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Citation	Japanese Journal of Veterinary Research, 36(2), 119-131
Issue Date	1988-05-20
DOI	10.14943/jjvr.36.2.119
Doc URL	http://hdl.handle.net/2115/3088
Type	bulletin (article)
File Information	KJ00002377048.pdf

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Jpn. J. Vet. Res., **36**, 119–131 (1988)

HYMENOLEPIDID AND DILEPIDID CESTODES WITH ARMED ROSTELLUM IN SHREWS, *SOREX* SPP., FROM HOKKAIDO, JAPAN

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(Accepted for publication March 26, 1988)

The cestode fauna was examined in 110 *Sorex unguiculatus*, 6 *S. caecutiens saevus* and 12 *S. gracillimus* collected in Hokkaido, Japan, in 1974 and 1987. Nine species of HYMENOLEPIDIDAE and one species of DILEPIDIDAE with armed rostellum were identified, and the prevalence in *Sorex unguiculatus* was as follows ; *Neoskrjabinolepis schaldybini* (35.5%), *N. singularis* (40.0%), *Neoskrjabinolepis* sp. (0.9%), *Staphylocystis furcata* (23.6%), *S. toxometra* (12.7%), *Lineolepis skrjabini* (1.8%), *Skrjabinacanthus diplocoronatus* (11.8%), *S. jacutensis* (one case of *S. gracillimus*), *Pseudodiorchis prolifer* (17.3%), and *Molluscotaenia baicalensis* (38.2%). Additionally, the number, length and arrangement of rostellar hooks of *S. diplocoronatus* SPASSKY et MOROSOV, 1959 were redescribed.

Key words : HYMENOLEPIDIDAE, DILEPIDIDAE, *Sorex* spp., INSECTIVORA, Japan

INTRODUCTION

A lot of papers about the parasite and parasitic fauna of INSECTIVORA have been published by European, Russian and North American researchers since the middle of 19th century. Soricid insectivores have the abundant fauna in cestode parasites and most of the worms, with few exceptions, belong to the HYMENOLEPIDIDAE (OLSEN, 1969 ; SCHMIDT, 1986 ; VAUCHER, 1971). In the field of taxonomy, however, there exists some confusion, and the distributional data of the cestodes are still incomplete, especially in the Far East.

Up to this time, although two new cestode-species were reported recently from *Crocidura dsinezumi* and *C. horsfieldi* (SAWADA & HARADA, 1986), the cestode fauna of Japanese insectivores including five species of the genus *Sorex* (ABE, 1967) has not been clarified yet. The present study deals with the cestode-species with armed

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rostellum collected from *S. unguiculatus, S. caecutiens saevus* and *S. gracillimus* in Hokkaido, Japan.

MATERIALS AND METHODS

In 1974 and 1987, 128 shrews, namely 110 *S. unguiculatus*, 6 *S. caecutiens saevus* and 12 *S. gracillimus*, were collected using livetraps from the northern and southern parts of Hokkaido (Teshio, the suburbs of Sapporo , Naganuma, Abuta, Yakumo and Mori) (Fig. 1). The animals were autopsied as soon as they were collected, and fixed in 10% formalin solution. Worms from the intestine were collected using dissection-microscope and stained with Semichon's acetic carmine or Heidenhain's iron haematoxylin. Measurements of worms were determined using the stained specimens except for eggs and rostellar hooks, which were measured after isolation from the fixed specimens. Figures were prepared with the use of a camera lucida. The specimens are deposited in the Department of Parasitology, Faculty of Veterinary Medicine, Hokkaido University, Sapporo 060, Japan.

Fig. 1 Places where shrews were collected in 1974 and 1987.

RESULTS AND DISCUSSION

Ten species of cestodes with armed rostellum belonging to HYMENOLEPIDIDAE or DILEPIDIDAE were found from 94 out of 110 *S. unguiculatus*, 5 out of 6 *S. caecutiens saevus* and 9 out of 12 *S. gracillimus* (Table 1). In the following descriptions, all measurements are in mm.

