronatus* isolates. *B. xylophilus* and *B. mucronatus* isolates can be differentiated by their DNA band patterns. These approaches together with cross-hybridization studies confirm the taxonomic status of *B. xylophilus* and *B. mucronatus* and demonstrate some of their relative relationships. *Department of Biological Sciences, Simon Fraser University, Burnaby, Vancouver, British Columbia, V5A 1S6, Canada.*

RILEY, M. B., CARTER, G. E. Jr., & NYCZEPIR, A. P. *Effect of* Meloidogyne incognita *and* Criconemella xenoplax *on ACC and MACC content in peach* (Prunus persica *(L.) Batsch).*

The effect of *Meloidogyne incognita* and *Criconemella xenoplax* on 1-aminocyclopropane-1-carboxylic acid (ACC) and malonyl-ACC (MACC) in peach (*Prunus persica* (L.) Batsch) was measured. ACC and MACC are two compounds associated with ethylene production in plants. The two rootstocks used in this study were Lovell, susceptible to both nematodes, and Nemaguard, resistant to *M. incognita*. In greenhouse tests *M. incognita* increased MACC levels in leaves of Lovell seedlings. *C. xenoplax* increased ACC levels in Lovell and Nemaguard roots and MACC levels in Lovell and Nemaguard leaves. Increased root ACC levels and leaf MACC levels served as indicators of susceptibility to *M. incognita* and *C. xenoplax* in the rootstocks studied. In field plots few differences in ACC and MACC levels were found between trees grown in nematode-infested soil and trees grown in non-infested soil. *Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634-0377, USA, and USDA, ARS, S. E. Fruit and Tree Nut Research Laboratory, Byron, GA 31008, USA.*

RIVOAL, R. *The cereal cyst nematode,* Heterodera avenae.

A teaching video-film was produced (U.MATIC PAL, 14 min. 30 sec with French or English commentary; copies are available in VHS = PAL, SECAM, NTSC) to summarize information gathered on this species in France during about 15 years. It shows the symptoms of attack of the nematode in fields, and on roots of wheat and maize. Infection and migration of juveniles (J2) in cortex cells are observed with I.C. microscopy. Different stages of the biological cycle

are shown as well as feeding sites (giant cells) caused by *Heterodera* juveniles. The polytypism of the nematode in France is reviewed with occurrence of pathotypes (virulence) and consequences of two ecotypes hatching behaviour on sensitivity of winter and spring cereals. The effects of *H. avenae* on wheat production is analyzed with reference to root development and water transfer. The film ends with integrated aspects of plant protection. *Laboratoire de Zoologie, Centre de Recherches de Rennes, 35650 Le Rheu, France.*

ROBBINS, R. T. *Observations on the taxonomy of the Longidoridae in North America.*

Of the 5 widely accepted genera of Longidoridae, 3 have been reported from North America (N.A.): *Xiphinema*, 37 species; *Longidorus*, 10; and *Paralongidorus*, 2. Among the *Xiphinema* species 19 fit in the *americanum* group; the remaining species are variable. In an on-going study of over 60 populations of *Longidorus* from N.A. at least 6 are undescribed species. In N.A. *Paralongidorus* is reported only from California and Florida. *Longidorus diadecturus* is widespread in N.A. and is especially interesting taxonomically because of the posterior location of the stylet guide and the distinctly shaped (SEM) odontophore base with flange-like structures. The similarity in its stylet guide location and the odontophore base to *L. fursti* is striking. SEM studies of the odontophore base of related *Longidorus* species with posteriorly located stylet guides may show them to be similar. *Neolongidorus*, a recently designated genus, is differentiated from *Longidorus* in part by the posterior location of the stylet guide. *Nematology Lab., Univ. of Arkansas, Fayetteville, AR 72701, USA.*

RODRIGUEZ-KABANA, R. *Cropping systems for the management of phytonematodes.*

Damage caused by nematodes is one of the limiting factors in crop production. Traditional nematode management is based on the use of crop rotations, resistant cultivars, nematicides or combinations of these methods. For crops like peanut, there are no cultivars available resistant to root-knot nematodes. There are soybean cultivars resistant to some of the species of root-knot nematodes; however, most fields have nematode infestations composed of mixtures of species. Research at Auburn has shown that tropical crops can be used effectively in rotation to manage nematode problems. Rotations with American jointvetch, castorbean, hairy indigo, partridge pea, sesame, and velvetbean have resulted in good nematode control and increased yields of peanut and soybean. Some crops (castorbean, sesame) are considered "active" in that they produce compounds that are nematicidal while others (e.g., corn, sorghum) are simply nonhost, that is "passive". *Department of Plant Pathology, Auburn University, Auburn, Alabama 36849-5409, USA.*

RODRIGUEZ-KABANA, R., MORGAN-JONES, G., CROVETTI, A. J. & DEVIDAS, P. *Screening of microorganisms for control of plant parasitic nematodes.*

The objective of this project was to isolate and identify microorganisms parasitising root-knot nematodes (*Meloidogyne* spp.) and cyst nematodes (*Globodera* spp. and *Heterodera* spp.) in the southern United States. On the basis of a survey, thirty-nine species of fungi (belonging to the genera *Acremonium, Geotrichum, Cylindrocarpon, Gliocladium, Myrothecium, Stachybotrys, Trichocladium, Ulocladium* and *Verticillium*) and over 50 bacterial strains (*Aeromonas, Bacillus, Chaetomium, Klebsiella, Serratia*) were isolated, identified and evaluated for their biocontrol effects. Some of the organisms were evaluated for production of nematicidal metabolites. The experimental approach including the methods, and the effect of various amendments and culture conditions on the biocontrol efficacy of 7 active leads are presented. *Department of Plant Pathology, Auburn University, Auburn, Alabama 36849 and Abbott Laboratories, 6131 RFD, Long Grove, Illinois 60047, USA.*

ROESSNER, J. *Persistent effect of a single application of antagonistic fungi on* Globodera rostochiensis.

Antagonistic fungi of *G. rostochiensis* (*Preussia* sp., *Cladosporium herbarum* and two isolates of *Fusarium oxysporum*) were tested singly or in combinations in greenhouse pot-trials with potatoes cv. Grata with different water regimes. The organic material, including the first generation of

G. rostochiensis cysts, was extracted and mixed with uncontaminated soil for new pots. The experiment was evaluated after the second cycle of the nematode. *G. rostochiensis* was more or less negatively affected by the antagonistic fungi singly and in combinations. These effects were more pronounced in the second generation and under a low water regime. The application of fungal combinations had no advantage over the single fungal isolates. *Institut für Phytopathologie und Angewandte Zoologie, Justus-Liebig-Universität, Giessen, Deutschland.*

ROMERO, D.[1]), AGUADED, S.[2]), LOPEZ BRAÑA, I.[2]), MENA, M.[2]), DELIBES, A.[2]), VALDEOLIVAS, A.[1]) & GARCIA OLMEDO, F.[2]). *Transfer and characterization of genes for resistance to* Heterodera avenae *from* Aegilops ventricosa *to hexaploid wheat.*

Seventy lines (H-93) with 42 chromosomes were obtained by crossing the wild grass *A. ventricosa* (genomes $D^vD^vM^vM^v$) and hexaploid wheat *T. aestivum* (AABBDD) using tetraploid wheat, *T. turgidum* (AABB) as a "bridge" species. These lines were tested for resistance to the cyst nematode *H. avenae*. A low proportion of the H-93 lines were found to be highly resistant, and line H-93-B was selected for further studies because of its good performance in successive tests. Reciprocal crosses (F_1 and F_2 generations) were obtained from line H-93-8 and *T. aestivum* and tested for resistance. The resistance was inherited as though determined by a single mendelian factor. The chromosomal location of this factor has been investigated using biochemical markers, DNA probes and cytological methods. [1])*Instituto de Edafología y Biología Vegetal. Serrano 115 dupl, 28006 Madrid* and [2])*ETSI Agronomos, Avda Complutense s.n., 28040 Madrid, Spain.*

ROOS, M. H., BOERSEMA, J. H., KOOYMAN, F. J. N. & RUITENBERG, E. J. *Molecular biology of benzimidazole resistance in the parasitic nematode* Haemonchus contortus.

Parasitic helminths cause a number of the most serious and widespread infectious diseases in man and animals. Anthelmintics are one of the most important tools in this control. In veterinary medicine anthelmintics are extensively used but drug resistance has resulted because of systematic and frequent use. Little is known about the molecular mechanisms that are involved in this drug resistance. Since anthelmintics interfere with worm specific processes or with processes that are more sensitive to the drugs than those in the host, the study of the mechanisms of drug resistance opens a unique opportunity to characterize helminth specific traits. We studied the resistance against benzimidazoles, a group of drugs that is known to inhibit the assembly of microtubules. *Department of Infectious Diseases and Immunology, Faculty of Veterinary Medicine, University of Utrecht, Yalelaan 1, 3508 TD Utrecht, The Netherlands.*

ROOSJEN, Js & VENINGA, G. *Effect of incorporation method of non-fumigants on the multiplication of* Globodera pallida.

