Phoresy Between a Mushroom-infesting Fly and Two Free-living Nematodes Associated with Mushroom Culture[1]

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Free-living nematodes are pests of commercial mushroom production. On occasions they contribute significantly to mushroom yield reductions; however, their role in decreased production is not fully understood (1,2). Control has been achieved through effective sanitation and good cultural practices. Pasteurization of the old crop has been practiced to kill nematodes in compost and structural framework. Proper preparation of compost, casing soil, and spawn effectively produces nematode-free materials, but despite these precautions, crops are often infested with nematodes.

Hussey et al. (3) suggested that nema-

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todes are transported into the houses by mushroom-infesting flies. Members of the Rhabditidae, Diplogasteridae, Chambersiellidae, Cephalobidae, Aphelenchidae, Aphelenchoididae, Cylindrocorporidae, Dorylaimidae, Neotylenchidae, Monochidae, Panagrolaimidae, Plectidae, Strongylidae, and Tylenchidae are reported to have phoretic associations with insects (4). Thus, the objective of this study was to determine if certain free-living nematode pests of commercial mushrooms could be transported by mushroom flies.

Two free-living nematodes, *Caenorhabditis elegans* (Maupas, 1899) Dougherty and *Cruzenema lambdiensis* (Maupas, 1900) n. comb., and a mushroom fly, *Lycoriella mali* (Fetch), were selected for the phoretic study. All species were obtained from stock cultures maintained at Pennsylvania State University. Nematode culture medium was prepared from pasteurized compost and peat moss. Compost, 8.6 g, was placed in 30-ml pill cups, top-dressed with 4.6 g of peat moss, and stored in plastic boxes (30 × 15 × 8.5 cm) with tight fitting lids. *Caenorhabditis elegans* and *C. lambdiensis* were cultured for 8 and 35 days, respectively, prior to the test. At that time the culture of *C. elegans* was swarming but that of *C. lambdiensis* was not. *Lycoriella mali* pupae were taken from spawned compost-agar cultures. Adult females oviposited on the mycelium, and the progeny were reared to late pupal stage and removed for the study.

Five pest-free cultures were positioned around a *C. elegans* or *C. lambdiensis* infested-culture within the plastic box (Fig. 1). Twenty *L. mali* pupae were placed in a small vial positioned horizontally on the infested culture. Adult flies emerged from the pupae within 2 days. The experiment was replicated five times for each nematode species. Control treatments included one with flies but without nematodes and the other without either flies or nematodes. All cultures were carefully watered to prevent splashing. The boxes were randomized inside a growth chamber and incubated at 21 ± 1 C for 18 days. Cultures were then examined for nematodes by milcroscopic examination of the culture surface and the Baermann funnel extraction procedure.