HYMENOLEPIDIDAE

1) *Neoskrjabinolepis schaldybini* SPASSKY, 1947

Strobila up to 13.4 in length, 0.24–0.42 in maximum width, containing a few hundreds of proglottides; scolex 0.216–0.252 wide, 0.144–0.216 long; suckers 0.068–0.084 in diameter; rostellum 0.072–0.080 wide, 0.096–0.148 long; rostellar sheath 0.100–0.108 wide, 0.148–0.168 long; rostellar hooks 10 in number, 0.038–0.042 long (Fig. 2A); testes 3 in number in each proglottid, arranged in a line; eggs 0.048–0.060 × 0.058–0.074; embryophore, having polar filaments, 0.018–0.022 × 0.032–0.038; oncosphere 0.017–0.019 × 0.023–0.028.

This cestode was one of the most common species, and found from 39 *S. unguiculatus* (infection rate; 35.5%), 2 *S. caecutiens saevus* (33.3%) and 4 *S. gracillimus* (33.3%). The maximum number of infected worms was 99.

2) *Neoskrjabinolepis singularis* (CHOLODKOWSKY, 1912) SPASSKY, 1954

Strobila up to 14.4 in length, 0.20–0.38 in maximum width, containing a few hundreds of proglottides; scolex 0.296–0.316 wide, 0.184–0.212 long; suckers 0.068–0.080 wide, 0.108 long; rostellum 0.092–0.136 wide, 0.084–0.136 long; rostellar sheath 0.120–0.144 wide, 0.116–0.200 long; rostellar hooks 10 in number, 0.053–0.058 long (Fig. 2B); testes 3 in number, arranged in a line; eggs 0.044–0.054 × 0.062–0.074; embryophore 0.023–0.032 × 0.030–0.043; oncosphere 0.016–0.019 × 0.020–0.025.

The specimens were obtained from 44 *S. unguiculatus* (40.0%), 3 *S. caecutiens saevus* (50%) and 1 *S. gracillimus* (8.3%), and the maximum number of infected worms was 68. The gravid proglottides of this species and *N. schaldybini* described above were easily detached from the strobila during the fixation and staining processes, and those proglottides measured up to 18.9 or 8.0 long, respectively. Many authors considered *N. schaldybini* SPASSKY, 1947 as a synonym of *N. singularis* (CHOLODKOWSKY, 1912) SPASSKY, 1954 (PROKOPIC, 1956; ZARNOWSKI, 1956). As shown by VAUCHER (1971), this species is easily differentiable from *N. schaldybini* mainly by the following points; larger size and different shape of rostellar hooks, larger size of scolex and its appendices and lack of polar filaments of the embryophore.

3) *Neoskrjabinolepis* sp.

A few worms from one of *S. unguiculatus* in Teshio and one of *S. caecutiens saevus* in Naganuma had 10 rostellar hooks measuring 0.040 long and of a shape, which resembled those of *Neoskrjabinolepis* spp. mentioned above, however, differed from both of these two species (Fig. 2 A-C). Due to inadequate condition of the specimens, it was impossible to compare this species with *N. schaldybini* and *N. singularis* comprehensively.

4) *Staphylocystis furcata* (STIEDA, 1862) SPASSKY, 1950

Strobila 7.2–13.4 in length, 0.56–1.10 in maximum width, containing ca. 200–300 proglottides including 8–15 gravid ones; scolex 0.180–0.240 wide, 0.184–0.220 long; suckers 0.068–0.080 in diameter; rostellum 0.056–0.080 wide, 0.060–0.108 long; rostellar sheath 0.072–0.120 wide, 0.048–0.168 long; rostellar hooks 26–30 in number, 0.025–0.028 long (Fig. 2D); testes 3 in number in each proglottid, 0.048–0.072 × 0.032–0.050, arranged in a triangle; cirrus sac dorsal to osmoregulatory canals, 0.076–0.098 long, 0.028–0.034 in diameter; trilobed ovary 0.160–0.248 wide, 0.056–0.084 long; reniform vitellium 0.080–0.096 wide, 0.040–0.048 long; eggs 0.032–0.038 × 0.042–0.053; embryophore 0.022–0.030 × 0.026–0.038.

