

Host Range of *Noctuidonema guyanense* (Nematoda: Aphelenchoididae): An Ectoparasite of Moths in French Guiana

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ABSTRACT Arthropods of French Guiana were examined to delineate the host range of a newly described species of an ectoparasitic nematode, *Noctuidonema guyanense* Remillet & Silvain, of adult Lepidoptera. Moths in five families (Lasiocampidae, Noctuidae, Notodontidae, Pyralidae, and Sphingidae) harbored *N. guyanense*. Twenty-five species of Noctuidae were infected. Multiple species of *Spodoptera* and *Mocis* served as hosts for *N. guyanense*. The most commonly infected hosts were *Lesmone formularis* Hübner, *S. dolichos* (F.), *S. frugiperda* (J. E. Smith), and *Xanthopastis timais* (Cramer). Lepidoptera in 19 families, including 121 species of Noctuidae, did not harbor *N. guyanense*. Also, arthropods in 12 orders and 70 families of non-lepidopteran insects, 2 orders of Arachnida, and 5 families of Araneae were not infected by *N. guyanense*. It appears that *N. guyanense* is primarily an ectoparasite of moths in Noctuidae.

KEY WORDS Insecta, nematoda, ectoparasite, Lepidoptera

IN FRENCH GUIANA IN 1982, *Noctuidonema guyanense* Remillet & Silvain was discovered infecting *Spodoptera androgea* (Cramer) and was subsequently described as a new genus and species of an insect-parasitic nematode (Remillet & Silvain 1988). Although *N. guyanense* is most commonly found on moths of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), in French Guiana, it also attacks adults of *S. latifascia* Walker, *S. marima* (Schaus), *Anicla infecta* (Ochsenheimer), and *Leucania* spp. (Remillet & Silvain 1988). The life cycle and host range for *N. guyanense* are unknown. Anticipating that *N. guyanense* potentially may be useful as a biological control agent against *S. frugiperda* in the southeastern United States, we studied its host range in French Guiana during July and August of 1987. The objective of this study was to document the unsuitability of nontarget insect taxa as hosts for *N. guyanense* as a preliminary to its introduction into the United States for further study.

Materials and Methods

Insects were collected from a white sheet (1.5 by 2 m) illuminated by UV light, by pheromone traps, and by sweeping vegetation from a variety of habitats in northeastern French Guiana. Sites and habitats from which collections were made included ORSTOM Center, UV light trap near

bamboo and grasses bordered by tropical forest about 10 m from the edge of a low cliff separating tidal flats from the base of Mt. Montabo, elevation 5 m; Mt. Montabo, sweeping vegetation along road on east side of mountain in tropical rain forest, elevation from 10 to 200 m; Suzini, pheromone traps in open pasture with tropical forest remnant along fencelines, elevation 5 m; IRAT, UV light trap near bean, cassava, and sugarcane adjacent to Mt. Cabassou supporting heavy tropical forest, elevation 20 m; Matoury, pheromone traps among hydroponic cultures of bean, cucumber, and lettuce approximately 1 km from tropical forest, elevation 20 m; Matoury, pheromone traps in pasture bordered on three sides by tropical forests, elevation 20 m; Matoury, sweeping vegetation along 1 km of road east of Matoury with tropical forests about 1 km distant, elevation 20 m; Pointe Combi, UV light trap in weedy area near pasture with the Sinnamary River and tropical forest nearby, elevation 5 m; Kaw, UV light trap in dense tropical forest about 5 km west of village, elevation 100 m; and Cacao, UV light trap surrounded by dense secondary vegetation near the Comté River with tropical forest about 1 km in all directions, elevation 30 m. Collections were made daily from 16 July 1987 through 11 August 1987, during the early part of the annual dry season.

Non-lepidopteran insects were transferred upon collection to individual vials containing 10% formalin for preservation, and stored for subsequent microscopic examination for infection. Non-lepidopteran insects were identified only to family by consulting keys and descriptions provided in Borror & DeLong (1964) and Jaques (1947).

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Lepidoptera were killed immediately upon collection by placing them in a kill jar charged with ethyl acetate. Abdomens were excised at their juncture with the metathorax and placed in individual vials containing 2% formalin for fixing, preservation, and storage for subsequent processing and microscopic examination. Abdomens of macro-Lepidoptera (large sphingids) were excised approximately one-third from the posterior end and handled as stated above. Adult Lepidoptera minus their abdomens were pinned and identified with numbered labels corresponding with their respective abdomens.

