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Short note

Tests of Antarctic soils for insect parasitic nematodes

CHRISTINE T. GRIFFIN[1], M.J. DOWNES[1] and W.BLOCK[2]

[1]Department of Biology, St. Patrick's College, Maynooth, Co. Kildare, Ireland.
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, U.K.

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Introduction

Nematodes of the families Heterorhabditidae and Steinernematidae are obligate parasites of a wide range of insects (Poinar 1979). The third stage juvenile of these nematodes is a non-feeding infective form which carries symbiotic insect-pathogenic bacteria (*Xenorhabdus* spp.) in its intestine. Under favourable conditions the juveniles can survive for months in the soil. They are attracted to and enter insects. After invading the haemocoel they release the symbiont. The bacteria multiply, kill the host by septicaemia, and provide suitable conditions for nematode growth and reproduction. After one to two weeks, the newly formed infective juveniles leave the cadaver and seek new hosts.

Under suitable conditions, steinernematids and heterorhabditids may provide effective biological control of certain insect pests (e.g. Bedding & Miller 1981, Simons 1981). The nematode-bacterial complex can be mass produced *in vitro* and several species are produced commercially for use against selected pest species.

Bedding & Akhurst (1975) developed a method of recovering insect parasitic nematodes of the families Heterorhabditidae and Steinernematidae from soil by baiting samples with live insects. Surveys using this method have shown these nematodes to be common and widely distributed in many parts of the world including Australia, North America and Europe (see Akhurst &Bedding 1986).

Steinernematids and heterorhabditids have not been reported from Antarctic soils. However, there has been no specific effort aimed at their recovery. Forty species of other nematodes have been recorded from the maritime Antarctic, and 22 from the subantarctic zone (Maslen 1979). These include microbial feeders, fungivores and predatory species. At Signy Island, nematode populations of 663–924x 10^3 individuals m^{-2} in moss substrates have been estimated by Caldwell (1981). As part of an ongoing search for isolates active at low temperatures for pest control purposes, soil samples from subantarctic South Georgia and Signy Island in the maritime Antarctic were tested for the presence of insect parasitic nematodes.

Materials and Methods

A total of 41 samples of soil and surface vegetation were collected during the austral summer, between February and March 1988. Eleven were from around Husvik, South Georgia (54°12'S, 37°43'W) and 30 from Signy Island (60°43'S, 45°36'W) in the South Orkney Islands. They were taken from a variety of habitats including grassland, moss turf and fellfield fines. The samples included mineral and peat substrates, both wet and dry. The samples were stored individually in plastic bags and shipped to the laboratory under refrigeration (+4°C). They were tested for insect parasitic nematodes by baiting with wax moth (*Galleria mellonella*) larvae (Bedding & Akhurst 1975). Five late instar larvae were placed in the bottom of a screw-top jar (0.5 l capacity) which was then filled with soil. The insects were recovered after two weeks at 15°C. The test was repeated using fresh insects in the same soil samples for one week at 20°C. Insects which died were incubated on damp paper to encourage nematode reproduction. When infective juveniles failed to emerge after several weeks, cadavers were dissected and examined for parasites.

Results

Of the 410 *Galleria mellonella* used as bait at the two incubation temperatures, 39% died ($\bar{x}$: 1.95 insects $sample^{-1}$). There was an average of 2.2 dead insects $sample^{-1}$ at 15°C and 1.7 at 20°C, with a range of 0–5 at both temperatures. In five of the samples, no insects died at either incubation temperature. None of the bait insects showed evidence of parasitisation by steinernematids or heterorhabditids, such as characteristic colour changes due to the bacterial symbiont, or the emergence of infective juveniles on prolonged incubation. Other entomopathogens which may have caused mortality of the bait insects were not investigated.

Discussion

Steinernematids have been isolated from soil north of the Arctic circle (Husberg *et al.* 1988). To persist near the poles, nematodes would be expected to show some degree of cold adaptation. Steinernematid and heterorhabditid nematodes

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show considerable inter- and intra-specific variation in temperature relations. Minimum temperatures for infection by a number of species and strains from different geographic regions ranged from 4 to 8°C for steinernematids and 8 to 12°C for heterorhabditids (Molyneux 1986). The temperature range tends to be correlated with the region of origin of the isolate (Molyneux 1984). Infective juveniles of a strain of *Steinernema carpocapsae* from Vancouver survived exposure to -10°C, and the survivors were able to infect and kill insects (Schmiege 1963). In principle, therefore, steinernematids at least might be expected to tolerate conditions of the maritime and subantarctic, although heterorhabditids, with their higher temperature requirements, may not.