This species was found from 26 *S. unguiculatus* (23.6%), and the maximum number of infected worms was 9. Internal and external seminal vesicles and seminal receptacle were well-developed, and persisted voluminously even in the gravid proglottides.

5) *Staphylocystis toxometra* (BAER, 1932) YAMAGUTI, 1959

Strobila 4.8–9.8 in length, 0.18–0.24 in maximum width, containing 102–140 proglottides including 2–9 gravid ones; scolex 0.148–0.180 wide, 0.100–0.152 long; suckers 0.044–0.060 wide, 0.076–0.100 long; rostellum 0.036–0.044 wide, 0.046–0.060 long; rostellar sheath 0.032–0.060 wide, 0.080–0.120 long; rostellar hooks 10 in number, 0.036–0.040 long (Fig. 2E); testes 3 in number in each proglottid, ca. 0.030 × 0.020, arranged in a line; cirrus sac 0.042–0.046 long, 0.012–0.015 wide; ovary ca. 0.056 wide, 0.034 long; vitellium 0.018–0.022 wide, 0.014 long; embryophore 0.019–0.028 × 0.026–0.034; oncosphere 0.014–0.017 × 0.018–0.020.

This species had a horseshoe-shaped uterus in the mature proglottides and conspicuously elongated gravid proglottides, of which the length was up to 4 times the width. This species was found from 14 *S. unguiculatus* (12.7%), and the maximum number of infected worms was 16. *Hymenolepis scutigera* (DUJARDIN, 1845) is a synonym of *Staphylocystis toxometra* (BAER, 1932), and the former species name is also widely used (VAUCHER, 1971).

6) *Lineolepis skrjabini* SPASSKY et MOROSOV, 1959

Strobila of two nearly complete worms 9.1 and 10.0 in length, 0.30 and 0.24 in maximum width, containing 281 and 294 proglottides, respectively, including few gravid ones; scolex 0.200–0.268 wide, 0.160–0.200 long; suckers 0.068–0.080 wide, 0.112–0.152 long; rostellum 0.064 wide, 0.064–0.072 long (one exceptionally 0.120 long); rostellar sheath 0.096–0.104 wide, 0.104–0.120 long; rostellar hooks 8 in number, 0.052–0.055 long (Fig. 2F); testes 3 in number in each proglottid, 0.034–0.042 in diameter, arranged in an obtuse-angled triangle; cirrus sac dorsal to osmoregulatory canals, 0.044–0.056 long, 0.016–0.018 wide; cirrus spinose, 0.008–0.009 in diameter; transversely elongated ovary 0.080–0.090 wide, 0.044–0.048 long; oval vitellium 0.028–0.034 wide, 0.022–0.024 long.

Four specimens belonging to this species were obtained from 2 *S. unguiculatus* (1.8%) in a suburb of Sapporo; each animal harbored one and three worms, respectively. SPASSKY & MOROSOV (1959) described this species from *S. araneus* and *S.* sp. in western Siberia. Except for slightly smaller size of rostellar hooks than the original description of 0.057–0.060, almost all characteristics and measurements were identical. Although, in the present study, this species is classified in the genus *Lineolepis* SPASSKY, 1958 according to the original description, the authors consider that there is no reason to distinguish it from the genus *Staphylocystis* VILLOT, 1877.

