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Citation	Japanese Journal of Veterinary Research, 36(1), 53-67
Issue Date	1988-01-30
DOI	10.14943/jjvr.36.1.53
Doc URL	http://hdl.handle.net/2115/3084
Type	bulletin (article)
File Information	KJ00002376921.pdf



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PSEUDOPARASITISM BY THELASTOMATID
NEMATODES IN MOLES,
MOGERA SPP., IN JAPAN

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(Accepted for publication December 28, 1987)

Nine species of nematodes of Thelastomatidae were obtained from 23 of 366 specimens of moles in Japan, *Mogera wogura*, *M. robusta* and *M. tokudae*. Among those nematodes, eight species, *Chitwoodiella ovofilamenta*, *Singhiella singhi*, *Mirzaiella asiatica*, *M. haroldi*, *Binema korsakowi*, *B. mirzaia*, *Cameronia biovata* and *C. multiovata* are the parasites of mole-cricket, *Gryllotalpa* spp. *Pseudonymus hydrophili* is the parasite of water scavenger beetles of Hydrophilidae. Therefore, the authors considered the present case as an example of pseudoparasitism.

Key words: pseudoparasitism, Thelastomatidae, *Mogera* spp., Japan

At least three species of moles, *Mogera* spp. are found in Japan (ABE, 1967, 1968, 1985) but reports of their helminth fauna are very few (YAMAGUTI, 1941). The authors have carried out studies on the helminths of some hundred mole specimens collected at various sites in Japan.

In this paper, the authors report pseudoparasitism by nine nematode species of Thelastomatidae. There have been no reports of this family from mammalian hosts, and this is the first report of this family in Japan.

MATERIALS ANDS METHODS

During the period from 1958 to 1968, 366 specimens of *Mogera wogura*, *M. robusta* and *M. tokudae* were collected as shown in Table 1. The specimens were fixed in 10% formalin, and the helminths were collected from their intestines and cleared in lacto-phenol solution.

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RESULT

Nine species of thelastomatids were collected. Their occurrence in each mole species and each month are shown in Table 2. The helminth specimens had become more fragile in the mole intestines as compared with other nematodes, and were often broken under cover-slips. In the following descriptions, all measurements are in μ unless otherwise noted.

1) *Chitwoodiella ovofilamenta*

Host: *Mogera wogura* and *M. tokudae*

Locality: Hanaizumi, Iwate Pref.; Ryoju, Sado Is. and Shibata, Niigata Pref.

Description: 6 mature and 7 immature females were collected. The descriptions are based on the mature worms.

Female: 1.49–1.69mm long by 0.18–0.21mm in wide. Annules 11–14 in number, only in the cervical region. First annule 4.9–8.7 wide, remaining annules 4.0–6.0 wide. Buccal cavity 38.8–40.7 long by 4.9–6.8 in minimum width and 7.8–19.4 in maximum width, with striations throughout its length. One worm with buccal wall protruding from anterior end. Esophagus 0.38–0.56mm long; corpus 0.28–0.47mm long by 25.2–31.0 wide; isthmus 17.5–38.8 long by 19.4–25.2 wide; posterior valvular bulb 54.3–91.2 long by 60.1–79.5 wide. Nerve ring 0.12–0.16mm from anterior end. Intestine thickened anteriorly forming a cardia. Anus 0.21–0.29mm from posterior end. Tail attenuated filiformly, 0.14–0.20mm long. Eggs elliptical, 75.7–79.5 long by 36.9–40.7 wide, laid in the form of a chain being connected with each other and enveloped by threads at each pole.

Remarks: In the genus *Chitwoodiella*, there are two species, *C. ovofilamenta* and *C. thapari*, found from the mole-cricket, *Gryllotalpa africana*, in India (BASIR, 1948, 1949; SKRYABIN et al., 1960). These species resemble each other closely. It was difficult to identify the present specimen from the both species by only females. The total length of females of *C. ovofilamenta* (BASIR, 1948; SKRYABIN et al., 1960) and *C. thapari* are 1.11–2.15mm and 1.5–2.6mm, respectively. *C. thapari* may be larger than described because the illustrated females of *C. thapari* are only immature ones (SKRYABIN et al., 1960).

