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Neatus picipes as an Intermediate Host of *Hymenolepis diminuta*

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Abstract

The role of *Neatus picipes* as an intermediate host of *Hymenolepis diminuta* was investigated. Beetles were collected by hand weekly or biweekly at a cowshed in the Experimental Farm of the Nihon University from April 1986 to April 1987. A total of 2,525 beetles, 2,361 *N. picipes,* 158 *Tenebrio obscurus,* 4 *Tenebrio* sp. and 2 *Histerweymarni* sp., was collected. Cysticercoids were found in 101 (4.3%) of the 2,361 collected *N. picipes* and none were detected in the other species of beetles. The infection rates were higher in spring and summer than in autumn and winter, *i.e.*, 5.2% in spring, 5.0% in summer, 2.5% in autumn and 2.1% in winter. Average measurements of isolated cysticercoids were 1,452.38 ± 86.56 μm in total body length, 341.94 ± 13.96 μm in mid-body width, 1,030.81 ± 81.76 μm in hind-body length, and 422.18 ± 96.37 μm in extra-capsule length. Rats were orally inoculated with cysticercoids obtained from *N. picipes.* All the four rats dosed with cysticercoids were infected and a prepatent period was 16 days on average. Harvested adult worms from the rats were identified as *H. diminuta* by morphological characteristics. Laboratory bred *N. picipes* were experimentally infected with *H. diminuta* eggs. Mature cysticercoids, which were infective to rats were obtained from beetles 12 days post inoculation. These results clearly demonstrate that *N. picipes* act as the intermediate host of *H. diminuta.*

Key words: Cestoda, *Hymenolepis diminuta,* insect host, *Neatus picipes*

Introduction

Hymenolepis diminuta (Rudolphi, 1819) Blanchard, 1891 is a cosmopolitan tapeworm of rats. It has been also reported that this parasite occurs with high prevalence in *Rattus rattus* and *R. norvegicus* in Japan (Itagaki and Itagaki, 1965; Yamada *et al.*, 1936). More than 50 arthropod species of the orders of Coleoptera, Dermaptera, Embioptera, Lepidoptera, Orthoptera, Siphonaptera and Diplopoda were reported as intermediate hosts of *H. diminuta* in the world. However, in Japan only one investigation concerning ratfleas acting as an intermediate host of *H. diminuta* was reported by Yamada *et al.* (1936).

Recently the authors observed *H. diminuta* infections in 11 of 16 *R. rattus* (68.8%) captured at a cowshed in the Experimental Farm of the Nihon University; whereas none of 66 *R. rattus* captured at a dogshed in this farm were infected with this parasite. In addition, the authors found that the gregarious beetle, *Neatus picipes*, harbored cysticercoids of *H. diminuta* at the cowshed but not at the dogshed. These findings may suggest that *N. picipes* is an intermediate host of *H. diminuta* in this habitat. In the present study a role of *N. picipes* as an intermediate host of *H. diminuta* was experimentally investigated.

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Materials and Methods

Collection of beetles:

Beetles were collected by hand weekly or biweekly at a cowshed in the Experimental Farm of the Nihon University from April 1986 to April 1987.

Detection of cysticercoids from collected beetles:

Collected beetles were anesthetized with ether

or chloroform, and then the abdomen with organs was cut apart from the remaining part of the body. Cysticercoids were examined under a microscope by slightly pressing the abdominal organs of beetles on a glass slide. The detected cysticercoids were measured and examined morphologically.

Experimental infection of rats with cysticercoid:

Cysticercoids obtained from *N. picipes* were orally inoculated into rats with a catheter. Twenty cysticercoids were administrated to rat no. 1, 5 to rat no. 2, 7 to rat no. 3, and 4 to rat no. 4. Mature worms recovered from inoculated rats were identified by morphological examination.

Experimental infection of *N. picipes* with *H. diminuta*:

A laboratory bred colony of *N. picipes* was used for experimental infections. The beetle was maintained on rice powder at 25°C.

H. diminuta eggs were collected from gravid proglottides obtained from rats experimentally infected with *H. diminuta*. Eggs were administered according to the method described by Narihara (1937b).

Each two to four beetles was dissected 3, 6, 9, 12 and 15 days after egg administration. The beetles were dissected for detecting cysticercoids as described above. Cysticercoids recovered from inoculated *N. picipes* were measured and examined morphologically.

Results

Detection of *H. diminuta* cysticercoids in collected beetles and monthly changes in infection rates:

A total of 2,525 beetles, 2,361 *N. picipes*, 158 *Tenebrio obscurus*, 4 *Tenebrio* sp. and 2 *Histerweymarni* sp., was collected.

Cysticercoids were detected from 101 (4.3%) of the 2,361 *N. picipes*, while none was observed in the other species of beetles collected.

Monthly infection rates were relatively higher from April to October than in the other months as shown in Table 1.