7) *Skrjabinacanthus diplocoronatus* SPASSKY et MOROSOV, 1959

Strobila 46.2–65.4 in length, 0.82–1.14 in maximum width, consisted of ca. 500 proglottides including 27–60 gravid ones; scolex 0.170–0.220 wide, 0.120–0.160 long; suckers 0.068–0.072 wide, 0.088–0.112 long; rostellum 0.048–0.072 wide, 0.040–0.060 long; rostellar sheath 0.076–0.088 wide, 0.092–0.124 long; rostellar hooks usually 33 (one exceptionally 38) in number, 0.018–0.041 long, disposed irregularly (Fig. 2G & 3A–C); testes 3 in number in each proglottid, 0.048–0.068 × 0.080–0.112, arranged in a triangle (Fig. 3D); cirrus sac 0.184–0.216 long, 0.040–0.048 wide; lobed ovary 0.176–0.272 wide, 0.076–0.092 long; lobed vitellium 0.084–0.140 wide, 0.052–0.072 long; eggs 0.040–0.051 × 0.056–0.077 (Fig. 3E); embryophore with polar filaments, 0.023–0.028 × 0.054–0.062; oncosphere 0.016–0.018 × 0.023–0.027.

This species was found from 13 *S. unguiculatus* (11.8%), 2 *S. caecutiens saevus* (33.3%) and 4 *S. gracillimus* (33.3%). The maximum number of infected worms was 9, including immature specimens.

Present specimens show close similarity to the original description of *S. diplocoronatus* by SPASSKY and MOROSOV (1959) except for the number, length and arrangement of rostellar hooks. The morphology of the hooks was identical to the original description. They reported two crowns of 34 rostellar hooks, measuring 0.035–0.038 in the anterior row and 0.029–0.032 in the posterior row. However, all specimens examined in the present study showed that the length of the rostellar hooks, usually

33 in number, ranged between 0.018 and 0.041 (Fig. 3C) and the disposition of those hooks was irregular (Figs 3A & 3B). The characteristics concerning rostellar hooks mentioned above has also been recognized in *S. jacutensis* (VAUCHER, 1971).

8) *Skrjabinacanthus jacutensis* SPASSKY et MOROSOV, 1959

Two specimens of immature *S. jacutensis* were obtained from one *S. gracillimus* in Teshio. Rostellar hooks were found to be 18 in number and measured 0.028–0.051 in length (Fig. 2H).

9) *Pseudodiorchis prolifer* (VILLOT, 1890) KISIELEWSKA, 1960

Strobila 0.672 in length, 0.148 in maximum width, containing 42 proglottides; scolex 0.176 wide, 0.104 long; suckers 0.064 wide, 0.056 long; rostellum 0.032 wide, 0.048 long; rostellar sheath 0.056 in width, 0.090 long; rostellar hooks ca. 120 in number, ca. 0.005 long (Fig. 2I); testes 2 in number in each proglottid, 0.016 × 0.007; cirrus sac 0.046 long, 0.011 wide; cirrus spinose; ovary 0.041 wide, 0.008 long; vitellium 0.012 wide, 0.007 long; eggs 0.034–0.038 × 0.052–0.054; embryophore 0.025–0.026 × 0.036–0.038.

This minute species was found from 19 *S. unguiculatus* (17.3%) and 1 *S. gracillimus* (8.3%), and the maximum number of infected worms was 308. The above description was based on a specimen collected at Teshio, where 2 *S. unguiculatus* were infected. The specimens collected at other localities showed some differences in whole dimension as compared with those of Teshio. For example, a complete worm from other localities was 1.480 long and 0.216 wide, having 76 proglottides. More detailed examinations concerning the specimens from Sapporo suburbs and southern Hokkaido are planned.