2) *Singhiella singhi*

Host: *Mogera wogura* and *M. tokudae*

Locality: Hanaizumi, Iwate Pref. and Ryoju, Sado Is.

Description: Only one mature male and one immature female were obtained.

Male: 1.11mm long and 0.07mm wide. Annules 12 in number, only in the cervical region; first annule 21.3 wide, remaining annules 4.0 wide. Buccal cavity 40.7 long by 4.9 in minimum width and 14.6 in maximum width. Oesophagus 0.31mm long; corpus 0.26mm long by 19.4 wide; isthmus 18.4 long by 13.6 wide; posterior valvular

bulb 44.4 long by 43.7 wide. Nerve ring 0.19mm from anterior end. Four pairs of caudal papillae, of which three pairs are pre-cloacal and one pair almost adcloacal; the first and third pairs ventral; the second pair sub-ventral; the fourth pair small and ventral, located adjacent minute tail. Both caudal alae and two ventral lines of small spikes present, being continued up to mid-body. Out of the lines, many spikes locate disorderly between first and second pair of papillae. Spicule absent.

Female: 0.89mm long and 0.06mm wide. Annules 16 in number, only in the cervical region; first annule 9.7 wide, remaining annules 3.7 wide. Buccal cavity 23.3 long by 7.8 in minimum width and 10.7 in maximum width. Oesophagus 0.28mm long; corpus 0.23mm long by 18.4 wide; isthmus 11.6 long by 19.4 wide; posterior valvular bulb 38.8 long by 35.9 wide. Nerve ring 0.14mm from anterior end. Tail filiform and sharp.

Remarks: The genus *Singhiella*, contains only one species, *S. singhi*, from the mole-cricket, *G. hexadactyla*, in Brazil (SKRYABIN et al., 1960). The mole-crickets have a global distribution (AOKI, 1973). These insects are also common in Japan. Many spikes on the male tail are very characteristic, and the measurements are much closed with those of *S. singhi* (SKRYABIN et al., 1960).

3) *Mirzaiella asiatica*

Host: *Mogera wogura* and *M. tokudae*

Locality: Tadami, Fukushima Pref. and Ryoju, Sado Is.

Description: One mature male, one mature female and one immature female were collected.

Male: 1.87mm long by 0.14mm wide. Annules on whole body, 9.5 wide in cervical region. Buccal cavity 26.2 long, 7.8 in minimum width, 17.5 in maximum width. Oesophagus 0.28mm long; corpus 0.20mm long by 29.1 wide; isthmus 14.6 long by 18.4 wide; posterior valvular bulb 60.1 long by 60.1 wide. Nerve ring 0.18mm from anterior end. Five pairs of caudal papillae; of which three pairs are large and precloacal. The first and third pairs almost symmetrical. Right one of the second pair absent. The fourth and fifth adcloacal pairs compound, and located adjacent to cloaca. Spicule absent. Caudal alae continued up to mid-body.

Female: 2.14mm long by 0.30mm wide. Annules on whole body, 11.2 wide in cervical region with first annule 36.9 wide. Buccal cavity 36.9 long, 3.9 in minimum width and 13.6 in maximum width. Oesophagus 0.61mm long; corpus 0.47mm long by 42.7 wide; isthmus 22.3 long by 27.2 wide; posterior valvular bulb 110.6 long by 126.1 wide. Nerve ring 0.26mm from anterior end. Anus 0.14mm from posterior end with anal gland. Tail 0.10mm long. Eggs elliptical, 62.1 long by 31.0 wide with polar tufts.

