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Opinion Article

Entomopathogenic nematodes in biological control

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DESCRIPTION

Entomopathogenic nematodes (EPNs) are insect-killing nematodes (thread worms). The term "entomopathogenic" is derived from the Greek words "entomon" (insect) and "pathogenic" (disease-causing). They are animals that operate as a biocontrol intermediary between microbial diseases and predators/ parasitoids, and are commonly connected with pathogens owing to their symbiotic relationship with bacteria. Unlike many other parasitic thread worms that cause sickness in humans (by sterilising or otherwise weakening their hosts), entomopathogenic nematodes only infect insects. Endoparasitic nematodes (EPNs) are parasitic worms that dwell inside their sick insect hosts. Moth larvae, butterflies, flies, and beetles, as well as adult beetles, grasshoppers, and crickets, are among the soil-dwelling insects infected. EPNs have been discovered all around the world in a range of biological situations. Their nature is diverse, intricate, and specialised. The Steinernematidae and Heterorhabditidae families of entomopathogenic nematodes have been studied the most. They are the only insect-parasitic nematodes that have the optimal combination of biological control capabilities.

Life cycle

Because of their economic importance, the life cycles of the genera belonging to the families Heterorhabditidae and Steinernematidae are extensively studied. Although their life cycles are similar, they are not connected phylogenetically. The cycle begins with an infective juvenile whose main function is to infect new hosts. The nematodes enter the insect's body cavity by natural body openings (mouth, anus, spiracles) or thin cuticle areas after a host is located. After consuming a bug, infectious juveniles release a mutualistic bacterium from their intestines, which swiftly multiplies. These bacteria from the genera Xenorhabdus and Photorhabdus, respectively, induce host mortality within 24–48 hours for steinerernematides and heterorhabditids. The nematodes provide a safe sanctuary for the bacteria, which in exchange for nutrients destroy the insect host. Without mutualism, no nematode can operate as an entomoparasite. The nematodes and bacteria feed on the liquefying host simultaneously and breed for numerous generations inside the cadaver, rising to adulthood *via* the J2-J4 growth stages. Steinernematid infectious juveniles can develop into either males or females, whereas heterorhabditids develop into self-fertilizing hermaphrodites with two sexes in succeeding generations. When the host's food supply runs out, the adults produce fresh infective youngsters that are more suited to surviving in the wild. The life cycles of EPNs are completed in a few days. After about a week, hundreds of thousands of infective juveniles emerge and disperse in search of new hosts, carrying a mutualistic bacterium inoculation obtained from the internal host environment. In the host corpse, the bacteria create the conditions for their development and reproduction. The nematodes bacteria provide anti-immune proteins to help them defeat their host's defences.

Although the biological control industry has known about EPNs since the 1980s, little is known about their biology in both wild and managed situations. The interactions between nematodes and their hosts are poorly understood, with more than half of Steinernema and Heterorhabditis species having unknown natural hosts. Because naturally infected host isolates are rare, local nematodes are typically baited with Galleria mellonella, a parasite-resistant lepidopteran. Because contact with a host is ensured in a laboratory and environmental circumstances are ideal, studies suggesting vast host ranges for EPNs were typically exaggerated; there are no "ecological barriers" to infection. As a result, the wide host range predicted by test results does not always imply insecticidal success. Nematodes may be mass manufactured and do not require special application equipment since they are compatible with standard agrochemical equipment such as backpack, pressurised, mist, electrostatic, fan, and aerial sprayers and irrigation systems.

A lack of understanding of nematode ecology has resulted in unexpected failures to manage pests in the field. Parasitic nematodes have been shown to be completely worthless against blackflies and mosquitoes due to their inability to swim. Because nematodes are particularly vulnerable to UV radiation and desiccation, EPNs were ineffective in controlling foliage-feeding pests. When nematode and target pest life cycles are compared,

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such failures are commonly explained. Environmental tolerances, dispersion patterns, and feeding preferences are all unique to each nematode species. Increased knowledge of the factors that influence EPN populations and the consequences for their communities will almost probably increase their efficacy as biological control agents. Using both EPNs (steinernematids and heterorhabditids) for biological control of plum curculio in Northeast American orchards has recently been reported to reduce populations by up to 70% in the field, depending on insect stage, treatment timing, and field circumstances. More study is being done to investigate how effective EPNs are as a biological control agent for organic producers as a substitute for pesticides that aren't as effective at managing insect infestations.