DILEPIDIDAE

10) *Molluscotaenia baicalensis* ELTYSHEV, 1971

Strobila 10.6–18.3 in length, 0.64-0.94 in maximum width, consisted of up to 133 proglottides including few or several gravid ones; scolex 0.47–0.55 wide, 0.37-0.52 long (Fig. 4A); suckers 0.14–0.21 wide, 0.24–0.32 long; rostellum 0.064–0.088 wide, 0.52–0.66 long; rostellar sheath 0.080–0.120 wide, 0.56–0.72 long; rostellar hooks 20 in number, 0.064–0.080 long (Fig. 2J), arranged in alternating 2 rows; testes 20–24 in number in each proglottid, ca. 0.040 × 0.054, at the posterior part of proglottid (Fig. 4B); cirrus sac dorsal to osmoregulatory canals, 0.10–0.12 long, 0.018–0.032 wide; lobulated ovary, 0.292–0.424 wide, 0.080–0.140 long; vitellium 0.096–0.132 wide, 0.044–0.068 long; eggs 0.024–0.026 × 0.044–0.056 (Fig. 4C); embryophore 0.020–0.022 × 0.034–0.036; oncosphere 0.016–0.018 × 0.024–0.028.

This dilepidid species was found from 42 *S. unguiculatus* (38.2%), and the maximum number of infected worms was 44, including immature specimens. *M.*

crassiscolex (LINSTOW, 1890) SPASSKY et ANDREIKO, 1969, which is widely found in Europe and western part of USSR, has some resemblance to this species, however, those two species are easily distinguished in the length of hooks and depth of rostellar sheath (ELTYSHEV, 1971; SPASSKY & ANDREIKO, 1969). By careful microscopical examination, the bottom of suckers were densely covered by spiny protrusions. This feature has been described in both *M. crassiscolex* (VAUCHER, 1971) and *M. baicalensis* (ELTYSHEV, 1971).

With the exception of *Neoskrjabinolepis* sp., *L. skrjabini*, *S. diplocoronatus* and *M. baicalensis*, the cestode-species described in the present study are known to be widely found among shrews in Europe (JOURDANE, 1971: KISIELEWSKA, 1961; MAS-COMA & GALLEGO, 1975; PROKOPIC, 1956; VAUCHER, 1971; ZARNOWSKI, 1956). Thus, these six cestode-species may have a broad distribution in the northern Eurasia corresponding to the distribution of host-species. *L. skrjabini*, *S. diplocoronatus* and *M. baicalensis* were reported only from USSR in the past (ELTYSHEV, 1971; SPASSKY & MOROSOV, 1959).

As shown in table 1, prevalence of each cestode from *S. unguiculatus* was different between Sapporo suburbs and Teshio, especially that of *N. schaldybini*, *S. furcata*, *P. prolifer* and *M. baicalensis*. This difference might reflect mainly ecological factors and be attributed to the distribution of intermediate hosts, e. g., insects, millipedes and mollusks (VAUCHER, 1971).

Multiple infections with cestodes are common in shrews (VAUCHER, 1971). In the present study, 31, 33, 16, 12 and 2 of *S. unguiculatus* were infected with one, 2, 3, 4 and 5 cestode-species with armed rostellum, respectively. VOGE and RAUSCH (1955) stated that "the frequency of multiple infections with hymenolepidids may be in part explained by the variety of insects and other invertebrates consumed and by a minimal or non-existing cross immunity of the definitive host".

ACKNOWLEDGEMENTS

We are indebted to Mr. Y. YOKOHATA of the Department of Parasitology, Faculty of Veterinary Medicine, Hokkaido University for his assistance in the collection of the animals in 1987. We also wish to express our thanks to Mr. JACOB TSUMA MAKANGA for reading the manuscript.