Non-fumigants are no longer broadcast but incorporated in the soil by rotavatory cultivators, rotating harrows or springtine cultivators. Incorporation proved to be restricted to the top 8 cm of the tillage layer. Using this application technique, damage to the crop is limited (to a great extent) but it is insufficient to prevent the multiplication of the nematode. Field experiments showed a more even incorporation in the total tillage layer by using a rotary spading machine. Though much lower, even then the nematode population is still increasing. A test with garden-cress (*Lepidium sativum*) showed that this was caused by an uneven distribution of the granules through the soil, forming non-treated niches where the nematodes are not affected by the active materials. It was shown that this defect could partly be met by increasing the number of particles (granules) i.e. the fineness of the compounds. *H. L. Hilbrands Laboratorium voor Bodemziekten, Mr. P. J. Troelstralaan 1a, 9402 BA Assen, The Netherlands.*

RUDEL, M. *Nematode transmitted virus diseases of grapevine in the Palatinate, Germany.*

The nepoviruses and their associated vector nematode species most frequently isolated from grapevines growing in the Rhineland - Palatinate are: grapevine fanleaf and *Xiphinema index*; arabis mosaic and *X. diversicaudatum*; raspberry ringspot and *Longidorus macrosoma*; tomato black

ring and *L. attenuatus*, and strawberry latent ringspot and *X. diversicaudatum*. *Paralongidorus maximus* and *X. vuittenezi* have been recovered from vineyards in which raspberry ringspot and grapevine fanleaf nepoviruses respectively were associated with diseased vines. Unequivocal evidence that these two nematode species are capable of vectoring their associated viruses has not been obtained. The occurrence of virus-vector species largely depends on the pre-vineyard vegetation and to a lesser extent on soil characteristics. Disease symptomatology in grapevines caused by nematode transmitted virus is variable with different grapevine varieties reacting differently to the same virus. Also, the presence of different strains of the viruses probably also accounts for some of the variability in the observed disease symptoms. *Landes- Lehr- und Forsuchungsanstalt für Landwirtschaft, Weinbau und Gartenbau, 6730 Neustadt an der Weinstrasse, Germany.*

SANDALL, L. J., & POWERS, T. O. *Comparison of PCR amplified mitochondrial DNA from* Heterodera *and* Globodera *species.*

The polymerase chain reaction (PCR) has been used to amplify specific nucleotide sequences of mitochondrial DNA for systematic analysis. Three sets of amplification primers were synthesized and tested on DNA extracted from single juveniles and cysts. Amplification products were produced from all nematode stages in both *Heterodera* and *Globodera* species. Regions of amplified DNA included a portion of the cytochrome oxidase subunit II gene, the large ribosomal RNA, and an undefined region containing at least one tRNA gene. *Department of Plant Pathology, University of Nebraska, 406 Plant Sciences Hall, Lincoln, Nebraska 68583-0772, USA.*

SANTO, G. S., MOJTAHEDI, H., HANG, A. N. & WILSON, J. H. *Host suitability of rapeseed cultivars for* Meloidogyne chitwoodi *and* M. hapla, *and their impact on* M. chitwoodi *as a soil amendment.*

The reproductive factor (Rf) (Pf at 55 days/5,000 Pi) of *Meloidogyne chitwoodi* races 1 and 2 and *M. hapla* on 14 cultivars of *Brassica napus* and *B. campestris* ranged from 1 to 82. The mean Rf of 15 for *M. hapla* was greater (P = 0.05) than the Rf of 8 and 2 for *M. chitwoodi* races 1 and 2, respectively. All three nematodes reproduced more (P = 0.05) efficiently on *B. campestris* than *B. napus*. Amending *M. chitwoodi* infested soil with shoots of Jupiter rapeseed, in plastic bags, reduced the nematode population more (P = 0.05) than wheat shoots. Incorporating Jupiter shoots to soil in microplots heavily infested with *M. chitwoodi* reduced the nematode population more (P = 0.05) than the fallow or corn treatments. The greatest reduction in nematode population density was attained by cropping rapeseed for 2 months and incorporating it into the soil as a green manure. *Department of Plant Pathology, Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, Washington 99350-9687, USA.*

SANTOS, L. C. *Studies of free-living nematodes inhabiting mosses collected in the SW of Spain.*

This paper is a first contribution to the knowledge of free-living moss inhabiting nematodes in natural regions in the Sevilla province and a part of a Cádiz province (SW of Spain). Some observations on several ecological aspects and distribution of the species found are noted. *Department of Animal Biology & Zoology, Faculty of Biology, Avda. Reina Mercedes 6, 41012 Sevilla, Spain.*

SANTOS, M. S. N. DE A., RODRIGUES, A. C. F. DE O. & ABRANTES, I. M. DE O. *Response of coffee plant cultivars to* Meloidogyne javanica *and* M. hapla.

The reactions have been evaluated of 2 cultivars of *Coffea arabica* (cv. Catuai vermelho) and 5 hybrids (3 of Sarchi × Hybrid of Timor and 2 of *Coffea arabica* cv. Caturra × Hybrid of Timor) to *Meloidogyne javanica* and *M. hapla* under greenhouse conditions. Ten plants of each cultivar or of each hybrid were inoculated with 5000 eggs/plant. The number of galls, egg masses and eggs were recorded 90 days after inoculation. *M. javanica* did not induce root galling in any of the cultivars or hybrids studied. By contrast, *M. hapla* induced slight root galling in all cultivars and hybrids and produced few eggs on hybrids Sarchi × Hybrid of Timor and *C. arabica* cv. Caturra × Hybrid of Timor. Further investigations are in progress to provide information on the resistance of *Coffea* cultivars or hybrids to *Meloidogyne* species. *Centro de Sistemática e Ecologia — INIC, Departamento de Zoologia, Universidade de Coimbra, 3049 Coimbra Codex, Portugal.*

SARAH, J. L. *Nematode of pineapple.*

Nematodes are one of the main problems for pineapple (*Ananas comosus*) production. *Pratylenchus brachyurus* in tropical Africa and Brazil, *Rotylenchulus reniformis* in Hawai, Philippines and the Carribbean, *Meloidogyne javanica* in southern Africa and Australia, are the dominant species. Root damage results in decreased growth rate and delayed development of plants with reddening and loss of turgidity of leaves. The economic impact of nematodes is very important: yield losses for the plant crop frequently reach 30% and the ratoon crop may fail completely. Nowadays, control is essentially chemical, but cultural practices such as fallow, or crop rotation with non-host plants are also used to decrease the soil population before planting. In the future, creation of resistant or tolerant varieties could be the most promising method to reduce the impact of nematodes on pineapple. *Fruit Department of Centre de Coopération Internationale en Recherche Agronomique pour le Développement, CIRAD/IRFA, BP 5035, 34032 Montpellier Cedex 1, France.*

SAYRE, R. M., WERGIN, W. P. & STURHAN, D. *Comparison of the fine structure of* Pasteuria *sp. from* Heterodera glycines *with a related bacterium parasitizing* H. goettingiana.

On the basis of its unique host, *Heterodera goettingiana*, and differences in fine structure of its sporangium and endospore the bacterial parasite of the pea cyst nematode (BPCN) was readily distinguished from a closely related bacterium (BSCN) parasitizing the soybean cyst nematode, *Heterodera glycines*. Electron micrographs of both bacteria showed a cup-shaped sporangium and similar measurements. Sporangia of BPCN averaged 3.91 ± 0.21 µm in diameter and 3.08 ± 0.31 µm in height, while BSCN was 4.37 ± 0.31µm in diameter and 3.19 ± 0.32 µm in height. BPCN is somewhat unusual among *Pasteuria* spp. in that it completes its life cycle in the second juvenile stage of *H. goettingiana*. This distinction coupled with the several other differences in the ultrastructure of its sporangia suggests BPCN might be assigned to a new species within the genus *Pasteuria. USDA, ARS, Nematology Laboratory and Electron Microscopy Laboratory, Beltsville, MD 20705, USA, and Biologische Bundesanstalt, Institut für Nematologie und Wirbeltierkunde, Toppheideweg 88, D-4400, Münster, Germany.*

SCHLANG, J. *Influence of cacao-shells on* Heterodera schachtii.