Remarks: The genus *Mirzaiella* comprises three species, *M. asiatica* (BASIR, 1942; SKRYABIN et al., 1960), *M. haroldi* (FAROOQUI, 1967) and *M. alii* (FAROOQUI, 1966),

which are distinguished mainly by the feature of the tail of the male. The present male was identified as *M. asiatica* because of this feature, although a deformity of the second caudal papillae lacked the right papilla. This species has been reported from *G. africana* and *G. gryllotalpa* in India (BASIR, 1942; SKRYABIN et al., 1960), France (JARRY, 1964) and USSR (KAKULIYA, 1968). In the present specimens, the annules were observed on whole body, although they have been found only in the cervical region in the type specimen. However, the authors consider that this difference may be a local variation.

4) *Mirzaiella haroldi*

Host: *Mogera wogura*

Locality: Hanaizumi, Iwate Pref. and Bange, Fukushima Pref.

Description: One mature and one immature male and one mature and one immature female were obtained.

Male: 1.56mm long by 0.10mm wide. Annules 12 in number and 3.1 wide, only in cervical region. Buccal cavity cylindrical, 34.9 long by 5.8 wide. Oesophagus 0.28mm; corpus 0.21mm long by 23.2 wide; isthmus 23.3 long by 15.5 wide; posterior valvular bulb 54.3 long by 50.4 wide. Nerve ring 0.17mm from anterior end. Seven pairs of caudal papillae; of which four pairs are precloacal and three pairs almost adcloacal. The first precloacal pair asymmetrical and ventral. The second pair subventral and large; the third pair ventral and small; the fourth pair subventral and small. Spicule absent. Caudal alae continued up to midbody where they tend to attain a ventral position.

Female: 2.30mm long by 0.23mm wide. Annules 10 in number and 11.2 wide. Buccal cavity 33.0 long, 11.6 in minimum width and 13.6 in maximum width. Oesophagus 0.75mm long; corpus 0.64mm long by 36.9 wide; isthmus 17.5 long by 18.4 wide; posterior valvular bulb 93.1 long by 93.1 wide. Nerve ring 0.25mm from anterior end. Anus 0.32mm from posterior end. Tail 0.19mm long. Eggs elliptical, 73.7 long by 36.9 wide.

Remarks: The present species was distinguished by the feature of the tail from the other two species of genus *Mirzaiella*. This species has been reported only in *G. africana* in India (FAROOQUI, 1968a).

5) *Binema korsakowi*

Host: *Mogera wogura* and *M. tokudae*

Locality: Hanaizumi, Iwate Pref., Bange and Tadami, Fukushima Pref. and Ryoju, Sado Is.

Description: 8 mature females were collected.

Female: 1.48–1.79mm long by 0.13–0.29mm wide. Annules absent or striated indistinctly on whole body, 5.4–6.4 wide. Buccal cavity 33.0–54.3 long, 7.8–19.4 in

minimum width and 9.7–29.1 in maximum width. Oesophagus 0.35–0.68mm long; corpus 0.28–0.58mm long by 27.2 to 40.7 wide; isthmus 3.9–23.3 long by 21.3 to 29.1 wide; posterior valvular bulb 71.8–100.9 long by 81.5 to 110.6 wide. Nerve ring 0.10 to 0.29mm from anterior end. Tail filiform, with smooth base, 0.10–0.16 mm long. Eggs elliptical, 56.3–73.7 long by 31.0–40.7 wide. Some eggs in packet per one pair.

Remarks: The genus *Binema* contains at least four species; *B. korsakowi* (= *B. binema*, *B. hispana* and *B. mediae*), *B. mirzaia*, *B. ornatum* (= *Talpicola ornata*,) and *B. pseudornatum* (= *T. pseudornata*) (BAIN, 1965; BASIR, 1942; FAROOQUI, 1966, 1968b, 1968c, JARRY, 1964; SKRYABIN et al., 1960). The present specimens were identified as *B. korsakowi* or *B. pseudornatum*, judging from the morphology of the tail, but the female of *B. pseudornatum* is much larger than the present ones. *B. korsakowi* has been found from *G. africana*, *G. hexadactyla* and a beetle *Scapteriscus borellii* in Spain, Brazil, France and Madagascar (BAIN, 1965; FAROOQUI, 1968b; JARRY, 1964; SKRYABIN et al., 1960).