The occurrence of insect parasitic nematodes requires the availability of suitable hosts. Signy Island has a species poor arthropod community, consisting only of collembolans and mites (Block 1984). Steinernematids and heterorhabditids have a broad host range (Poinar 1979), and both families are capable of parasitising Collembola (Ireson & Miller 1983). Collembolans frequently occur in dense clusters and population densities of up to 100,000 individuals m^{-2} have been recorded at Signy Island (Block 1982). This could be expected to facilitate nematode parasitisation. Mites are more likely to pose a risk as predators than as potential hosts for such nematodes (Epsky *et al.* 1988). The arthropod fauna of South Georgia is more diverse (Gressitt 1970) with representatives of 9 insect orders including Diptera and Coleoptera (Block *et al.* 1988), and should provide suitable hosts for parasitic nematodes. The failure of this limited survey to demonstrate the presence of insect parasitic nematodes at Signy Island and South Georgia suggests that they may be absent from Antarctic soils, but the finding requires confirmation, especially for the subantarctic.

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References

Akhurst, R.J. & Bedding, R.A. 1986. Natural occurrence of insect pathogenic nematodes (Steinernematidae and Heterorhabditidae) in soil in Australia. *Journal of the Australian entomology Society*, **25**, 241-244.

Bedding, R.A. & Akhurst, R.J. 1975. A simple technique for the detection of insect parasitic rhabditid nematodes in soil. *Nematologica*, **21**, 109-110.

Bedding, R.A. & Miller, L.A. 1981. Use of a nematode *Heterorhabditis heliothidis*, to control black vine weevil, *Otiorhynchus sulcatus* in potted plants. *Annals of applied Biology*, **99**, 211-216.

Block, W. 1982. The Signy Island terrestrial reference sites: XIV. Population studies on the Collembola. *British Antarctic Survey Bulletin*, **55**, 33-49.

Block, W. 1984. Terrestrial microbiology, invertebrates and ecosystems. *In* Laws, R.M. *ed. Antarctic Ecology*, vol. **1**. London and New York: Academic Press, 163-236.

Block, W., Sømme, L., Ring, R., Ottesen, P. & Worland, M.R. 1988. Adaptations of arthropods to the subantarctic environment. *British Antarctic Survey Bulletin*, **81**, 65-67.

Caldwell, J.R. 1981. Biomass and respiration of nematode populations in two moss communities at Signy Island, Maritime Antarctic. *Oikos*, **37**, 160-166.

Epsky, N.D., Walter, D.E. & Capinera, J.C. 1988. Potential role of microarthropods as biotic mortality factors of entomogenous nematodes (Rhabditida: Steinernematidae, Heterorhabditidae). *Journal of Economic Entomology*, **81**, 821-825.

Gressitt, J.L. 1970. Subantarctic entomology, particularly of South Georgia and Heard Island. *Pacific Insects Monograph*, **23**, 1-374.

Husberg, G.B., Vänninen, I. & Hokkanen, H. 1988. Insektpathogena svamper och nematoder i odlingsjorden i Finland. [Insect pathogenic fungi and nematodes in fields in Finland]. Växtskyddsnotiser, **52**, 38-42.

Ireson, J.E. & Miller, L.A. 1983. Susceptibility of the collembolan *Sminthurus viridis* to the insect parasitic nematodes *Neoaplectana bibionis* and *Heterorhabditis heliothidis*. *Entomologia Experimentalis et Applicata*, **34**, 342-343.

Maslen, N.R. 1979. Additions to the nematode fauna of the Antarctic region with keys to taxa. *British Antarctic Survey Bulletin*, **49**, 207-229.

Molyneux, A.S. 1984. The effect of temperature on the infectivity of Heterorhabditid and Steinernematid nematodes for larvae of the sheep blowfly, *Lucilia cuprina*. *Proceedings of the 4th Australian Applied Entomology Research Conference, Adelaide*, 344-351.

Molyneux. A.S. 1986. *Heterorhabditis* spp. and *Steinernema* (= *Neoaplectana*) spp.: temperature and aspects of behaviour and infectivity. *Experimental Parasitology*, **62**, 169-180.

Poinar, G.O., Jr. 1979. *Nematodes for Biological Control of Insects*. *Boca Raton*, Florida: CRC Press, 277 pp.

Schmiege, D.C. 1963. The feasibility of using a neoaplectanid nematode for control of some forest pests. *Journal of Economic Entomology*, **56**, 427-431.

Simons, W.R. 1981. Biological control of *Otiorhynchus sulcatus* with Heterorhabditid nematodes in the glasshouse. *Netherlands Journal of Plant Pathology*, **87**, 149-158.

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