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Echinorhynchus cotti Yamaguti, 1935 (Acanthocephala: Echinorhynchidae) in Fish of the Kanita River, with a Note on the Life Cycle

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Echinorhynchus cotti was described by Yamaguti (1935) from the sculpin, *Cottus pollux*, in Siga Prefecture. Fukui and Morisita (1937) and Yamaguti (1939) found the species in the fork-tailed bullhead, *Pelteobagrus nudiceps*, and the type host from Lake Biwa, respectively.

In April 1974, a mass occurrence of *E. cotti* was found in the char, *Salvelinus leucomaenis*, from the Kanita River, Aomori Prefecture. As our knowledge of the parasite was very sparse, its occurrence promoted us to elucidate morphological and ecological characters of *E. cotti*. The present paper deals with the occurrence and morphology of *E. cotti* in fish from the Kanita River, and also attempts to clarify its life cycle. Detailed studies of the ecology of *E. cotti* are continuing and will be published in separate articles.

Materials and Methods

Fish were collected by rod and line from the Kanita River, Aomori Prefecture, during April and November 1974. They were brought to the field laboratory, and examined as soon as possible. They were killed by pithing, measured, weighed, and opened by a midventral incision. The whole of alimentary tract was removed, dissected longitudinally, and placed in Ringer's solution. The worms were removed carefully, and fixed in 70% alcohol under the coverslips. Subsequently, they were stained in alum carmine or Heidenhain's iron hematoxylin, dehydrated through an alcohol series, cleared in xylene, and mounted in Canada balsam.

In addition, aquatic arthropods were collected from the Fujinomata Brook, a small tributary of the Kanita River, in August 1974. They were fixed in 5% formalin, brought to the laboratory, and examined for *E. cotti* larvae with a binocular dissecting microscope. A single larva was found and treated as mentined above.

The following redescription is based on fifty-five specimens (25 males and 30 females) from the char, *S. leucomaenis*, collected in May and August 1974. At least two complete counts of the number of rows of hooks were made around the proboscis, and the hooks per longitudinal row were counted in five rows of each worm. Hooks in full side view were measured from the free point of thorn to the back edge of root. Mature eggs teased from fixed gravid females were measured. Figures were drawn with the aid of a microprojector or a camera lucida. All measure-

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Table 1 Occurrence of *Echinorhynchus cotti* in fish of the Kanita River

Fish species	No. of fish examined	No. of fish infected	Incidence*	Mean intensity†	Intensity range‡
Salvelinus leucomaenis	218	160	73.4	9.2	1–101
Oncorhynchus masou	23	18	78.3	8.5	1–37
Salmo gairdneri	2	2	100	23.0	2–44
Tribolodon hakonensis	18	0	0	—	—

*: percentage of fish infected
†: mean number of worms per infected fish
‡: range of number of worms per infected fish

ments are in micrometers with averages in parentheses unless otherwise stated.

The specimens are deposited in the Meguro Parasitological Museum, Tokyo (M.P.M. Coll. No. 19326).

Results

1) Occurrence in fish

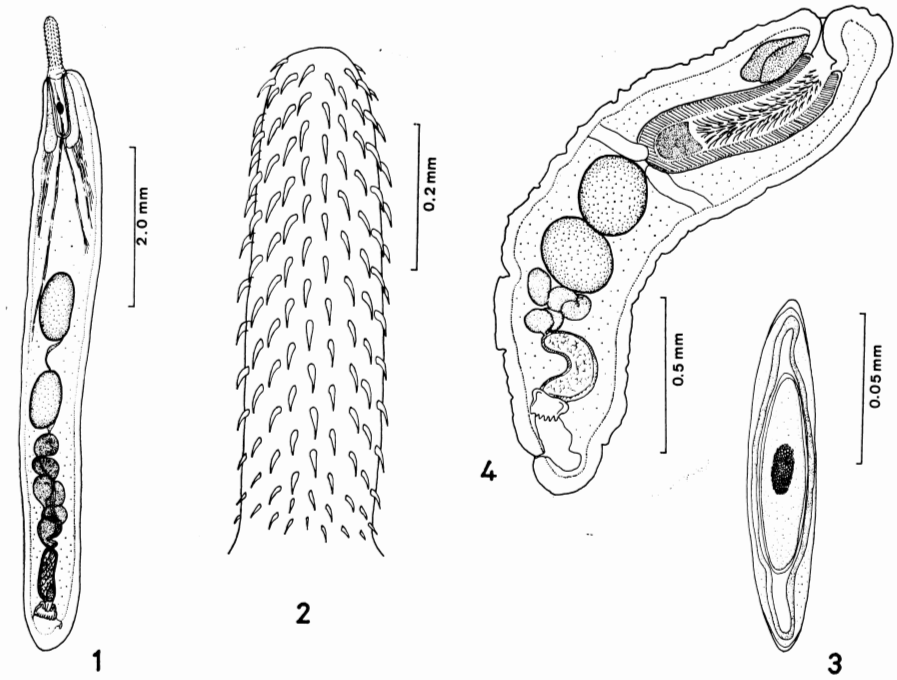
The incidence and intensity of *Echinorhynchus cotti* in fish from the Kanita River are shown in Table 1. The char, *S. leucomaenis*, the masu salmon (river-resident form), *Oncorhynchus masou*, and the rainbow trout, *Salmo gairdneri*, were heavily infected, whereas no infections were observed only in the dace, *Tribolodon hakonensis*. Gravid female worms containing mature eggs were found in all three species of salmonid fish. In the Kanita River, especially in the upper reaches or small tributaries, the char predominates and may be important as a definitive host of *E. cotti*.