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Table 1. Armed cestodes in *Sorex unguiculatus*, *S. caecutiens saevus* and *S.gracillimus* in Hokkaido, Japan

Host	*Sorex unguiculatus*			*S. caecutiens*	*S. gracillimus*
Locality (Collected number of shrews)	Sapporo suburbs (62)	Teshio(39)	Yakumo(6) Mori(1) Abuta (2)	Sapporo suburbs (4) Teshio(1) Naganuma (1)	Teshio (12)
Number of shrews infected with armed cestodes	53	35	6	5	9
Neoskrjabinolepis schaldybini	31	6	2	2	4
Neoskrjabinolepis singularis	23	16	5	3	1
Neoskrjabinolepis sp.	—	1	—	1	—
Staphylocystis furcata	24	1	1	—	—
Staphylocystis toxometra	9	2	3	—	—
Lineolepis skrjabini	2	—	—	—	—
Skrjabinacanthus diplocoronatus	3	9	1	2	4
Skrjabinacanthus jacutensis	—	—	—	—	1
Pseudodiorchis prolifer	16	2	1	—	1
Molluscotaenia baicalensis	13	29	—	—	—

EXPLANATION OF PLATES

PLATE I

Fig. 2 Rostellar hooks of 9 hymenolepidid and one dilepidid cestodes from *S. unguiculatus, S. caecutiens saevus* and *S. gracillimus* in Hokkaido, Japan

A. *Neoskrjabinolepis schaldybini*, B. *Neoskrjabinolepis singularis*, C. *Neoskrjabinolepis* sp. D. *Staphylocystis furcata*, E. *Staphylocystis toxometra*, F. *Lineolepis skrjabini*, G. *Skrjabinacanthus diplocoronatus*, H. *Skrjabinacanthus jacutensis*, I. *Pseudodiorchis prolifer*, J. *Molluscotaenia baicalensis*