Sugar beet seed pelleted with cacao-shell powder 100 and 400 g/Unit (100,000 seeds) significantly reduced penetration by and the multiplication rate of *H. schachtii*. The 400 g/U-formulation suppressed the penetration rate to the same level as a 30 g/U Carbofuran- and a 80 g/U Promet-formulation. In the 400 g/U-treatment the multiplication rate reached only a value of 1.1 in contrast to the control with a rate of 7.6. A positive effect on the yield of sugar beet was observed in field trials with cacao-shell powder. In watery extracts of cacao-shell powder an anti-hatching-factor was detected. *Biologische Bundesanstalt für Land- und Forstwirtschaft, Institut für Nematologie, Außenstelle 5013 Elsdorf, Dürener Str. 71, Deutschland.*

SCHMIDT, K.[1]), SIKORA, R. A.[2]) & RICHTER, O.[1]) *Modelling the population dynamics of* Heterodera schachtii *in sugar beet production systems.*

The life-cycle of *Heterodera schachtii* is described using a differential equation. The single transition probabilities of the discrete stages in the life-cycle are modelled by non-linear functions or derived from differential equations. Environmental dependencies are included by use of response functions. The model is designed for use in simulation of control strategies in cropping systems and the influence by abiotic and biotic factors on the nematode's population dynamics with time. [1])*Institut für Geographie und Geökologie, Langer Kamp 19c, 3300 Braunschweig;* [2])*Institut für Pflanzenkrankheiten der Universität Bonn, Nussalle 9, 5300 Bonn 1, Germany.*

SCHOMAKER, C. H. & BEEN, T. H. *Sampling strategies for potato cyst nematodes.*

To reduce the amount of nematicides used and to optimize economical returns, sampling methods are developed for the detection of cysts or the estimation of population densities in farmer's fields. The accuracy of these methods, which depends on the degree of irregularity of

the distribution of the cysts in the field, must be known. Therefore, spatial patterns in several fields were investigated as well as the statistical distribution of the cysts in samples from limited areas. The mathematical models describing these patterns and the qualities of their parameters are discussed. *Research Institute for Plant Protection. P.O. Box 9060, 6700 GW Wageningen, The Netherlands.*

SCHROEDER, L. M. & MAGNUSSON, C. *Transmission of* Bursaphelenchus mucronatus *by Swedish pine sawyers* Monochamus sutor.

A survey in Sweden demontrated the presence of *Bursaphelenchus mucronatus* in the pine sawyers *Monochamus sutor* and *M. galloprovincialis* emerging from logging debris. In certain areas more than 40% of the *M. sutor* specimens contained "dauerlarvae" of *B. mucronatus*. In a transmission study 182 *M. sutor* emerging from wood collected in central and northern Sweden, were allowed to feed on branch sections for two weeks in the laboratory. Twelve per cent of the beetles transmitted nematodes to both pine (*Pinus sylvestris*) and spruce (*Picea abies*). Subsequently, 12% of 63 male/female pairs provided with bolts for oviposition transmitted *B. mucronatus* to both pine and spruce. Apart from pathogenicity, the pinewood nematode *Bursaphelenchus xylophilus* and *B. mucronatus* have a similar biology, and in Japan they share the same species of vector insect. The establishment of *B. xylophilus* in a new area strongly depends on a functional system for its transmission. Our results suggest the existence in Sweden of such a system. *Department of Plant and Forest Protection, Swedish University of Agricultural Sciences, Box 7044, S-750 07 Uppsala, Sweden.*

SCHUSTER, R.-P. & SIKORA, R. A. *Biological control of* Globodera pallida *with fungal egg parasites in alginate granules as influenced by time of application.*

Fungal egg parasites incorporated into alginate granules and applied at planting time significantly ($p = 0.05$) increased parasitism of *G. pallida* eggs from 2% in the control to 30%. A reduction of 70% ($p = 0.05$) in the number of newly formed cysts was caused by the alginate which initially reduced root growth. The newly formed eggs were not parasitized when the fungus was applied at planting, because the fungus was shown to be ineffective 4 weeks after application. Fungi in alginate granules applied to 1 year old cysts caused 30% parasitism ($p = 0.05$) and a reduction in eggs/cysts of 33% ($p = 0.05$) after 8 weeks in field soil. Fungi in alginate applied 8 weeks before planting decreased penetration 57% ($p = 0.05$) compared to the untreated control. Metabolites of one fungus were highly toxic to *Panagrellus redivivus* and *G. pallida* indicating pathogenic mode of action. *Arbeitsgruppe Nematologie, Institut für Pflanzenkrankheiten Universität zu Bonn, Nußalle 9, 5300 Bonn, Germany.*

SIDDIQI, M. R. *An interesting new tylenchid genus from Tanzania.*

Specimens representing a taxonomically interesting new genus were collected from coffee soil in Tanzania. The females and males have a body about 0.3 mm long and superficially resemble species of *Paratylenchus*, but the male stylet and oesophagus are not degenerate. The new genus is characterized by a strongly annulated cuticle with annules bearing 32-36 longitudinal indentations at mid-body, a narrow lateral ridge which is raised above the body surface and a continuous, finely striated, hemispherical cephalic region. The stylet is 8-10 µm long and has unusually elongated basal knobs. The corpus is unusual in being broad and less than two stylet lengths long so that the distance between dorsal and subventral oesophageal gland orifices is only about 10 µm or one stylet length, the isthmus is elongate-slender and basal bulb is saccate and offset from the intestine. The vulva is at about 80 percent of the body and the vagina is directed forward. A rudimentary post-uterine sac is present. Spermatheca is round, offset and has small round sperm. Ovary is small, with less than 10 germ cells. Female tail is conoid, about as long as vulva-anus distance. Male tail is also conoid and lacks a bursa. The new genus belongs to the family Tylenchidae. Its systematic position is discussed. *CAB International Institute of Parasitology, 395a Hatfield Road, St. Albans, Herts AL4 OXU, UK.*

SIPES, B. S. & SCHMITT, D. P. *Viability of* Heterodera glycines: *overwinter survival.*

Eggs and juveniles of three parastic phenotypes (P1, P2, P3) of *Heterodera glycines* from North Carolina and hybrid progeny were overwintered in microplots during the winter of 1988-89 and then tested for viability. P1 parasitizes Lee 68 and PI-88788 soybeans. P2 parasitizes Lee 68, PI-88788 and Peking soybeans, whereas P3 parasitizes only Lee 68 soybean. Nematode viability was characterized by percent hatch, percent penetration and phenotype survival. Hatch after 5 days at 27°C in the presence of a root exudate averaged 13% over all phenotypes. P2 eggs hatched the most (14%), and P23 eggs (P2 × P3 hybrid) hatched least (12%). Percent hatch was not statistically different between isolates and hybrids. Penetration of soybean 7 days after inoculation ranged from 2% to 19%, averaging 8%. P1 penetrated soybean roots most successfully, and P2 penetrated least successfully ($P = 0.05$). Phenotypes parasitic on Peking survived less than those phenotypes parasitic on Lee 68 or PI-88788. Selection against the Peking phenotype averaged 0.6. *Department of Plant Pathology, North Carolina State University, Raleigh, NC, 27695-7616, USA.*

SMELT, J. H. & LEISTRA, M. *Availability, movement and (accelerated) transformation of soil-applied nematicides.*

The efficacy of soil-applied nematicides such as aldicarb, oxamyl and ethoprophos depends on dispersal of the nematodes in soil solution. Preferably the nematicides should be distributed over much of the root zone. This can be achieved by deep incorporation or by an adequate irrigation regime. The main processes which influence the availability in soil are adsorption, transportation with water, and transformation. The progress with computer simulation techniques has enabled more quantitative description of the influence of each process on the movement, availability and persistence. For long-term plant protection substantial persistence is desired, but this may present environmental risks. The rate of transformation is dependent on the properties of the nematicide and on soil and climatic conditions. Further it has become clear that repeated application of the same compounds may induce microbial adaptation leading to accelerated transformation. This seems to be a threat to nematicide efficacy in the future. *The Winand Staring Centre for Integrated Land, Soil and Water Research, P.O. Box 125, 6700 AC Wageningen, The Netherlands.*

SOBCZYK, K. *Field investigation of the prevalence, intensity, and comparative biomass of* Diplotriaena obtusa *in breeding swallows from California.*

During the 1989 breeding season, 110 swallows from two sites in the foothills of Amador County, California, were collected and examined for the air sac parasite, *D. obtusa.* The nematode was recovered from: 50% of the tree swallows, *Tachycineta bicolor*, 42.9% of the Northern roughwinged swallows, *Stelgidopteryx serripennis*, 14% of the cliff swallows, *Hirundo pyrrhonota*, and 11.8% of the violet-green swallows, *Tachycineta thalassina.* In infected birds, the median worm intensity was 2, but burdens ranged from 1-20. The corresponding comparative biomass ratios of worms to bird ranged from 0.04-7.7% with the majority of values falling below 1%. Both the magnitude of *D. obtusa* presence and its potential for respiratory interference (especially during the long, annual migratory flights) implicate this nematode as a probable regulator of California swallow populations. *Department of Nematology, University of California, Davis, CA 95616, USA.*

SOOMRO, M. H. & HAGUE, N. G. M. *Effect of* Meloidogyne graminicola *on root growth of wheat and sorghum.*