2) Description (Figs. 1–3)

General: Trunk cylindrical and elongate. Proboscis almost cylindrical, sometimes tapering anteriorly. Roots of hooks nearly as long as thorns, without modifications. Basal hooks spinelike. Neck short. Proboscis receptacle double-walled with ganglion at middle. Lemnisci longer than proboscis receptacle, occasionally lobed. Lacunar system well developed.

Males: Trunk 3.93 to 8.74 (5.29) mm long by 523 to 875 (718) wide. Proboscis 453 to 654 (579) long by 110 to 194 (165) wide; armed with 16 to 19 (usually 18 or 19) longitudinal rows of 11 to 15 (usually 13 or 14) hooks each. Largest hooks 42 to 50 (46) long. Smallest basal hooks 20 to 35 (28) long. Neck 74 to 123 (93) long by 233 to 296 (261) wide at junction with trunk. Proboscis receptacle 573 to 1107 (826) long by 110 to 262 (185) wide. Lemnisci 573 to 835 (676) long by 98 to 257 (158) wide. Reproductive system, from anterior margin of anterior testis to posterior end of trunk, 2.5 to 4.9 (3.5) mm long, occupying 56 to 70% (63%) of trunk length. Testes oval. Anterior testis 405 to 775 (577) long by 296 to 463 (384) wide. Posterior testis 356 to 785 (555) long by 296 to 433 (367) wide. Cement glands 5 to 8 (usually 5 or 6) in number, oval. Saefftigen's pouch 453 to 704 (588) long by 172 to 287 (237) wide. Vesicula seminalis 196 to 395 (252) long by 74 to 189 (124) wide. Genital pore subterminal.

Females: Trunk 5.4 to 12.9 (9.4) mm long by 594 to 1625 (1032) wide. Proboscis 523 to 704 (622) long by 147 to 221 (184) wide; armed with 16 to 21 (usually 18 or 19) longitudinal rows of 11 to 16 (usually 13 or 14) hooks each. Largest hooks 44 to 57 (50) long. Smallest basal hooks 20 to 40 (31) long. Neck 64 to 135 (102) long by 245 to 356 (311) wide at junction with trunk. Proboscis receptacle 754 to 1479 (949) long by 159 to 296 (230) wide. Reproductive system, from anterior margin of uterine bell to pos-



Figs. 1–4. *Echinorhynchus cotti*. 1. Male, 2. Proboscis of male, 3. Mature egg, 4. Cystacanth from *Paramoera japonica*.

terior end of trunk, 0.9 to 1.6 (1.3) mm long, occupying 8 to 21% (13%) of trunk length. Uterine bell 196 to 391 (259) long by 98 to 172 (128) wide. Uterus 420 to 1006 (732) long by 54 to 110 (74) wide. Mature eggs with prominent polar elongations, 110 to 127 (118) long by 22 to 25 (23) wide. Embryos 55 to 65 (60) long by 13 to 15 (14) wide. Genital pore terminal.

3) Life cycle and larval stage (Fig. 4)

Of approximately 600 aquatic arthropods from the Fujinomata Brook examined, one of 51 *Paramoera japonica* (Amphipoda: Pontogeneiidae) was parasitized by a male larva of *E. cotti*, but no other organisms such as Ephemeroptera, Plecoptera and Tricoptera were infected. The larva, which was in the early cystacanth stage, was obtained from the hemocoel of the amphipod, and showed the following morphological characters.