Most noctuids were identified by comparing specimens with reference collections maintained at ORSTOM Center, Cayenne, F. G., whose specimens were identified at the British Museum of Natural History, London. Other Lepidoptera were identified by comparing collected specimens with voucher specimens housed in the U.S. National Museum of Natural History, Washington, D.C., and from descriptions provided in Borror & DeLong (1964), Kimball (1965), Howe (1975), Watson & Whalley (1975), Hodges et al. (1983), and Covell (1984). Infrequently collected nonhosts of *N. guyanense* were identified only to family.

The identity of *Noctuidonema* was determined initially by comparing collected specimens with voucher specimens on file at ORSTOM, F. G., and subsequently from descriptions in Remillet & Silvain (1988).

For the purpose of this paper, *Noctuidonema* specimens reported from Noctuidae are treated as *guyanense*. However, our observations, and the observations of Laumond and Remillet of INRA (personal communications), indicate that further taxonomic research may result in the description of additional species of *Noctuidonema*.

Results and Discussion

Five families of French Guiana Lepidoptera had species harboring *N. guyanense*. Within Lasiocampidae, only one of the three examined specimens of *Euglyphis* sp. harbored *N. guyanense* (123 nematodes). The only specimens of *Nystalea eutalanta* (Dyar) (Notodontidae) captured harbored eight nematodes. A single specimen of *Lamprosema moccasalis* Schaus (Pylalidae) harbored 19 *N. guyanense* specimens. One of two specimens of *Erinnys obscura* (F.) (Sphingidae) was infected by *N. guyanense* (which was not counted).

Species of Noctuidae served as the primary hosts of *N. guyanense* among the Lepidoptera captured. Although 25 species in 20 genera of Noctuidae harbored *N. guyanense*, 15 species of hosts were represented by fewer than five specimens. Three of four specimens of *Aniela infecta* (Ochsenheimer) harbored an average of 72 nematodes. Single specimens of *Anomis oedema* Guenée, *Argyrogramma verruca* (F.), *Iscadia furcifera* (Walker), *Itomia opisthographa* Guenée, *Melipotis fascio-*

laris (Hübner), *Metria* sp., *Mocis diffluens* Guenée, *M. diplocyca* Hampson, *Ptichodis agrapta* Hampson, *Selenisa* sp., and *Tandilia rodea* Schaus harbored from 5 to 145 nematodes. Two specimens of *Nymbis arcuata* Walker harbored an average of 28 *N. guyanense* specimens. Multiple host species occurred within *Spodoptera* (five species) and *Mocis* (three species). Only 7 of the 25 host species had 10 or more specimens available for examination (Table 1). The incidence of infection for these seven species ranged from 4 to 51%. The intensity of infection for these seven species averaged 21 to 65 *N. guyanense* per host. One *S. androgea* male harbored 189 juvenile and adult nematodes. Other hosts harboring >100 nematodes included a female *A. infecta* (106), a male *S. dolichos* (F.) (110), and a male *S. latifascia* Walker (124). The four most commonly collected hosts were *Lesmone formularis* Hübner, *S. dolichos*, *S. frugiperda*, and *Xanthopastis timais* (Cramer), in which from 4 to 31% of the hosts harbored an average 21 to 34 *N. guyanense*. Although 51% of the *S. frugiperda* males were infected, only 13% of the females harbored *N. guyanense*. About 5.8% (74 of 1,279 preserved abdomens) of the Lepidoptera specimens examined harbored *N. guyanense*. Although infection data are not presented here, new host records for *N. guyanense* in French Guiana also include *Mocis disseverans* (Walker), *Spodoptera marima* (Schaus), *Leucania punctifera* Möschler, *L. infatuans* Franclemont, *L. rosea* Möschler, and *L. extenuata* Guenée (J.F.S., unpublished data).