The seasonal infection rates were higher in spring and summer than in autumn and winter:

Table 1 Monthly infection rate of *Hymenolepis diminuta* cysticercoids in *Neatus picipes*

Month	Number of *N. picipes* collected	Number of beetles positive for cysticercoids	% Infection
1986			
April	227	6	2.6
May	466	35	7.5
June	298	14	4.7
July	279	20	7.2
August	248	7	2.8
September	260	10	3.8
October	267	6	2.2
November	156	1	0.6
December	23	0	0.0
1987			
January	14	1	7.1
February	10	0	0.0
March	21	0	0.0
April	92	1	1.1
Total	2,361	101	4.3*

*: % infection to the total number.

i.e., 5.2% in spring, 5.0% in summer, 2.5% in autumn and 2.1% in winter.

Measurements of collected cysticercoids:

Average measurements of detected cysticercoids from collected *N. picipes* were 1,452.38 ± 86.56 μm in total body length, 341.94 ± 13.96 μm in mid-body width, 1,030.81 ± 81.76 μm in hind-body length and 422.18 ± 96.37 μm in extra-capsule length. Measurements were 2,950.0 μm in total body length and 2,340.0 μm in hindbody length for the biggest cysticercoid, and 1,695.0 μm in total body length, 930.0 μm in hind-body length and 390.0 μm in extra-capsule length for the smallest one.

Experimental infection of rats with cysticercoids:

All the rats dosed with cysticercoids were infected as shown in Table 2.

Morphological characteristics of scolices and proglottides of worms obtained from the experimentally infected rats coincided with the morphological descriptions of *H. diminuta* published by Itagaki and Itagaki (1965).

Average measurements were 76.51 ± 0.85 × 72.49 ± 0.72 μm for an eggshell and 43.56 ± 0.38 × 38.34 ± 0.26 μm for an embryo-shell. These measurements and shape of eggs coincided with those described by Narihara (1937a) and Moriyama (1961).

Experimental infection of *N. picipes* with *H. diminuta* eggs:

No cysticercoids were found in two beetles examined 3 days post-infection (PI). Two cysticercoids were obtained from one of three beetles examined 6 days PI. One cysticercoid was elliptic in shape, 107.5 × 70.0 μm in size and immotile. It had fine particles on the body surface and numerous granular masses inside the body that contained hooklets. The other cysticercoid was spherical to elliptic in shape, 62.5 × 37.5 μm in size, immotile, and possessed hooklets (Fig. 1). A cysticercoid was obtained from one of three beetles examined 9 days PI. This cysticercoid was 162.5 × 89.5 μm in size and had a horizontal U shaped body covered with a thin membrane (Fig. 2). A total of 237 cysticercoids were obtained from one of four beetles examined 12 days PI. Of these, 202 cysticercoids were isolated from the body cavity of the beetles and the remaining 35 cysticercoids were obtained from the tissues. Most cysticercoids had developed a scolex and a mid-body. All the cysticercoids were motile, and wavy and elastic movements were observed at the surface of the mid-body and at the tail of the cysticercoids, respectively. Mean measurements were as follows: 302.83 ± 8.27 × 190.00 ± 7.03 μm for the mid-body, 377.07 ± 42.36 × 64.90 ± 5.90 μm for the hind-body, 9.14 ± 0.76 μm for thickness of the fibrous zone, 144.66 ± 2.96 ± 117.29 ± 3.51 μm for the intra-capsule, 281.07 ± 7.91 × 179.24 ± 6.19 μm in the extra-capsule and 57.43 ± 2.37 × 74.44 ± 2.67 μm for the fore-body (Figs. 3 and 4). Some matured cysticercoids were inoculated in rats and the infection of the rats with *H. diminuta* was confirmed. No cysticercoids were obtained from three beetles examined 15 days PI.

Table 2 Experimental infection of rats with *Hymenolepis diminuta* cysticercoids obtained from *Neatus picipes*

Rat no.	No. of cysticercoid administered	Prepatent period (day)	Day at autopsy (post-infection)	No. of adult worm harvested
1	20	15	26	14
2	5	17	20	4
3	7	15	61	5
4	4	17	31	2

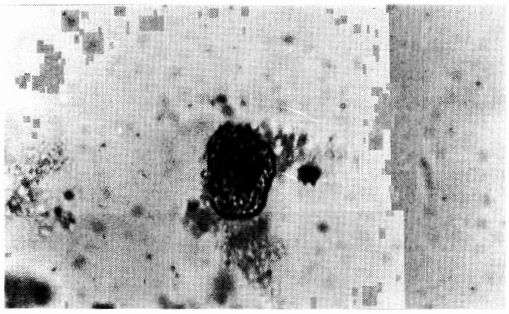

Fig. 1. Immature *Hymenolepis diminuta* cysticercoid harvested from experimentally infected *Neatus picipes* 6 days after infection. ×50.