6) *Binema mirzaia*

Host: *Mogera wogura* and *M. robusta*

Locality: Hanaizumi, Iwate Pref.; Semine, Miyagi Pref.; Bange, Fukushima Pref.; Shibata, Niigata Pref.; Chiyo and Agematsu, Nagano Pref. and Kagoshima, Kagoshima Pref.

Description: 11 mature and one immature females were obtained.

Female: 2.06–2.83mm long by 0.30 to 0.43mm wide. Annules 12–16 in number and 4.5–7.2 wide, only in cervical region. Buccal cavity cylindrical, 11.6–23.3 long by 7.8–11.7 wide. Oesophagus 0.41–0.59mm long; corpus 0.29–0.46mm long by 27.2 to 46.6 wide; indistinct isthmus 24.3–37.4 wide; posterior valvular bulb 100.9–133.9 long by 93.1–155.2 wide. Nerve ring 0.18–0.24mm from anterior end. Tail short, with blunt base, 0.01–0.06mm long. Eggs 52.4–73.7 long by 31.0–44.6 wide. Most eggs in packets per one pair.

Remarks: The present specimens were identified as *B. mirzaia* by the shape of the tail. This species has been reported in *G. africana* and a cockroach *Periplaneta americana* in India and Madagascar (FAROOQUI, 1968c, SKRYABIN et al., 1960).

7) *Cameronia biovata*

Host: *Mogera robusta* and *M. tokudae*

Locality: Shibata, Niigata Pref. and Yomikaki, Nagano Pref.

Description: Two females were collected.

Female: 2.34 and 3.53mm long by 0.38 and 0.49mm wide. Annules were well-developed on whole body; more than two hundred in number and 14.6 and 11.6 wide. Buccal cavity 10.7 and 13.6 long by 7.8 wide. Oesophagus 0.43mm and

0.47mm long, corpus 0.31mm and 0.34mm long by 39.0 and 47.3 wide; isthmus 9.7 and 23.3 long by 29.1 and 30.8 wide; posterior valvular bulb 102.8 and 110.6 long by 114.5 and 116.4 wide. Nerve ring 0.18 and 0.20mm from anterior end. Tail 0.05 and 0.06mm long. Eggs elliptical, with smooth surface, 130.0 long by 67.9 and 69.8 wide, flattened on one side and fused in pairs along the flattened side.

Remarks: Three species belong to the genus *Cameronia*: *C. biovata*, *C. multiovata* and *C. travassosi* (FAROOQUI, 1968d; JARRY, 1964; SKRYABIN et al., 1960). *C. multiovata* has no fused eggs, and the egg shell of *C. travassosi* is clearly ridged. The females of *C. travassosi* are almost double in length as compared with those of *C. biovata* and the present specimens. *C. biovata* has been found in *G. africana*, a beetle, *Scapteriscus tenuis*, and a water scavenger beetle, *Helochares pallipes*, in India and Brazil (SKRYABIN et al., 1960).

8) *Cameronia multiovata*

Host: *Mogera robusta*

Locality: Akoichi, Hiroshima Pref.

Description: Only one female was obtained.

Female: 1.23mm long by 0.35mm wide. Annules well-developed on whole body; 218 in number and 10.2 wide. Buccal cavity 11.6 long by 9.7 wide. Oesophagus 0.36mm long; corpus 0.23mm long by 33.0 wide; isthmus 25.2 long by 34.9 wide; posterior valvular bulb 108.6 long by 114.5 wide. Nerve ring 0.18mm from anterior end. Tail 0.09mm long. Eggs pear-shaped, 151.3–164.9 long by 52.4–58.2 wide with no fusing.