Lepidoptera not harboring *N. guyanense* included species from 19 families and 34 specimens of undetermined families. Moths of Noctuidae were the most common representatives of our collection, among which 121 species were negative for *N. guyanense* (Table 2). Also, nematodes were not found on adults among the commonly collected families Arctiidae, Ctenuchidae, Geometridae, Lymantriidae, Nymphalidae, Saturniidae, or Sphingidae. Likewise, moths of infrequently collected families of Lepidoptera did not harbor *N. guyanense*. Although moths of Noctuidae appear to be the preferred hosts of *N. guyanense* in French Guiana, only about 15% of the species collected were infected.

Non-lepidopteran arthropods of French Guiana examined for *N. guyanense* were distributed among 12 orders and 70 families of Insecta, 2 orders and 6 families of Arachnida, and 1 family of Diplopoda. Common insect taxa examined included Coleoptera, 146 specimens in 39 species; Diptera, 53 specimens in 23 species (plus undetermined species of Cecidomyiidae); Hemiptera, 51 specimens in 21 species; Homoptera, 14 specimens in 11 species; Hymenoptera, 168 specimens in 37 species; and Orthoptera, 52 specimens in 19 species. Also examined were 14 specimens in 5 families (and 5 unknown immatures) of Araneae. *N. guyanense* was not found on any of the 514 specimens of non-Lepidopteran arthropods examined.

Table 1. Alphabetical listing of Noctuidae hosts of *Noctuidonema guyanense* in French Guiana (July–August 1987)

Host ^a	No. hosts		Mean no. nematodes/host
	Examined	Infected	
Noctuidae			
Amphipyridae			
<i>Oxythres splendens</i> Druce	5	1	^b
<i>Spodoptera androgea</i> (Cramer)	13	3	65
<i>Spodoptera dolichos</i> (F.)	94	11	30
<i>Spodoptera frugiperda</i> (J. E. Smith)	51	20	21
<i>Spodoptera latifascia</i> Walker	5	2	109
<i>Spodoptera</i> sp.	5	1	24
Catocalinae (sensu lato)			
<i>Lesmone formularis</i> (Hübner)	28	7	25
<i>Mocis latipes</i> (Guenée)	11	1	^b
<i>Zale fictilis</i> (Guenée)	14	3	25
Hadeninae			
<i>Xanthopastis timais</i> (Cramer)	25	1	34

^a Listing is for species having ≥ 5 specimens examined.

^b Nematodes not counted.

Larvae of Coleoptera and Lepidoptera are commonly infected by nematodes, while natural infection of adult Lepidoptera by nematodes is rare (Triggiani 1976). Remillet & Silvain (1988) reported that *N. guyanense* represents the first known ectoparasitic nematode of adult Lepidoptera. However, adults of *S. litura* (F.) and *S. exigua* (Hübner) are easily infected with *Steinernema feltiae* Filipjev in the laboratory (Narayanan & Gopalakrishnan 1987, Timper et al. 1988). *Noctuidonema guyanense* is closely related with *Acugutturus parasiticus* Hunt, an obligate ectoparasitic nematode attacking the American cockroach, *Periplaneta americana* (L.), in St. Lucia (Hunt 1980). Both *A. parasiticus* and *N. guyanense* may have all stages present simultaneously on the abdomen of their host. Infection by *N. guyanense*

is usually confined to the intersegmental membranes of the posterior two abdominal segments, and less frequently more anterior on the abdomen, among the hair pencils, and on the claspers of male hosts.

Very little is known about the life cycle and biology of *N. guyanense* at this time. However, it appears to be an obligate ectoparasite on adult noctuid-size moths. Our data indicate that non-lepidopteran arthropods and microlepidoptera may not be suitable hosts for *N. guyanense*. Consequently, it appears that *N. guyanense* is a suitable candidate for further study as a possible biological agent for *S. frugiperda* in the southeastern United States.

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Table 2. Lepidoptera not harboring *Noctuidonema guyanense* in French Guiana (July–August 1987)

Family	No. species examined	No. specimens examined
Apatelodidae	1	14
Arctiidae	4	83
Ctenuchidae	7	31
Drepanidae	1	10
Geometridae	8	35
Hesperiidae	2	4
Lasiocampidae	?	13
Lycaenidae	1	1
Lymantriidae	?	32
Megalopygidae	?	4
Noctuidae	121	446
Notodontidae	5	104
Nymphalidae	2	13
Pseudosphingidae	1	2
Pterophoridae	1	1
Pyralidae	12	150
Saturniidae	1	16
Sphingidae	4	11
Tortricidae	2	2

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