Fig. 2

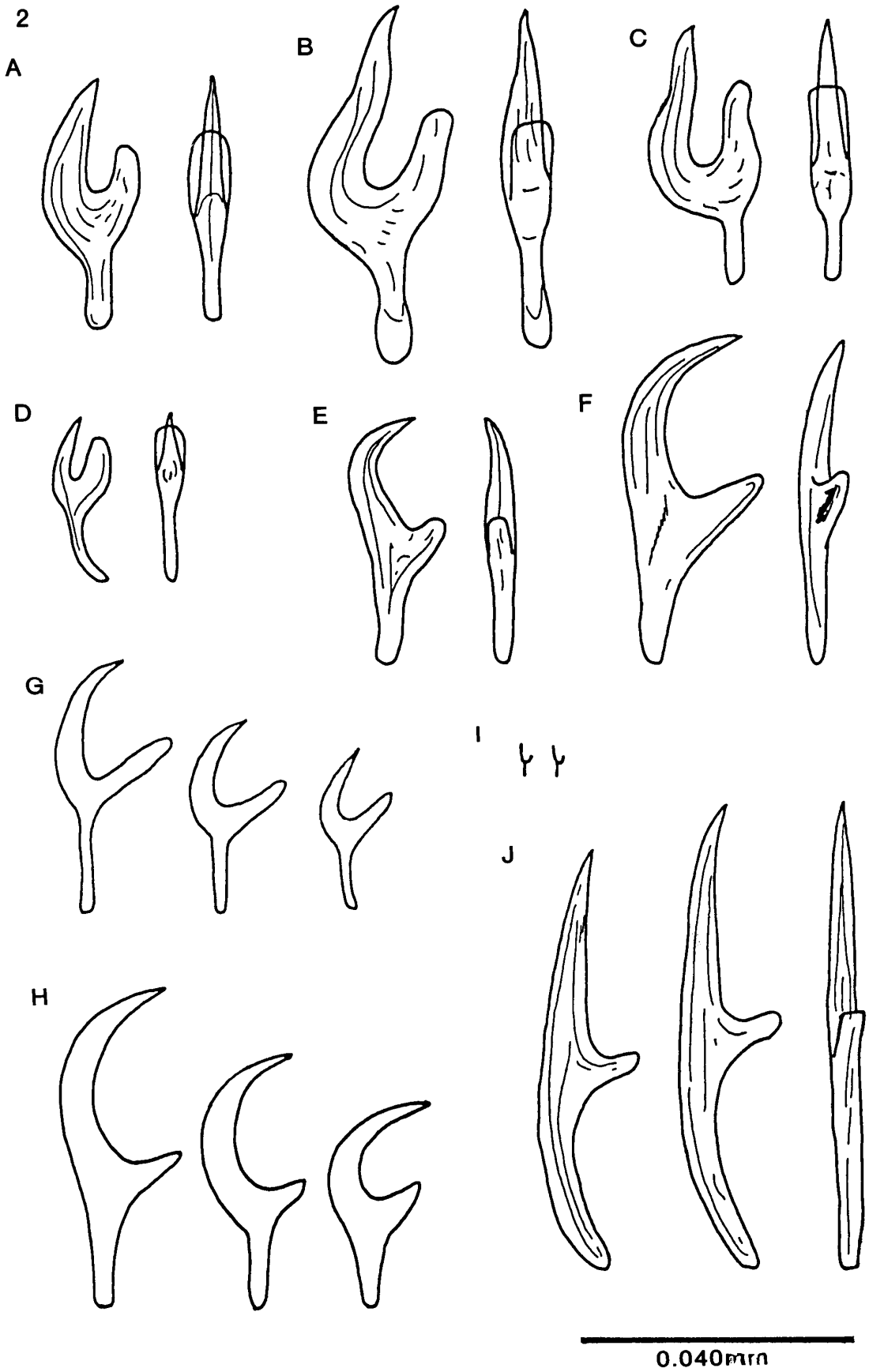


PLATE II

Fig. 3 *Skrjabinacanthus diplocoronatus*. A. Scolex, B. Irregular disposition of rostellar hooks, C. Length divergence of rostellar hooks, D. Mature segment, E. Egg