Remarks: Judging from the morphology of the eggs, the present specimen was identified as *C. multiovata*, which has been reported from *G. africana* and *G. gryllotalpa* in India, USSR and France (JARRY, 1961, 1964; SKRYABIN et al., 1960).

9) *Pseudonymus hydrophili*

Host: *Mogera wogura* and *M. tokudae*

Locality: Hanaizumi and Maesawa, Iwate Pref. and Ryoju, Sado Is.

Description: Four females were collected.

Female: 2.19–3.43mm long by 0.24mm–0.34mm wide. Annules 10–11 in number, only in cervical region; the first and second annules inflated. Buccal cavity 10.7–17.5 long by 9.7 wide. Oesophagus 0.35mm–0.43mm long, corpus 0.25mm–0.32mm long by 34.9–51.4 wide; isthmus 13.6–23.3 long by 25.2–36.9 wide; posterior valvular bulb 77.6–104.8 long by 105.7–117.4 wide. Nerve ring 0.13–0.17mm from anterior end. Tail 0.23–0.26mm. Eggs 67.9–83.4 long by 36.9–50.4 wide.

Remarks: The genus *Pseudonymus* contains at least eight species, but the two inflated annules have reported only in two species, *P. hydrophili* and *P. mehdii* (FAROOQUI, 1967; SKRYABIN et al., 1960). *P. mehdii* has an anterior lip which prolongs and

TABLE 1 Number of hosts, *Mogera* spp. in each locality

Prefecture	Locality	Host species (Captive month)		
		<i>M. wogura</i>	<i>M. robusta</i>	<i>M. tokudae</i>
Iwate	Hanaizumi	14 (Jul.)	-	-
"	Maesawa	1 (Jul.)	-	-
Miyagi	Semine	18 (Jul.)	-	-
Fukushima	Bange	6 (Nov.)	-	-
"	Tadami	14 (Nov.)	-	-
Niigata	Ryozu, Sado is. Is.	-	-	16 (Jun., Jul.)
"	Shibata	9 (Oct.)	-	12 (Jul., Oct.)
Nagano	Chiyo	-	9 (Jul.)	-
"	Yomikaki	-	12 (Aug.)	-
Hiroshima	Akoichi	-	17 (Jun., Jul.)	-
Kagoshima	Kagoshima	-	9 (Apr.)	-
	other localities	68 (Jul. -Nov.)	161 (Mar. -Jan.)	-
Total		130	208	28

Pseudoparasitism in moles

TABLE 2 Occurrence of thelastomatid nematodes in each host and month

Parasites	<i>Mogera wogura</i>				<i>M. robusta</i>			<i>M. tokudae</i>		Total
	Jul.	Aug.	Oct.	Nov.	Apr.	Jul.	Aug.	Jul.	Oct.	
<i>Chitwoodiella ovoides</i>	2	-	-	-	-	-	-	3	1	6
<i>Singhiella singhi</i>	1	-	-	-	-	-	-	1	-	2
<i>Mirzaiella asiatica</i>	-	-	-	2	-	-	-	1	-	3
<i>Mirzaiella haroldi</i>	1	-	-	1	-	-	-	-	-	2
<i>Binema korsakowi</i>	1	-	-	1	-	-	-	1	-	3
<i>Binema mirzaia</i>	2	1	1	2	2	1	-	-	-	9
<i>Cameronia biovata</i>	-	-	-	-	-	-	1	-	1	2
<i>Cameronia multiovata</i>	-	-	-	-	-	1	-	-	-	1
<i>Pseudonymus hydrophili</i>	2	-	-	-	-	-	-	1	-	3
Unidentified larva	1	-	-	-	-	-	-	-	-	1
Total	10	1	1	6	2	2	1	7	2	23

projects out of the body on the opening of the vulva, and a reniform excretory cell at the inside of the excretory pore. But the present specimens lacked both the anterior lips and excretory cells, and were identified as *P. hydrophili*, which has been found in water scavenger beetles *Hydrophilus piceus*, *Hydrous triangularis* and *Tropisternus nimbatus* in Europe, India and USA (SKRYABIN et al., 1960).