Root growth of wheat and sorghum seedlings inoculated with J2s of *M. graminicola* was studied under glasshouse conditions. Growth of both plant species was effectively reduced by nematode invasion but sorghum suffered greater loss than wheat; total root length of sorghum was reduced by 67% at 20 days after inoculation whereas the reduction in wheat was 54%. It was evident that *M. graminicola* can slow down root production and elongation, thereby reducing total root length of plants. *Crop Diseases Res. Institute, PARC, P.O. Box 1031 Islamabad, Pakistan and Dept. of Agriculture, University of Reading, England.*

SPEIJER, P.[1]) & SIKORA, R. A. *Interrelationships between* Pratylenchus goodeyi *and root-rotting fungi affecting banana in Kenya.*

Fusarium oxysporum was the commonest fungus isolated from red necrotic lesions of cooking banana cv. Nakyetengu (AAA), followed by *F. redolens, Nigrospora musae* and *Rhizoctonia solani. P. goodeyi* was consistently recovered from the same red lesions colonized by *F. oxysporum*; determined by examination of adjacent tissue sections taken from the same lesion. The positive relationship strongly suggests the existence of a complex disease interrelationship. The presence of tolerance/resistance to the root-rot complex was examined in a field survey and farmer questionnaire conducted in the major growing area. The roots and suckers were indexed for necrosis using a 0-4 scale with 0 = no lesions; 1 = few small lesions; 2 = several small lesions; 3 = one large lesion reaching stele and 4 = several large lesions. The sweet cultivar Sukali Ndizi (AB), that grows in infested fields for up to 30 years, was tolerant to the root-rotting complex. Conversely the cultivar Nakyetengu, which is replanted after 6-7 years, was susceptible. The root: sucker necrosis index for Sukali Ndizi was 1.4:0.3 versus 2.8:1.5 for Nakyetengu. *Institut für Pflanzenkrankheiten, Universität Bonn, Nussallee 9, 5300 Bonn, Germany; [1])Present address ICIPE Field Station, Box 30, Mbita, Kenya.*

SPIEGEL, Y., COHN, E., GALPER, S., LAPID DRORIT, SHARON EDNA & CHET, I.[1]) *Evaluation of chitinolytic and proteolytic microorganisms for controlling the root-knot nematode,* Meloidogyne javanica.

Soils infested with the root-knot nematode, *Meloidogyne javanica*, were treated with chitinolytic and proteolytic microorganisms isolated from chitin and protein - amended soils, and planted with tomato seedlings. Pot tests in green- and screenhouses as well as microplot experiments revealed an increase in top fresh weights and total fruit yield of nematode-infected plants exposed to the microorganisms, while second-stage juveniles (J2), root galling index and the number of nematode eggs per gram root decreased, compared to those of infected non-treated plants. In parallel *in vitro* tests, a significant delay in hatching, an increase in mortality of J2 and interference with host-finding, were recorded under conditions where egg masses, eggs or J2, occurred in the presence of microorganisms. *Department of Nematology, Agricultural Research Organization, The Volcani Center, Bet Dagan 50 250; [1])Dept. of Plant Pathology and Microbiology, The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot, Israel.*

SPIEGEL, Y.[1]), MCCLURE, M.[2]), KAHANE, I.[3]), ROBERTSON, W. M.[4]) & SOLOMON, R.[1]) *Specificity of association between the seed-gall nematodes,* Anguina agrostis, A. tritici, *and the bacterium* Corynebacterium rathayi.

Corynebacterium rathayi adheres to both *Anguina agrostis* and *A. tritici*, but differences in the nature of adhesion were noted. Similar patterns of binding of anti-WGA-FITC, initially led us to believe that the mechanism of bacterial adhesion was related to the presence of WGA lectin on the outer cuticle of both species of nematodes and its complementary carbohydrate on the bacterial capsule. However, treatment of either species of nematode with sodium periodate inhibited bacterial adhesion but not binding of anti-WGA antibody. Bacterial adhesion, therefore, is not mediated by WGA on the nematode surface. Electron microscopy (EM) confirmed the contribution of the nematodes' cuticular surface-coat (SC) to the process of adhesion, but it is still not clear how the SC interacts with the bacterial capsule or which of its components are involved. While complete removal of the SC with periodate prevented bacterial adhesion, juveniles which naturally resisted bacterial adhesion did not lack a SC. One explanation could be that the SC of individuals, to which bacteria do not adhere naturally, lacks crucial components which cannot be defined by conventional EM. *[1])Depts. of Nematology, and Virology, ARO, The Volcani Center, Bet Dagan 50-250, Israel; [2])Dept. of Plant Pathol. Univ. of Arizona, Tucson, AZ 85721, U.S.A.; [3])Dept. of Membrane and Ultras., The Hebrew Univ. of Jerusalem, Hadassah Medical School, Israel; [4])Dept. of Zoology, SCRI, Dundee DD2 5DA, Scotland.*

STARR, J. L. & SIMPSON, C. E. *Characterization of resistance to* Meloidogyne arenaria, *in a complex hybrid of* Arachis *spp.*

TP-135 is a complex hybrid which is resistant to reproduction of *Meloidogyne arenaria* and is derived from *Arachis batizocoi, A. cardenasii, A. chacoensis*, and *A. hypogaea*. Resistance in TP-135 is due to near complete inhibition of nematode development after juveniles penetrate the roots. Resistance appears to be a stable trait as no segregation has been observed among 72 individuals from F3, F4, or F5 generations. No variation in response of TP-135 to different populations of *M. arenaria* has been observed; plants were resistant to 10 geographically diverse nematode populations collected in the southern USA. When TP-135 was backcrossed to susceptible *A. hypogaea*, F1 progeny ranged from highly resistant to susceptible to nematode reproduction. *Texas Agricultural Experiment Station, College Station, TX 77843, USA.*

STIRLING, G. R., WEST, L. M. & SMITH, L. J. *Fungal and bacterial antagonists of root-knot nematodes from tropical and sub-tropical regions of Australia.*

Forty-six soils were collected, root-knot nematodes were counted and chitin (1% W/W) was incorporated into one of two pots of each soil. Tomato seedlings were then planted and pots were inoculated with *Meloidogyne javanica*. Egg parasites were observed in 78% of soils containing root-knot nematode and in 21% of soils where the nematode was absent. Addition of chitin did not affect levels of egg parasitism. The predominant parasites were *Paecilomyces lilacinus* and *Verticillium chlamydosporium*. Three methods were used to screen isolates of both fungi for their capacity to parasitize eggs but there was no correlation between the levels of egg parasitism obtained with each method.

Two hundred and eight rhizobacterial isolates from these soils were grown in shake culture and surface-sterilized *M. javanica* juveniles were added to diluted culture filtrate. 8% of the isolates caused inactivity in more than half the nematodes. Tomato seedlings were also drenched with bacterial suspensions and inoculated with the nematode. 10% of the isolates reduced the number of galls by 50% or more. *Queensland Department of Primary Industries, Plant Pathology Branch, Indooroopilly, Queensland, 4068, Australia.*

STOESSEL, S. & EHLERS, R.-U. *Influence of different* Xenorhabdus luminescens *clones on the propagation of* Heterorhabditis sp. *in monoxenic liquid cultures.*

Two strains of undescribed *Heterorhabditis* spp. were grown in monoxenic liquid cultures in Erlenmeyer flasks. The influence of different culture media and clones of their strain specific symbionts *X. luminescens* on the nematode population development and final yields was examined. Results alternated between 10,000 and 180,000; with average values of 60,000 nematodes/ml. Reasons for the uneven population dynamics are discussed. *Institut für Phytopathologie, Christian-Albrechts-Universität, 2300 Kiel, Germany.*

STURHAN, D. *Studies on the natural occurrence of* Steinernema *and* Heterorhabditis *in soil in West Germany.*

Among soil nematodes isolated from soil samples by various extraction methods, heterorhabditids and steinernematids were commonly detected. Infective-stage juveniles of these entomoparasitic nematodes were present in about 25% of the samples collected in many different biotopes throughout the Federal Republic of Germany. They were most commonly found in soil samples from forests and grassland but only rarely in agricultural soil. Based on morphological characters of the juveniles, *Heterorhabditis* sp., *Steinernema affinis, S. intermedium* and five additional *Steinernema* "forms" could be identified or differentiated. *Steinernema* "form A" and *S. intermedium* were most common and widely distributed, followed by *S. affinis* and *Steinernema* "form B". *Heterorhabditis* sp. was found at a few locations only. While most *S. affinis* records are from fields and grassland, occurrence of certain other *Steinernema* species was almost restricted to forest soil. Mixtures of two and even three species of these insect-parasitic nematodes were often observed. *Biologische Bundesanstalt, Institut für Nematologie und Wirbeltierkunde, Toppheideweg 88, D-4400 Münster, Germany.*

STURHAN, D. & WINKELHEIDE, R. *Studies on a* Pasteuria *isolate from* Heterodera goettingiana.