Fig. 4 *Molluscotaenia baicalensis*. A. Scolex, B. Mature segment, C. Egg

Fig. 3

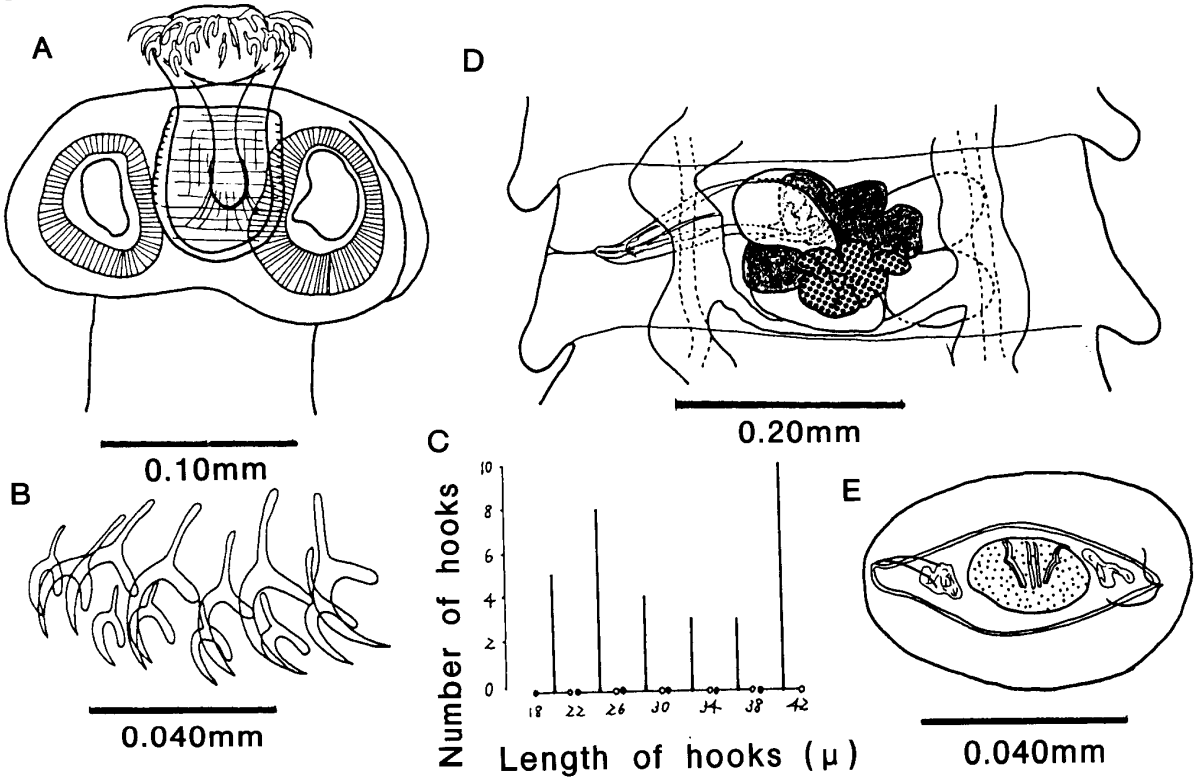
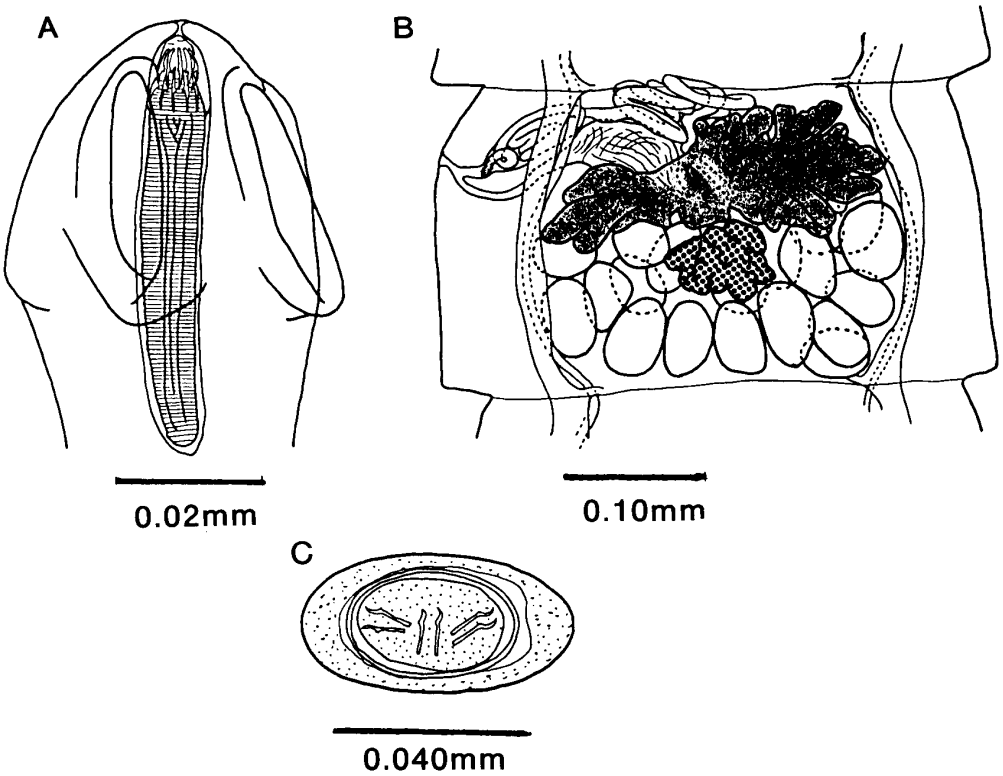

A
0.10mm
B
0.040mm
C
Number of hooks
Length of hooks (μ)
D
0.20mm
E
0.040mm

Fig. 4


A
0.02mm
B
0.10mm
C
0.040mm