Appendix: One immature female of this family was collected. But it was difficult to classify by fragmental state. Its host, locality and morphology are as follows:

Host: *Mogera wogura*

Locality: Hanaizumi, Iwate Pref.

Description: 1.69 mm long by 0.13 mm wide. Annules present only in cervical region; striae 5.5 wide. Buccal cavity 31.0 long, 9.7 in minimum width and 11.6 in maximum width. Oesophagus 0.60mm long; corpus 0.51mm by 29.1 wide; isthmus 15.5 long by 19.4 wide; posterior valvular bulb 69.8 long by 69.8 wide. Nerve ring 0.22mm from anterior end. Tail 0.11 mm long.

DISCUSSION

Most species of the family Thelastomatidae are the parasites of insects, and the eight species reported in this paper except for *Pseudonymus hydrophili* have been found from mole-crickets, *Gryllotalpa* spp., in some regions of the world. On the other hand, the moles are subterranean insectivores which prey on mole-crickets for food. Therefore, it can be supposed that these nematodes survive for some time in the foreign environment of the predatory moles. Their fragility under the cover-slips may be a result of the exposition to the unfavourable environment. It is therefore reasonable that the authors consider the present case to be one of pseudoparasitism (DOGIEL, 1964), and not of obligate parasitism.

The incidence of the worms was higher in *M. tokudae* than the other two species of moles. The analysis of the stomach contents of the same specimens in the present study by ABE (1968) has shown the higher rate of the occurrence of the mole-crickets in *M. tokudae* (47.8%) than *M. wogura* (22.7%) and *M. kobeae* (= *M. robusta*, 12.8%). *M. tokudae* was captured mostly in July, when it was the reproductive season of the mole-crickets (AOKI, 1973). In this season the activity of the mole-crickets is considered to increase, and the moles could catch them in higher rate.