In a population of *Heterodera goettingiana* originating from the type locality and kept in a microplot at Münster for many years, parasitism by a *Pasteuria* population was observed, probably of a new species. Up to 90% of second-stage juveniles in the soil had spores attached to their cuticles or were already killed by internal infection. *Pasteuria* sp. completes its life-cycle in the migrating juvenile stage of the pea-cyst nematode, in which between 400 and 600 spores develop. Infection of females and the cyst contents was never observed and attachment of spores to the cuticle in males rarely. In host specificity studies spores extracted from *H. goettingiana* juveniles adhered to the cuticle of some other members of the Heteroderidae family, including species of *Globodera* and *Meloidodera* but not in, e.g., *Meloidogyne* and *Pratylenchus* species. Spores of the *Pasteuria* isolate from *H. goettingiana* proved to be susceptible to high temperatures. *Biologische Bundesanstalt, Institut für Nematologie und Wirbeltierkunde, Toppheideweg 88, D-4400 Münster, Germany*

SUBBOTIN S. A., BALAKHNINA, V. P., & OSIPOVA E. V. *Ultrastructural changes in roots of susceptible and resistant barley varieties infected by* Bidera avenae *Woll.*

Larvae of *Bidera avenae* penetrated roots of susceptible (Donetskij-4), relatively resistant (Morocco), highly resistant (K-6808) barley varieties and induced the formation of syncytia. Syncytia had ameboid nuclei, numerous cytoplasmic organelles and wall ingrowths. Ultrastructural differences between varieties were revealed by the presence of small syncytia and hypersensitive reaction in feeding zone and surrounding cells in roots of resistant plants. Syncytia of resistant varieties were characterized by significantly smaller mitochondrial volume and decreased functional activity. *The All-Union K.J. Skrjabin Institute of Helminthology, Moscow, 117259, USSR.*

SWART, A. & HEYNS, J. *A SEM-study of the morphology of an undescribed* Lenonchium *species from South Africa (Nematoda: Nordiidae).*

The genus *Lenonchium* Siddiqi, 1965 is represented at the moment by five species: *L. oryzae* Siddiqi, 1965, *L. longidens* (Furstenberg & Heyns, 1966) Jairajpuri, 1967, *L. macrodorum* Ahmad & Jairajpuri, 1988, *L. denticaudatus* (Imamura, 1931) Siddiqi, 1969 and an undescribed species from South Africa. The undescribed species was collected from wet sand on the banks of the Sabie River, Kruger Nasional Park. The use of the scanning electron microscope (SEM) provided useful information about the morphology of this species. The lip region is slightly offset and provided with the usual six inner labial papillae, six outer labial papillae and four cephalic papillae which are morphologically different from the labial papillae. The ventromedian supplements of the male are situated in a differentiated area with prominent striae and each supplement consists of an elevated papilla surrounded by longitudinal ridges. The tail tip bears four fingerlike projections or mucros. The cuticular striations extends to the very tail tip, even to the mucros. *Department of Zoology, Rand Afrikaans University, P.O. Box 524, Johannesburg 2000, Republic of South Africa.*

TANDA, A. S. & SINGH, I. *Influence of temperature and root difflusates of African marigold on the egg hatch of root-knot nematode* (Meloidogyne incognita) *in tomato.*

The root-knot nematode, *Meloidogyne incognita* is known to infest a variety of plants throughout India and is a serious pest of vegetable crops including tomato. Studies on the influence of root diffusates of African marigold and tomato at different temperatures (5-30°C) revealed that the maximum egg inhibition was found at 5°C in tomato, tomato + marigold and marigold alone. Minimum egg inhibition was observed at 25°C in tomato, tomato + marigold and marigold alone root difflusates, respectively. Maximum average number of juveniles hatching was recorded at 25°C. All the concentrations (N, N/10, N/100) of root diffusates of marigold inhibited egg hatching which was directly proportional to the concentrations of diffusates. *Department of Plant Pathology, Punjab Agricultural University, Ludhiana-141 004, Punjab, India.*

TAYLOR, C. E., BROWN, D. J. F. & TRUDGILL, D. L. *The association between nepoviruses and their vector nematodes in Europe and the Mediterranean basin.*

Five *Longidorus* and three *Xiphinema* species are vectors of nepoviruses in Europe. In northern European countries raspberry ringspot and tomato black ring nepoviruses transmitted by *L. attenuatus, L. elongatus* and *L. macrosoma* are most frequently recorded with arabis mosaic nepovirus transmitted by *X. diversicaudatum* occuring throughout northern and central Europe. Strawberry latent ringspot nepovirus, also transmitted by *X. diversicaudatum*, occurs sporadically in northern Europe but is more frequently identified in central and eastern European countries. Grapevine fanleaf nepovirus (GFLV) and its associated vector, *X. index*, occur in most vine growing areas throughout Europe but *X. italiae* has been reported transmitting GFLV only in Israel. In Italy and Greece *L. apulus* and *L. fasciatus* have been identified as the vectors of artichoke Italian latent nepovirus whereas several other nepoviruses identified from Italy, and other Mediterranean countries, have not been associated with a vector nematode. *Zoology Department, Scottish Crop Research Institute, Dundee DD2 5DA, Scotland.*

TENENTE, R., C. V.[1]) & EVANS, A. A. F.[2]) *Winter survival of two races of* Ditylenchus dipsaci.

Two *Ditylenchus* populations, a bean race and an oat race, were grown on field bean as host. Infested mature plants were uprooted from the field in October, replanted in sterilized soil and kept outdoors for winter. Initial populations were counted in October and at 45-day intervals until April. Numbers of each stage of *D. dipsaci* present in the plant tissue and the soil beneath were recorded. At all collections the fourth stage predominated and by April 72% of the oat races and 92% of the bean race J4 survivors were in the soil. Overall, bean races had 27% of survival in the stem and 38% in the soil whereas 20% of the oat race survived in the stem and 60% in the soil. [1])*CENARGEN/EMBRAPA — C. Postal 102373 (70770) Brasilia, DF-Brasil;* [2])*Imperial College at Silwood Park, Ascot, Berkshire, SL5 7PY, England.*

TIILIKKALA, K. *The influence of accumulated soil temperature on the lipid reserves of* Globodera rostochiensis *juveniles.*

The influence of four soil temperatures (12°, 16°, 20°, 24°C) and three growing times (59, 69 and 79 days) on the lipid reserves of *G. rostochiensis* juveniles was estimated with computer-aided image analysis. An increase in accumulated temperature increased the lipid contents of the juveniles. The highest lipid estimates were detected in juveniles grown for 69 days at 20°C. The same temperature was the optimum for population increase and growth of the juveniles. In Finland the average soil temperature during the growing season of potatoes is 14°-15°C. The pest potential of *G. rostochiensis* may therefore be limited because of the low accumulation of heat units and the reduced initial energy reserves of the juveniles. *Agric. Res. Centre, Dept. of Pest Investigation, 31600 Jokioinen, Finland.*

TIYAGI, S. A. & ALAM, M. M. *Interactive effects of* Meloidogyne incognita *and* Fusarium oxysporum f. ciceri *on different plant growth stages of chickpea,* Cicer arietinum.

The root-knot nematode, *Meloidogyne incognita* and the wilt fungus, *Fusarium oxysporum* f. *ciceri* caused considerable damage to chickpea plants when inoculated singly or concomitantly. Their interactive effects were examined at vegetative, anthesis, pre-blooming, full-blooming, post-blooming, pod-setting and pod-maturing stages. Different growth parameters, e.g., plant length and weight, number of buds, flowers and pods, root-nodule index, percent pollen fertility and total chlorophyll content were reduced significantly by these treatments from the very first stage. At each plant growth stage the damage was more in combined inoculations than in individual ones. However, the damage increased from vegetative to pod-maturing stage. The root galling caused by the nematode was significantly inhibited by the fungus. However, the inhibition was more pronounced towards later stages of plant growth. The number and size of the root-nodules were also adversely affected by the test pathogens. *Department of Botany, Aligarh Muslim University, Aligarh 202 002, India.*

TOMMINEN, J.[1]) & LAHTINEN, A.[2]) *Interception of the pine wood nematode* Bursaphelenchus xylophilus *in green lumber imported to Finland from Canada.*

Pine wood nematode (*Bursaphelenchus xylophilus*) was discovered in two shiploads of green lumber imported to Finland from Canada in December 1989 and in January 1990. Both pine and spruce boards were involved. Also some of the dunnage appeared to be infested. A closer examination was conducted on 38 boards (2 × 6's) and 17 revealed PWN infestation. All the 38 boards were heavily damaged by *Monochamus* pine sawyer larvae. During the storage in an outdoor lot in Turku harbor the maximum ambient temperature was 5.8°C and the minimum temperature -23.7°C. Highest nematode numbers were 116 per gram of dry wood and lowest 5 per gram of dry wood. The third dispersal stage clearly predominated. A possible threat of dispersion of PWN from contaminated boards to standing trees is discussed. [1])*Department of Agricultural and Forest Zoology, University of Helsinki, SF-00710 Helsinki, Finland* [2])*National Board of Agriculture, Plant Quarantine Service, Pl 250, SF-00171 Helsinki, Finland.*

TRUDGILL, D. L. & PHILLIPS, M. S. *Mechanisms of yield reduction and of crop tolerance in potato/potato cyst nematode interactions.*

Root damage by invading PCN markedly reduces root growth and the efficiency of nutrient uptake. As a consequence it was hypothesised that plants suffer from chronic deficiencies which reduce the rate of top growth. Experiments in pots and the field have shown that the degree of damage is strongly influenced by an interaction between levels of PCN and of fertiliser, but that there are cultivar differences in the response. A series of studies on two cultivars of contrasting agronomy and tolerance showed that the proportional effect of PCN damage on top growth was initially similar but that its effect on harvested tuber yield was substantially related to its effects on canopy development and percentage light interception. These results point to the need to base nematode damage models on crop growth and yield models and to recognise the interaction with environmental factors, including husbandry and host genotype. *Zoology Department, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland.*

TUNLID, A. & NORDBRING-HERTZ, B. *Surface polymers of the nematode-trapping fungus* Arthrobotrys oligospora.