Trunk nearly cylindrical, wrinkled, flexed dorsally, and slightly wider at middle, 2.21 mm long by 0.52 mm wide. Proboscis completely inverted within proboscis receptacle. Hooks 25 to 40 long. Proboscis receptacle occupying anterior one-third of trunk length, with ganglion near posterior end. Retractor muscles emerging at the tip of receptacle, attaching to body wall. Lemnisci short, 194 to 223 long by 58 to 78 wide. Testes oval and contiguous. Anterior testis 273 long by 224 wide. Posterior testis 232 long by 253 wide. Ovoid cement glands begining immediately behind posterior testis, 68 to 92 wide. Saefftigen's pouch 269 long. Genital pore subterminal.

Discussion

Recoveries of *Echinorhynchus cotti* in the char, *Salvelinus leucomaenis*, the masu salmon, *Oncorhynchus masou*, and the rain-

bow trout, *Salmo gairdneri*, from the Kanita River, Aomori Prefecture, constitute new host and locality records. Since the previously reported localities of the parasite are restricted to Siga Prefecture (Yamaguti, 1935, 1935; Fukui and Morisita, 1937), its occurrence suggests that *E. cotti* may be widely distributed in Honshu, the main island of Japan.

Morphologically, our specimens of *E. cotti* show no significant differences from those of Yamaguti's descriptions, except for a few points. Yamaguti (1935) reported that the male genital pore is terminal, but it apparently lies subterminally. Furthermore, although Yamaguti (1939) noted that the largest hooks are subapical, their positions are not constant and vary individually. In our specimens, most of them are the third hooks from the tip of the proboscis.

Marked intraspecific variability is also observed in some characters; body size, number of proboscis hooks, size of hooks and number of cement glands. Grabda-Kazubska and Ejsymont (1969) described the variability in *Echinorhynchus borealis*, but little information is available concerning that in the genus. The related genus *Acanthocephalus* is known to be considerably variable with age, sex, host, and geographical location (Lühe, 1912; Bullock, 1962; Amin, 1975). The problem of the variability in *E. cotti* should be clarified on the many specimens from different hosts and from various geographical locations.

Of the four species of fish from the Kanita River examined, only the dace, *Tribolodon hakonensis*, was free of *E. cotti*. This absence of infection may be a reflection of the feeding habit of the fish. The stomach content analyses revealed that the dace is herbivorous rather than omnivorous, but that the three species of salmonid fish infected are all carnivorous. It is considered, therefore, that the dace may not take intermediate hosts as food.

Several species of amphipod crustaceans are known to serve as intermediate hosts for species of the genus *Echinorhynchus*. Nybelin (1923, 1924) reported four species of marine amphipods as intermediate hosts of *E. gadi*. Ekbaum (1938) also obtained *E. gadi* from *Cyphocaris challengeri*. Larvae of *E. salmonis* were found in *Pontoporeia affinis* (Nybelin, 1924; Amin, 1978). Brownell (1970) ascertained *P. affinis* to be an intermediate host of *E. salmonis* by feeding experiments. Awachie (1965, 1966) observed the ecology of *E. truttae* larvae in *Gammarus pulex*, and completed the life cycle of the parasite, using *G. pulex* and brown trout as hosts. The amphipod, *Paramoera japonica*, from which we obtained a cystacanth of *E. cotti*, is adundant in the Kanita River, and no other species of amphipods are distributed. It appears certain that *P. japonica* is an intermediate host of *E. cotti* although not experimentally verified.

Summary

A total of 261 fish consisting of four species from the Kanita River, Aomori Prefecture, were examined for *Echinorhynchus cotti* during April and November 1974. The char, *Salvelinus leucomaenis*, the masu salmon (river-resident form), *Oncorhynchus masou*, and the rainbow trout, *Salmo gairdneri*, were infected with the parasite, whereas no infections were observed in the dace, *Tribolodon hakonensis*. Recoveries of *E. cotti* from these salmonid fish of the river constitute new host and locality records. A single cystacanth of *E. cotti* was also obtained from the hemocoel of the amphipod, *Paramoera japonica*, from a small tributary of the river. The amphipod is considered to serve as an intermediate host for *E. cotti*.

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青森県蟹田川産魚類に寄生するカジカコウトウチュウとその生活環

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1974年4月～11月に青森県蟹田川より淡水魚4種，合計261尾を採集してカジカコウトウチュウ（鰍鉤頭虫）*Echinorhynchus cotti* の寄生状況を調べるとともに，その形態を再記載した．本種はイワナ *Salvelinus leucomaenis*，ヤマメ *Oncorhynchus masou*，およびニジマス *Salmo gairdneri* に寄生が確認されたが，ウグイ *Tribolodon hakonensis* に寄生はみられなかった．上記サケ科魚類3種は本鉤頭虫の新終宿主であり，青森県は新分布地として追加される．また，同川の一支流より採集した端脚類の1種 *Paramoera japonica* よりカジカコウトウチュウの幼虫が得られ，本種の中間宿主と考えられた．