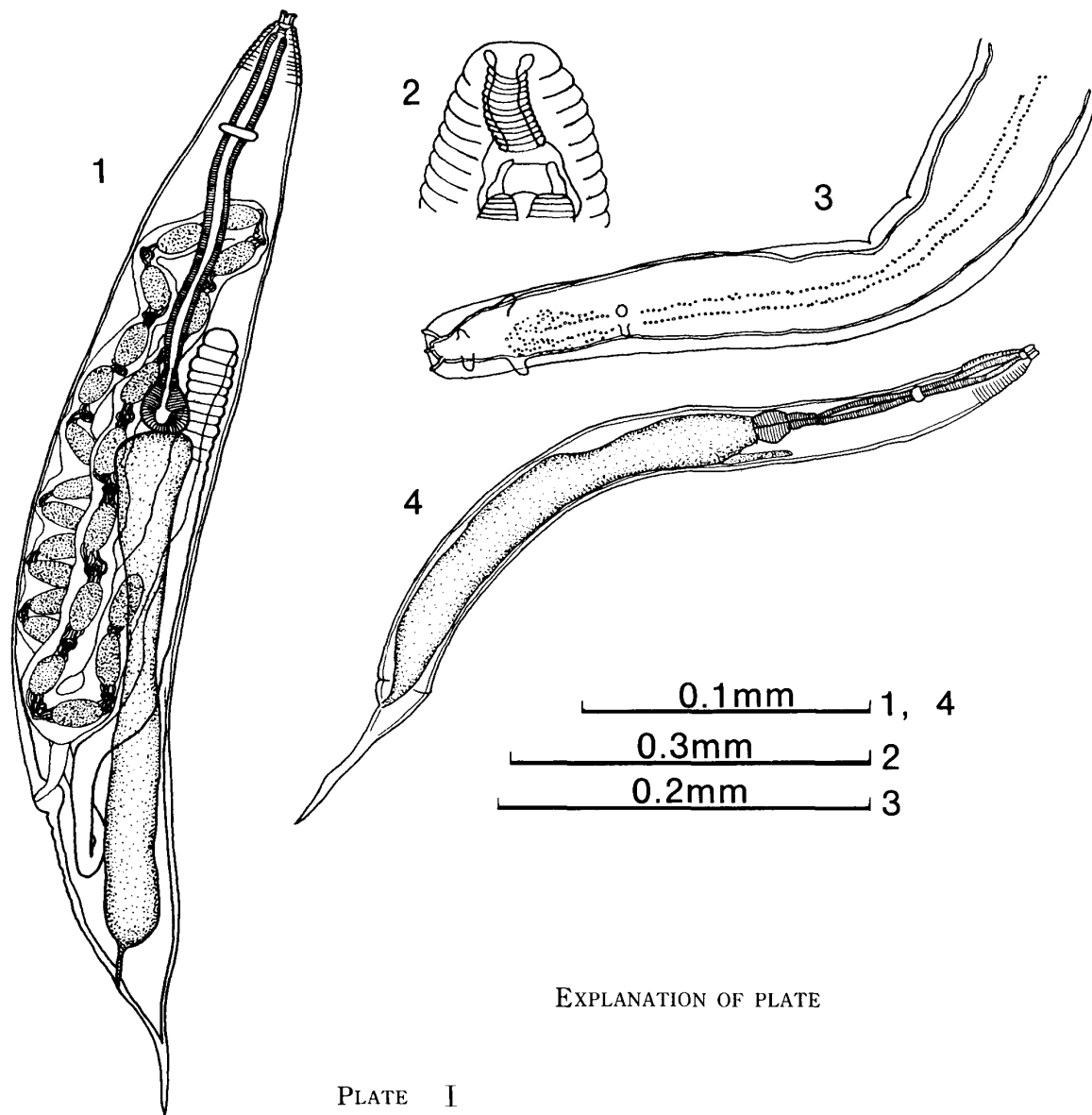
ACKNOWLEDGEMENTS

The authors wish to express our thanks to Mr. Mark MICALLEF, Cancer Institute, Hokkaido University for reading the manuscript.