The structure and function of surface polymers from adhesive networks of *A. oligospora* have been studied. Electron-microscopical examination demonstrated that both traps and vegetative hyphae were surrounded by an extracellular layer of polymers staining with ruthenium red. Attachment of nematodes significantly decreased when part of this layer was extracted from the traps using chaotropic salts (LiC1). Spectroscopic analysis of the polymers showed that the main components in the extracts from both traps and vegetative hyphae were carbohydrates, containing both neutral sugars and uronic acids. Among the minor components were several proteins. Gel electrophoresis revealed that the surface extracts from traps contained at least two proteins with molecular weights of 32,000 and 45,000, which were not present on vegetative hyphae. We propose that the adhesion of nematodes to *A. oligospora* involves several steps, including an interaction between a fungal lectin and a nematode receptor previously studied, and changes in the structure of the extracellular polymers. *Department of Ecology, Chemical Ecology/Ecotoxicology(1) and Microbial Ecology(2), University of Lund, Helgonavägen 5, S-223 62 Lund, Sweden.*

VELEMA, R. A. J. & BOERMA, M. *The influence of an infestation of the potato cyst nematode* Globodera pallida, *and the occurrence of drought, on the yield of various potato varieties.*

Results of field experiments to determine the single and combined effects of an infestation by the potato cyst nematode *G. pallida* and the occurrence of drought on the productivity of a range of potato varieties showed that: 1. Tolerance against a nematode infestation and tolerance against drought are two distinct phenomena, and need not be interrelated. 2. Damage caused by the potato cyst nematode *G. pallida* and damage caused by drought are not cumulative. *H. L. Hilbrands Laboratory for soil borne pests and diseases, P. O. Box 323, 9400 AH Assen, The Netherlands.*

VENKATACHARI S., PAYAN L. A., DICKSON D. W., & HEWLETT, T. E. *Use of isozyme phenotypes to diagnose four* Meloidogyne *spp.*

Five isozyme phenotypes from single mature *Meloidogyne* spp. females obtained by isoelectric focusing eelectrophoresis were used in an attempt to find characteristic patterns that could be used to diagnose Florida populations of *Meloidogyne arenaria* race 1, *M. incognita* race 1, and *M. javanica*. A North Carolina population of *M. hapla* was included for comparison. Esterase phenotypes had the greatest diagnostic value because all the species showed distinct phenotypic patterns. These results are complemented by distinctive diagnostic patterns from phosphoglucose isomerase. Isozyme patterns from isocitrate dehydrogenase, malate dehydrogenase, and α-glycerophosphate dehydrogenase were not of diagnostic value in separating the *Meloidogyne* species tested, since they reveal a high degree of similarity among the four *Meloidogyne* species. *Department of Entomology and Nematology, University of Florida, Gainesville, FL, 32611-0611, USA.*

VERMA, A. C., DIXIT, J. & SINGH, R. D. *Varietal response of tomato genotypes to infection with* Meloidogyne incognita.

The response of fifteen tomato genotypes to infection with *M. incognita* was studied by releasing 500 second stage juveniles around the feeder root zones of 15 days old seedlings grown in pots containing sterile soil. After 45 days, growth characters of plants, root-knot index, production of egg mass and final nematode population were studied. None of the genotypes was found immune. However, the NR-7, NT-8, NT-12 and Mangla genotypes produced very low numbers of galls and numbers of nematodes recovered both from pot soil and plants were very much lower than from the other cultivars, indicating resistant reaction of these genotypes. Genotypes NTD-108, NTD-110, NTD-90, NTD-5, NTD-120, HS-101, NTD-21 and Vaishali with gall indices ranging from 3.4-4.0 were susceptible. *Department of Nematology and Vegetable Science, N.D. Univ. of Agric. & Techn., Narendranagar, Kumarganj, Faizabad (U.P.). India.*

VERMA, A. C., GAUTAM, N. C. & PATHAK, S. P. *Reaction of okra* (Abelmoschus esculentus *(L.)Moench.) genotypes to* Meloidogyne incognita.

Green pod yield of okra(lady's finger) responsed inversely when the crop is affected by *Meloidogyne incognita* during growth, resulting in considerable economic loss. Present inferences were drawn from the screening of 36 genotypes by inoculating 500 freshly hatched juveniles of *M. incognita*, in clay pots filled with nematode free soil, on ten days old seedlings. A susceptible cultivar, Pusa Sawani was sown as control. During the course of investigation for 45 days, the observations were recorded for number of galls and egg masses per plant on a scale of 1-5. Genotypes exhibited variable reaction to this nematode. The seven resistant genotypes viz. KS-310, KS-315, I.C.-12205, Sel. 2-2, AE-100 and E.C.-52392 had the lowest gall index (1.0-1.8) while four genotypes (E.C.-22096, KS-306, KS-319 & KS-301) rated moderately resistant with gall index between 2.4-2.6. Susceptible reaction (3.6-4.5 gall index) displayed by 21 genotypes and cultivars Pus a Sawani, G-2 Verma Jwel and I.C.-6467 categorised as highly susceptible (4.6-5.0 gall index). *Department of Nematology, Vegetable Science and Plant Pathology, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.), India.*

VOVLAS, N. *Morphological details, new hosts and histopathology of* Heterodera hordecalis, *from Italy.*

Morpho-anatomical studies of *Heterodera hordecalis* Anderson, are presented with light and scanning electron microscope (SEM) observations made on all life stages of this species, isolated and maintained on *Cynodon dactylon*, a common grass on the Adriatic coastal dunes of Southern Italy. The main morphological diagnostic features distinguishing *H. hordecalis* from the most closely related species *H. latipons* are also illustrated and discussed. *Heterodera hordecalis* was found in glasshouse tests heavily parasitizing, in addition to *C. dactylon*, the roots of durum wheat (*Triticum durum*) and rice (*Oryza sativa*) which increase the host range of the species. Histological observations of cross sections of nematode-infected roots of barley, bermuda grass, rye, rice and

wheat revealed that infective stages of *H. hordecalis* cause the formation of specialized cells in a moderately expanded stelar syncytium involving 5-8 cells. *Istituto di Nematologia Agraria C.N.R., Via G. Amendola 165/A, 70126 Bari, Italy.*

VRAIN, T. C. *The effect of an organic amendment on control of* Pratylenchus penetrans *with a non-fumigant nematicide and a parasitic fungus.*

Panagrellus redivivus infected with *Meria coniospora* were inoculated to *Pratylenchus penetrans* infested soil amended with chicken manure. The fungus and the manure both controlled *P. penetrans*. The effect was correlated with the number of *P. redivivus*, and the amount of manure added to the soil, in the absence of host plants. In the presence of host plants the fungal effect was reduced considerably, but the manure was still effective. In raspberry field plots the manure (250 g/m^2) did not affect Vydate's effectiveness in preventing nematode multiplication, while a rate of 750 g/m^2 of manure without nematicide had a strong nematicidal effect. *Agriculture Canada Research Station, Vancouver, B.C., V6T 1X2, Canada.*

VRAIN, T. C., WAKARCHUK, D., & HAMILTON, R. I. *A ribosomal DNA probe from* Xiphinema bricolensis *to identify* Xiphinema *species.*

We have constructed a probe containing the 5.8 s RNA gene and the internal transcribed spacer (ITS) of the ribosomal RNA (rRNA) cistron of *Xiphinema bricolensis* (*Xb*). A pUC13 library of cloned EcoR1 genomic DNA fragments of *Xb* was screened with cDNA prepared from *Xb* RNA, and with *Caenorhabditis elegans* (*Ce*) rDNA probes. Nucleotide sequence analysis indicated that clones flanking the ITS of ribosomal cistron were obtained. The region between the small and large subunit RNAs was PCR amplified and cloned. The ITS and other *Xb* rDNA clones are used to identify RFLP's in species of *Xiphinema. Agriculture Canada Research Station, Vancouver, B.C. V6T 1X2, Canada.*

