Natural Enemies of Nematodes

studies of complex soil environment aimed at favoring fungi and other organisms that limit plant nematode populations

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Nematodes are attacked by a variety of organisms including protozoa, fungi, and other nematodes. There are indications that some bacteria may cause reductions in nematode populations and, although no virus diseases of nematodes are known at present, some conceivably exist.

Fungi

Many species of fungi—mainly hyphomycetous *Moniliales* — which capture nematodes in unusual ways are widely distributed in California, both in agricultural soils and in virgin areas. They enmesh the nematodes in a mycelium of interwoven threadlike filaments, either by sticky knobs or by the general stickiness of the individual threads—hyphae —or through snares or loops which, when triggered as a nematode passes through them, hold and constrict the prey very tightly. In all cases, the cuticle of the nematode is penetrated by an outgrowth of the fungus, which ramifies through the body of the captured prey and absorbs its contents. Such fungi can be grown on artificial media and, under laboratory conditions at least, are capable of destroying large numbers of nematodes.

Trapping fungi evidently vary in their ability to reduce nematode populations in the soil. Their effectiveness has not yet been adequately investigated. Research workers in Hawaii, about twenty years ago, demonstrated that one of the five species of nematode-trapping fungi used in an experiment was able to reduce a poulation of root-knot nematodes significantly. The fact that many fungus species occur in the soil in association with large populations of nematodes parasitic on some California crops would indicate that in the natural biological balance of the soil these fungi are not completely effective in controlling such parasites. The possibility exists that species of fungi discovered in other regions of the world may prove more effective in reducing the important plant nematodes in California. Areas to which nematode species are native may yield natural enemies not occurring elsewhere, but almost nothing is known about geographic origins of important plant parasitic nematodes.

Fungi of another group that attacks nematodes are obligate parasites belonging mostly to the *Zoopagaceae,* a family of *Mucorales.* These fungi operate mainly by the production of sticky spores which adhere to the nematodes, although some species also have sticky hyphae. There are also several species of *Chytrids* and other lower *Phycomycetes* which are obligate parasites of nematodes. They produce tiny zoospores which attach themselves to the surface of a nematode, penetrate its cuticle and develop within its body, eventually producing more zoospores which attack more nematodes. However, the ravages of this group of fungi appear to be directed mostly toward free-living soil forms and do not greatly affect populations of plant-parasitic nematodes.

It has been believed for some time that decaying vegetable matter, manure, and similar soil amendments can restrict some nematode populations in the soil. Such materials may favor the development of fungi and other organisms that attack nematodes. Trials with mulches of olive pomace, pine shavings, redwood shavings, or shredded fir bark in citrus groves, where one to several species of nematode-capturing fungi occurred naturally, have failed to control populations of the citrus nematode. Whether similar practices have any practical value with other crops remains to be determined.

Predaceous and parasitic fungi are obviously beneficial members of the soil flora, and should be considered in shaping general agricultural practices. An attempt is being made to determine whether efficient and practical methods for utilizing such fungi can be developed. Much remains to be learned about basic soil biology. However, where these organisms can be effectively incorporated into soils or their activity augmented, their use as control agents may promise to be one with long-lasting effects.

Predaceous Nematodes

Several types of nematodes which apparently feed mainly on other nematodes are widely distributed in all soils, although generally not in large numbers. They are abundant in California soils and are under investigation as possible agents in biological control. Some have relatively large mouths with rasping toothlike structures which tear into the bodies of their victims, but they have not been found to be very effective in reducing populations of the plant parasitic nematodes.

A few species of predaceous stylet-bearing nematodes, having hollow spears with which they pierce the cuticle of their prey and suck out the body contents, have been isolated from California soils and can be reared artificially in the laboratory and increased to fairly large numbers. Relatively little is known about the biology of the group, but tests are under way which will indicate whether or not they can provide a practical control method for plant parasitic nematodes.

Toxic Plants

Another phase of biological control of plant parasitic nematodes was recently discovered in the Netherlands, where certain plants were found to possess nematocidal substances in their roots. Species of *Tagetes,* the common African marigolds, can reduce populations of root-lesion nematodes—*Pratylenchus* spp.—in the soil, but not all plant parasitic nematodes are affected by the same plants. Trials now under way in some southern California rose nurseries may indicate whether marigolds can be used to reduce root-lesion nematode populations in infested soil. Other plants may exist which possess similar properties and are effective on a wider range of nematode pests.

Eradication Unlikely

The utilization of natural enemies of nematodes for their control has received sporadic attention during the past 20–30 years, but much remains to be learned about this subject. Complete eradication of a plant parasitic nematode species by its natural enemies will be unlikely. However, contrived biological control holds out a possibility of keeping nematode pests in check to a point where their attacks on crops are economically unnoticed.

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