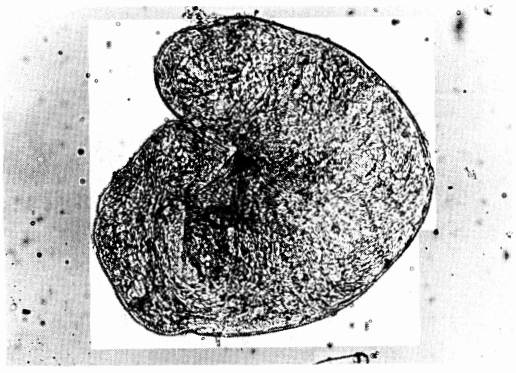

Fig. 2. *Hymenolepis diminuta* cysticercoid harvested from experimentally infected *N. picipes* 9 days after infection. ×250.

Discussion

In the present study, seasonal changes in infection rates of *H. diminuta* in *N. picipes* was observed and a tendency of higher infections was seen from spring to summer. The infection rates reached about 7% levels in May and July.

Few investigations concerning the infection rate of *H. diminuta* in the intermediate hosts have been made in Japan. Yamada *et al.* (1936) investigated the incidence of *H. diminuta* cysticercoids in ratfleas from rats captured in Kobe city: the infection rate was low and only 18 (1.28%) of 1,409 fleas belonging to four species were found positive for cysticercoids. In the present study, no infection was observed in 158 *Tenebrio obscurus* collected at the same place as that of *N. picipes,* although that species is closely related

Fig. 3. Numerous *H. diminuta* cysticercoids harvested from one experimentally infected *N. picipes* 12 days after infection. ×25.

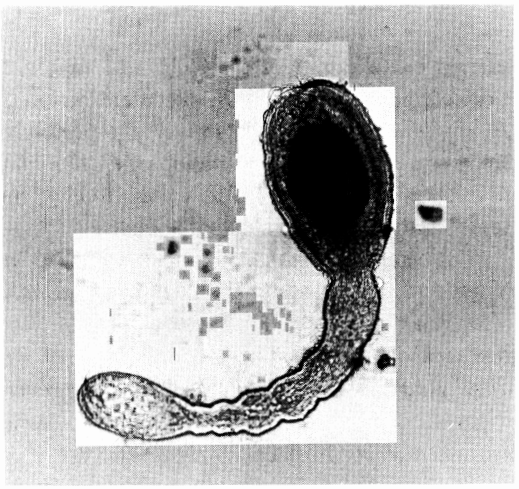

Fig. 4. Matured *H. diminuta* cysticercoid showing scolex and mid-body harvested from experimentally infected *N. picipes* 12 days after infection. ×25.

to *N. picipes* and infections of *T. molitor* with *H. diminuta* has been confirmed (Arai, 1980; Shiraki, 1981). This result suggested that susceptibility to *H. diminuta* is different between the species even if the beetles belong to the same genus or family.

Development and growth of *H. diminuta* in rats infected by inoculating mature cysticercoids have been described by many researchers (Dohi, 1959). Hongou (1925) and Yamada *et al.* (1936)

Table 3 Comparison of sizes of *Hymenolepis diminuta* cysticercoids in different intermediate hosts

Intermediate host	Total length (μm)	Fore-body		Mid-body		Hind-body		Intra-capsule		Extra-capsule		Reference
		Length	Width	Length	Width	Length	Width	Length	Width	Length	Width	
Tribolinm navalefavricius	815	108	110	295	225	520	145	160	138	310	220	Asada *et al.*
Kakivoria flavofasciata	810	105	104	295	230	515	165	154	126	285	210	Asada *et al.*
Ephestia sp.	830	91	92	310	245	520	120	145	123	315	230	Dohi *et al.*
Ceratophyllus anisus	777.6	90.2	96.7	293.9	220.4	483.7	114.5	148.5	124.8	278.2	196.7	Yamada *et al.*
Ceratophyllus fasciatus	790.2	104.3	105.3	317.7	256.4	671.0	119.2	164.0	136.5	306.0	225.5	Yamada *et al.*
Tribolium ferrgineum	907.0	84.6	85.7	380.0	248.0	527.0	149.0	NE*	NE	NE	NE	Narihara
Neatus picipes	1452.4	NE	NE	429.9	341.9	1030.0	NE	NE	NE	422.2	341.9	
Neatus picipes	679.9	57.4	74.4	302.8	190.0	377.1	64.9	144.7	117.3	281.1	179.2	

(12 days after experimental infection)

carried out experimental infection of rats with cysticercoids and showed the prepatent period of *H. diminuta* to be 16 and 15 days, respectively. In this study, the prepatent period of *H. diminuta* in experimentally infected rats was 16 days; the same as those reported by previously.

Tribolium ferrugineum (Narihara, 1937b; Voge and Heyneman, 1957), *Pyralis farinalis* (Hongou, 1925) and so on have already been reported to be the intermediate host of *H. diminuta* (Heicher and Gallati, 1978). However, there is no publication describing *N. picipes* as an intermediate host of *H. diminuta*.

The growth of *H. diminuta* observed in *N. picipes* in the present study was slower than that reported in other insect hosts in previous reports (Table 3).

The difference in growth rates was considered to be due to the differences in egg administration technique and/or environmental temperature. Moreover, crowding effect of parasites in the intermediate host which was reported in final hosts with heavy infections (Moriya, 1954) possibly affect the growth rate.

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