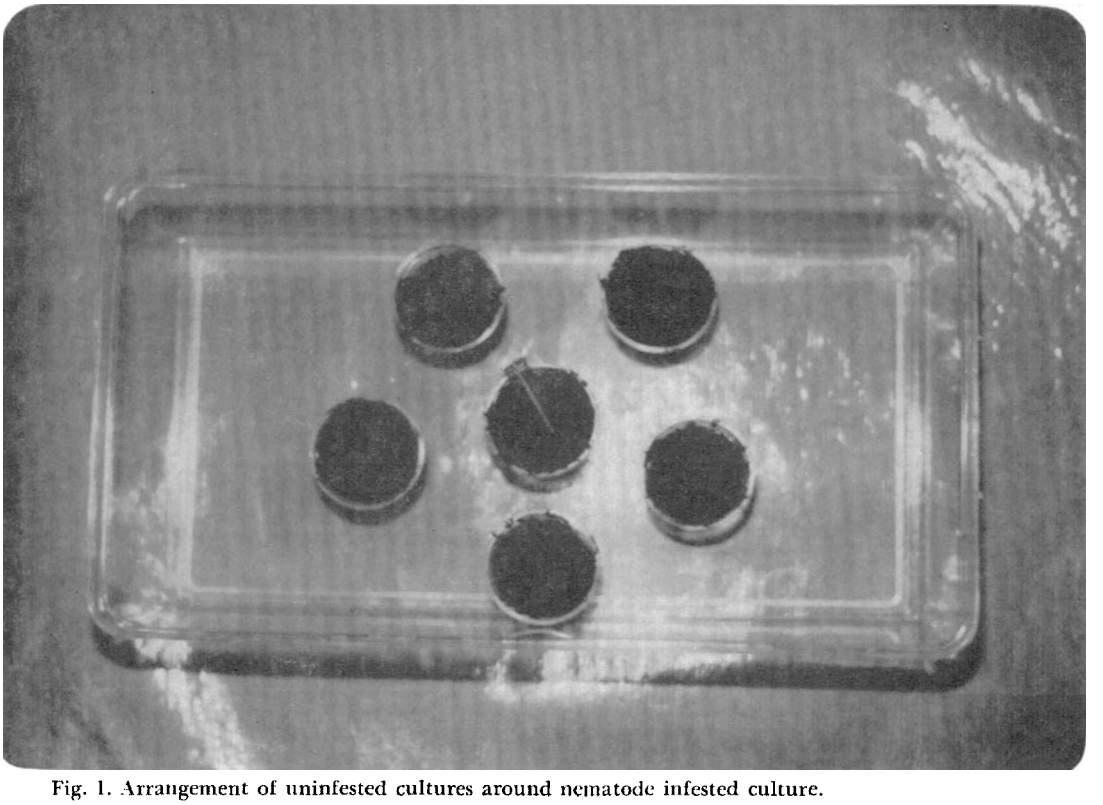

Fig. 1. Arrangement of uninfested cultures around nematode infested culture.

The experiment was designed to approximate the conditions present within the mushroom industry under which phoretic association may occur. In a nematode-infested crop, *L. mali* pupate, eclose, and ambulate on the surface of the mushroom bed. In the process, nematodes or eggs could become attached to the fly and be transplanted to an uninfested area.

Both nematodes had phoretic associations with the mushroom fly. The presence of fly larvae in the pill cups indicated that the adult flies had visited the location. The absence of nematodes in the control treatment provided evidence that the nematodes were carried by the flies as contrasted to being present on the pupal cases or in the original culture materials. *Cruzenema lambdiensis* was transported to only 8% of the uninfested cultures while *C. elegans* was carried to 52% of the uninfested cultures (Table 1).

The swarming behavior of nematodes may enhance the probability of phoresis since the rhythmic curling and flexing motions of the swarms may bring the nematodes into contact with the insects. It is most likely that juveniles or mature nematodes are carried on the legs or abdomen of the flies. *Caenorhabditis elegans* swarmed within 8 days of inoculation, however, *C. lambdiensis* did not swarm during the course of this experiment nor has it been observed to swarm in PSU cultures. This perhaps, accounts in part for the low percentage of the transfer of *C. lambdiensis*.

Table 1. Phoresy of *Cruzenema lambdiensis* and *Caenorhabditis elegans* by the Sciarid fly, *Lycoriella mali*.

Replicate*	Percentage of containers infested	
	C. lambdiensis	*C. elegans*
1	20	60
2	0	100
3	20	40
4	0	20
5	0	40
For all replicates	8	52

*Five containers per replicate.

The application of these discoveries concerning phoresis pertains chiefly to the logistics of fly control within the mushroom industry. Establishment of phoretic transport of nematodes emphasizes the importance of physically tight mushroom houses. The physical exclusion of *L. mali* is not only vital to prevent the damage produced by this fly alone; it also diminishes the probability of an associated nematode problem as well. In addition, fly containment in an existing crop is essential to prevent the migration of flies and nematodes into other houses. In nematode-infested houses, strict fly control is also important to curtail dispersal of nematodes. Additional pesticide applications may be required to lower the fly level.

This study has shown the phoretic relationship between *L. mali, C. lambdiensis,* and *C. elegans*. Future work should include the epidemiological impact of the nematode-fly complex under crop conditions and the combined effect of fly and nematode on mushroom yield.

LITERATURE CITED

1. Bloom, J. R. 1977. Nematodes. Mushroom News 25:9-11.

2. Cairns, E. J., and C. A. Thomas. 1950. Nematodes causing crop losses. Mushroom Science 1, 89-91.

3. Hussey, N. W., W. H. Read, and J. J. Hesling. 1969. The pests of protected cultivation: biology and control of glasshouse and mushroom pests. New York: American Elsevier Publishing Company.

4. Poinar, George O., Jr. 1975. Entomogenous nematodes: a manual and lists of insect-nematode associations. Leiden, Netherlands: E. J. Brill.