WACEKE, J. M. *Effects of organic materials on pathogenicity of* Meloidogyne incognita *on okra.*

Sun- or oven-dried chicken manure, sawdust, goat manure and mature maize stalks, bean stems and kale leaves were incorporated into the soil 14 days prior to inoculation at the rate of 20 g per planting hole or 15 cm-diameter plastic pots. Okra plants were inoculated with 2500 ± 50 *M. incognita* eggs and second stage juveniles. Chicken manure, goat manure and kale leaves suppressed pathogenic effects of *M. incognita* by up to 75.7%, 68.9%, and 67.2%, respectively. Maize had varying effects. Sawdust and bean stems did not suppress the pathogen in most cases. *Department of Botany, Kenyatta University, P.O. Box 43844, Nairobi, Kenya.*

WALTER, D. E., KAPLAN, D. T. & DAVIS, E. L. *Colonization of greenhouse nematode cultures by antagonists.*

Greenhouse cultures of *Meloidogyne* spp., *Tylenchulus semipenetrans, Pratylenchus coffeae*, and *Belonolaimus longicaudatus* were found to be heavily infested with nematophagous mites, primarily Mesostigmata (9 species) and Cunaxidae (2 species). Mite densities often exceeded one mite/cc in rootknot nematode cultures. Densities of nematophagous mites increased with time and decreased with declining J2 densities. Mean species number increased linearly with time. Greenhouse nematode cultures also contained 13 species of nematophagous fungi, some of which may be vectored by mites. These results suggest that antagonists introduced with nematode inoculum are a potential source of experimental error. *USDA-ARS, 2120 Camden Rd., Orlando, FL 32803, USA.*

WANG, J. X. *Field application of nematode* Steinernema carpocapsae *against peach fruit moth* Carposina nipponensis.

Successive field trials using *S. carpocapsae* to control *C. nipponensis*, the most important pest in apple production in China, have been conducted in a variety of orchards ranging from Northwest to Northeast China and Central to North China over the last five years. 91.8% to 98.4%

of the soil dwelling larvae were killed by *S. carpocapsae* infection instead of becoming adults which lay eggs leading to damage of the fruit. Results showed that using this nematode to replace chemical insecticides in the control of this pest is highly feasible. Grower trials over hundreds of hectares of orchard are currently being carried out. *Guangdong Entomological Institute, Guangzhou, China.*

WAUDO, S. W., SENSU REDDY, K. V., & LUBEGA, C. M. *Occurrence and prevalence of banana nematodes in Kenya.*

A survey was carried out to determine distribution and prevalence of banana nematodes in 22 administratives districts in Kenya, East Africa. The nematodes *Pratylenchus goodeyi* and *Radopholus similis* were found in 100 and 68% of samples, respectively: *Helicotylenchus* spp. (*H. micronatus* and *H. multicinctus*) were found in 80%. Up to 277,778 *P. goodeyi* and up to 90,000 *R. similis* were obtained per gram of dry root. Up to 1800 *Helicotylenchus* spp. were obtained from 100 cm^3 of soil. Other nematodes found in the banana fields in small numbers were *Meloidogyne* spp., *Tylenchus* spp. and *Hemicycliophora* spp. *Crop Pest Research Programme, International Centre of Insect Physiology and Ecology, P.O. Box 30772, Nairobi, Kenya.*

WESTERMAN, P. R. *The influence of storage on efficacy, persistence and host-searching ability of the insect parasitic nematode,* Heterorhabditis *sp., and an attempt to quantify nematode quality.*

Various batches of the insect parasitic nematode *Heterorhabditis* sp. (Dutch isolates HL81 and HFr86) differed significantly in efficacy against black vine weevil larvae (*Otiorhynchus sulcatus*) in strawberries, after prolonged storage in aerated water at 5°C. Persistence in potting soil and host-searching ability in sand columns were also remarkably affected by storage. Regression analysis showed that for this species of *Heterorhabditis* 'quality' was related to relative age of the nematodes at 5°C, retention of second stage cuticles around the third stage infectives and visual assessment of absence or presence of food reserves in the nematodes. Average nematode survival in the batch was not related to quality. This experiment should be repeated with more replicates to prove a strict relationship, which would make it possible to predict nematode 'quality' before application in the field. *Friesland College of Agriculture, Antillenweg 3, 8931 BV Leeuwarden, The Netherlands.*

WIGGERS, R. J. & STARR, J. L. *Molecular analysis of giant cell DNA.*

Nuclei of giant cells induced by *Meloidogyne incognita* in *Pisum sativum* have more chromosomes and total DNA than nuclei of normal cells. Four DNA probes containing sequences from ribulose 1,5-bisphosphate carboxylase, histone 3, actin, and the 18-28s rRNA genes were used to probe giant cell DNA. Slot blot hybridization was used to determine the relative copy number of each sequence. All probes hybridized to both giant cell DNA and DNA from unaffected root-tip cells. Additionally, giant cell and root-tip DNA exhibited the same amount of hybridization as determined by densitometer analysis of autoradiographs. Based on these data, we concluded that there is no evidence of specific gene amplification on any of these genes in giant cell nuclei. *Texas Agricultural Experiment Station, College Station, TX 77843, USA.*

WILLIAMSON, V. M., COLWELL, G., MEI, H., & HO, J.-Y. *Molecular analysis of the region of the tomato genome containing* Mi, *a gene conferring resistance to root-knot nematodes.*

Restriction fragment length polymorphisms (RFLPs) associated with the presence of *Mi* in tomato, *Lycopersicon esculentum*, have been identified by probing Southern blots of tomato DNA with a number of DNA probes. One of these DNA probes, CD67, was previously mapped to approximately 7 recombination units (centiMorgans [cM]) from *Mi*. Two additional RFLPs distinguishing resistant and susceptible tomato cultivars were obtained using a DNA probe located near the genomic location of CD67. RFLPs were also obtained using DNA corresponding to the cloned gene *Aps-1*, located less than one cM from *Mi*. Additional fragments that exhibit RFLPs when used to probe resistant and susceptible tomato DNA's have been obtained, but not characterized. The presence of multiple RFLPs near *Mi* suggests that a significant

stretch of "foreign" DNA, presumably from the wild species that was the source of resistance (*L. peruvianum*), is still present in resistant lines of tomato. *Department of Nematology, University of California, Davis, CA 95616, USA.*

WINCHELL, K. L. & MCGAWLEY, E. C. *Interaction of* Hoplolaimus galeatus, Fusarium oxysporum, *and* Macrophomina phaseolina *on Centennial soybean.*

In 6 of 7 experiments conducted, *H. galeatus* caused significant damage to Centennial soybeans. In 4 separate experiments, the presence of *F. oxysporum* (*F.o.*) resulted in significantly augmented root penetration by *H. galeatus*. Conversely, *M. phaseolina* (*M.p.*) caused significant reductions in root penetration. When the nematode was combined with both fungi the *F.o.* × *M.p.* interaction was significant and antagonistic to nematode reproduction and colonization by *M.p. Department of Plant Path. & Crop Phys., L.S.U., B.R., LA, USA.*

WIXTED, D. W., & MACGUIDWIN, A. E. *Differences in root egress between adult male and female* Pratylenchus penetrans.

Experiments were conducted to determine if movement out of roots differs for adult male and female *P. penetrans*. Three pea (*Pisum sativum*) root explants, one each inoculated with males, females, or uninoculated were placed parallel to each other or in a radial pattern in 1.2% water agar plates. After five days in both experiments, a significantly larger proportion of males (50-75%) than females (4%) left roots. Of those males which left the male-inoculated root, 50% subsequently infected the female-inoculated root, while less than 5% entered the uninoculated root. Similar results were obtained using intact seedlings in soil. When roots were inoculated with both sexes together, there was no difference in egress between the sexes, and egress by males was less than that from roots inoculated with males alone. Root growth, infection by nematodes comparable to that on intact seedlings, development of lesions on infected roots and presence of eggs in female-inoculated roots indicate that the explants were suitable hosts for the nematodes. Roots inoculated with females developed significantly more lesions than those inoculated with males. *Department of Plant Pathology, University of Wisconsin, Madison WI 53706, USA.*

WYSS, U. *Behaviour patterns of* Heterodera schachtii *throughout development.*

Over 150 individuals were studied at 25 ± 1°C inside roots of cruciferous host plants with video-enhanced time lapse techniques. Destructive intracellular migration of J2 juveniles changed into subtle probing, once cells close or within the vascular cylinder had been reached. The stylet-tip remained finally protruded in a selected cell for 7-8 h without any pumping action of the metacorpus. Secretions of the two subventral glands were then most probably not injected. The dorsal gland became increasingly active during the "induction" phase. A few defaecations preceded the first pumping action of the metacorpus. Feeding was in a series of repeated cyles, consisting of three distinctive phases (I-III) that were maintained throughout development, with average numbers of cycles varying between 38 and 66, depending on the pre-adult stages. J3 males removed considerably more food than J3 females from a very active syncytium, but injected less saliva from the dorsal gland to maintain it. Feeding tubes, connected to the stylet-tip aperture and repeatedly formed within a zone of modified cytoplasm by dorsal gland secretions in phase III, became visible at the earliest 30 h after feeding had started. Moulting, initiated and terminated by an increased activity of the subventral glands, lasted on average 21 h for each stage. Critical stages during development will be emphasized. *Inst.f. Phytopathologie, Universität Kiel, D-2300 Kiel 1, Germany.*

WYSS, U.[1]), VOSS, B.[1]) & JANSSON, H.-B.[2]) *Parasitic behaviour of* Catenaria anguillulae, *infecting eggs of* Meloidogyne incognita.