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EXPLANATION OF PLATE

PLATE I

Figs. 1 & 2 *Chitwoodiella ovofilamenta*

Fig. 1 Female, general view

Fig. 2 Female, anterior end

Figs. 3 & 4 *Singhiella singhi*

Fig. 3 Male, posterior end

Fig. 4 Immature female, general view

PLATE II

Figs. 1-4 *Mirzaiella asiatica*

Fig. 1 Male, anterior end

Fig. 2 Male, posterior end

Fig. 3 Female, general view

Fig. 4 Female, anterior end

Figs. 5-6 *Mirzaiella haroldi*

Fig. 5 Male, anterior end

Fig. 6 Male, posterior end

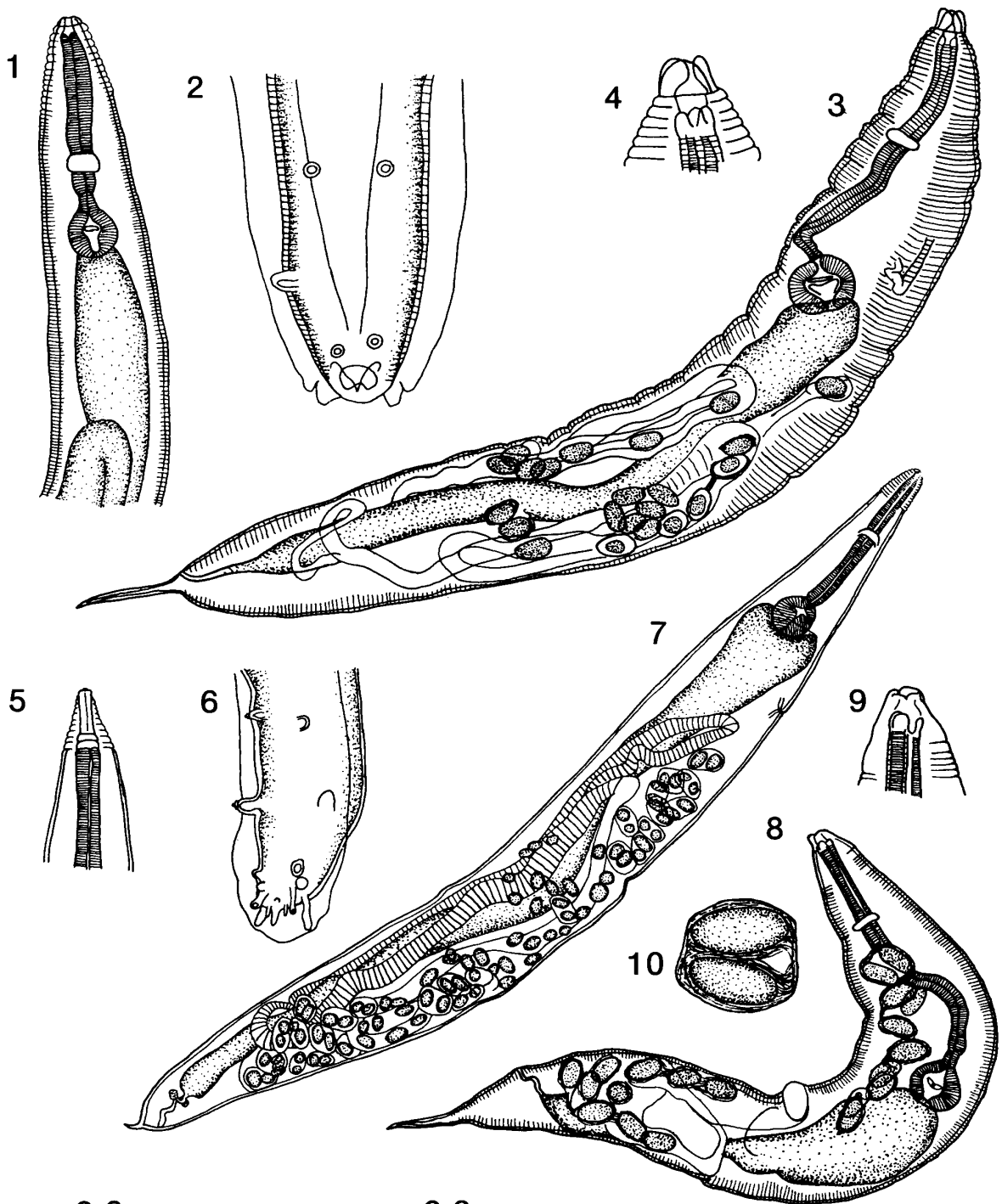
Fig. 7 *Binema mirzaia*, Female, general view

Figs. 8-10 *Binema korsakowi*

Fig. 8 Female, general view

Fig. 9 Female, anterior end

Fig. 10 Eggs in packet



0.2mm 1, 2, 6 0.8mm 4, 9, 10
0.4mm 3, 7, 8 0.4mm 5

PLATE III

Figs. 1-2 *Cameronia biovata*

Fig. 1 Female, general view

Fig. 2 Eggs

Figs. 3-4 *Cameronia multiovata*

Fig. 3 Female, anterior end

Fig. 4 Eggs

Figs. 5-6 *Pseudonymus hydrophili*

Fig. 5 Female, anterior end

Fig. 6 Female, posterior end

Fig. 7 Unidentified larva, general view