Zoospores of the chytridiomycetous fungus *C. anguillulae*, obtained from axenic cultures on nutrient media, were added to *M. incognita* eggs at different stages of embryogenic development in diluted salt solution and studied at 25°C, using video-enhanced light microscopy. Zoospores

moved around at random for many hours without becoming attached to the eggs. However, once a zoospore encysted by coincidence and germinated in such a way that the germ tube penetrated the egg shell and the inner lipid layer, zoospores were suddenly attracted to the penetration site and after germination the embryo was killed within minutes. Occasionally a second phase of massive attraction and encystment occurred soon after. On eggs with fully developed J2 juveniles zoospore attraction and encystment was always in two phases, first after a zoospore had penetrated the lipid layer and second immediately after the juvenile had been killed within about one hour. Juveniles ready to hatch were not killed and those that had hatched were never attacked. Due to the abundant and rapid development of new zoospores in parasitized eggs, packed with zoosporangia, all eggs were finally destroyed within three to four days. [1])*Institut für Phytopathologie der Universität Kiel, D-2300 Kiel, Germany and* [2])*Department of Microbial Ecology, Lund University, S-223 62 Lund, Sweden.*

YANG, H. W., ZHANG, G. Y., ZHANG, S. H. & JIAN, H. *Control of* Holcocerus insularis *(Lep.: Cossidae) with* Steinernema feltiae *on a large scale.*

Forty thousand shade trees infested by carpenterworm, *Holcocerus insularis*, have been treated by the nematode *Stenernema feltiae* in several cities in northern China since 1988. The dosage used in practice was 1,000 infective juveniles per ml. About 200 ml of nematode suspension were injected into each tree. Larval mortality reached 96.8%. Most of *Holcocerus* larvae were infected by the nematodes, crawling out of their tunnels to die. This new technique of biological control is accepted by the Landscape Bureau, to be applied where the shade trees are seriously infested by various carpenterworms. *Biological Control Research Institute, Chinese Academy of Agricultural Sciences, Bejjing 100081, China.*

YEATES, G. W. *Adult body size in a second species of* Pakira (Leptolaimidae) — *taxonomic and ecological status.*

A new species of *Pakira* from New Zealand forests shows a range of female body length (1.53-3.98 mm) and a juvenile (2.63 mm) substantially longer than some females. Previously encountered apparent "species pairs due to polyploidy" include *Synonchium pacificum* (L = 1.59, 2.96 mm; bivalents = 5, 10), *Plectus antarcticus + frigophilus, Hemicycliophora chathami chathami + H. c. major* and perhaps *Iotonchus basidontus + stockdilli.* There have been cytological studies of heteroderid nematodes to support taxonomic work. In genera without such distinct biochemical relations with their hosts, increases in size assumed to be associated with polyploidy may impact on other dimensions of their realised multi-dimensional niche. Given complementary temporal distribution of tylenchid species in roots and the apparent complementary size of cohabiting mononchids, it is difficult to accept "a genus occupies an ecological niche" (Maggenti, 1989, *Rev. Nématol. 12:* 3-6) when there is apparent "Gausian" divergence/speciation within a guild to increase the overall resource available. Once gene flow in bisexual species ceases speciation has occurred; until that has been demonstrated, subspecific rank may be appropriate. *Division of Land and Soil Science, DSIR, Private Bag, Lower Hutt, New Zealand.*

YEATES, G. W. & BAMFORTH, S. S. *Recolonization by nematodes of methyl bromide sterilized soil in forest and pasture.*

Undisturbed soil cores 29.7 cm in diam. and 30 cm deep were surrounded by PVC pipe, fumigated with methyl bromide in a chamber and returned to the field; nematode abundance in 0-50 mm soil was determined after 0, 1, 5, 12, 26, 54, 110 and 166 days; untreated soil served as a baseline; nematodes were extracted by the 2-flask method from bulked samples from 3 replicate cores at each site; the 4 sites were evergreen forest and grazed pasture each under c.1400 and c.2200 mm rainfall. On day 26 a cephalobid was found within an arthropod chelicera in the wetter forest. On subsequent days all fumigated sites yielded nematodes. On day 166 numbers / 10 g moist soil were drier forest 17 (untreated 38), pasture 76 (167); moister forest 7 (62), pasture 89 (307); genera present were 8 (18), 7 (20); 4 (23), 9 (19). All fumigated soils yielded Rhabditinae, *Cephalobus, Plectus* and *Mononchus*; 3 sites yielded both *Panagrolaimus* and *Monhystera; Aphelenchus, Anaplectus, Pungentus* and *Alaimus* were each found at 1 site; cadavers of

Criconemoides were still being extracted. *Division of Land and Soil Sciences, DSIR, Private Bag, Lower Hutt, New Zealand.*

ZAHEER, K. & FLEMING, C. *Studies on genetic variation in* Globodera rostochiensis *and* G. pallida *from Northern Ireland, Cyprus and the Falkland Islands.*

Genetic variation in populations of *Globodera rostochiensis* and *G. pallida* from three areas — Northern Ireland, Cyprus and the Falkland Islands — was examined using isoelectric focusing and specific enzyme staining. Genetic heterogeneity within and among the three regions was assessed and related to the potato cyst nematode pathotypes and virulence groupings present. The patterns of genetic variation detected were used to infer the extent and source of the original PCN introductions into the three regions. *Department of Agricultural Zoology, Nematology Laboratory, Queen's University, Belfast, U.K.*

ZOON, F. C. *Interaction of plant parasitic nematodes and abiotic soil development in the decline of* Hippophaë rhamnoides *L.*

The plant parasitic nematofauna under *H. rhamnoides* in different stages of dune succession was analysed. Canonical correspondence analysis was used to reveal relations with abiotic soil factors. A divergent development was found in nematofauna and other soil factors. Soil pH and N were principal factors in the ordinations. Inoculation of the dominant *Dolichorhynchus microphasmis* in pot experiments caused severe reduction of growth and nodulation. Apparently, reduced phosphorus uptake was the most important effect. Furthermore, the density of *D. microphasmis* on roots of seedlings planted in the field was higher in the late *H. rhamnoides* stage than in an early stage. It seems likely that the ratio of soil N/P determines to what extent nematodes can be harmful to *H. rhamnoides* in dune soils. *Inst. for Ecol. Research, P.O. Box 40, 6666 ZG Heteren, The Netherlands.*

ZUNKE, U. *Feeding behaviour and biology of the root lesion nematode* Pratylenchus penetrans *in comparison to different species of plant parasitic nematodes.*

Although *Pratylenchus penetrans* is one of the smallest species of plant parasitic nematodes a video-system (*Rev. Nématol.* 9, 91-94, 1986) enables *in vivo* observations to be made at high magnification (up to 3000 ×) of the nematodes within the roots and in the root hair area, revealing details which cannot be seen even with optimal IC-microscopy.

A comparison between film analysis of feeding behaviour and biology of a sedentary plant parasitic nematode such as *Heterodera schachtii* (film E 2904, IWF Goettingen, F.R.G., 1986) and of a migratory root lesion nematode such as *Pratylenchus penetrans* (film C 1676, IWF Goettingen, F.R.G., 1988) demonstrated clearly the basic patterns of the behaviour of *P. penetrans* under aspects of nematode evolution. By contrast with *H. schachtii, P. penetrans* fed from root hairs and cortex cells inside roots of different host plants. After the stylet had penetrated a cell, each time a very small "salivation zone" was formed around the stylet tip. The behaviour of food ingestion could be separated into phases of brief and extended feeding periods. During food uptake a feeding tube was never observed. The root hair and cortex cell responses to nematode feeding included only increased rate of cytoplasmic streaming and hypertrophy of the nucleus.

More observations on aspects of egg-laying, moulting and migration are discussed in relation to work and film analysis on the feeding behaviour of other plant parasitic nematodes. *Institut für Angewandte Botanik, Marseillerstr. 7, D-2000 Hamburg 36, Germany.*