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STUDIES ON FINNISH LARVAL FLUKES

WITH A LIST OF KNOWN FINNISH ADULT FLUKES

(TREMATODA: MALACOCOTYLEA)

BY

BO-JUNGAR WIKGREN

(ZOOLOGICAL STATION, TVÄRMINNE)

WITH 63 FIGURES AND 8 TABLES IN THE TEXT AND 6 PLATES

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INTRODUCTION

In most countries of the world the study of trematodes has advanced at least to the point that the commonest trematode species are known as adults and pioneer works on the larval stages are in existence. In many countries this field of helminthology has been extensively studied.

In Finland the trematodes have been very poorly investigated. ALEXANDER v. NORDMANN (1803—1866) is a well known name in helminthology; most of his investigations were, however, performed abroad. From 1849 onwards he was Professor of Zoology at Helsinki/Helsingfors University. The monogenetic trematodes have been studied by ALAROTU (1944), who describes two new species and gives a list of the known Finnish species. No real taxonomic paper on Finnish digenetic trematodes seems to exist, nor have they been listed in full except for the list given by JÄÄSKELÄINEN (1921) for parasites of fish, and that given by MUROMA (1951). MUROMA's list is based on a collection containing samples from game animals only.

The 28 digenetic trematodes found in Finland are listed on p. 84. It is quite certain that only a very small fraction of the species here occurring are known.

This paper is the first study on larval trematodes to be published in Finland, but not the first to be undertaken. In 1911 the late V. JÄRVINEN, M. A., studied the giant cercaria of the fish parasite *Azygia lucii* (Müller 1776) (synonym: *Cercaria mirabilis* Braun 1891). With the permisson of Prof. ALEX. LUTHER some few quotations from JÄRVINEN's manuscript are made. JÄRVINEN appears to have been the first to point out the similarities between the larva *Cercaria mirabilis* and the adult *Azygia lucii*. He was not, however, able to prove convincingly the relationship between them. The other work was carried out in 1933—1934 by Mrs. AILI SELINHEIMO, M.A. (née: VALTONEN). SELINHEIMO describes 10 cercariae found in the vicinity of the Tvärminne Zoological Station and treats some of these histologically. The specific descriptions given by SELINHEIMO are included in this paper by her permisson. The histological investigation will be published separately.

My investigation has been carried out at the Tvärminne Zoological Station in the years of 1946—1948, 1950 and 1952. Some observations were made in

1954. During this time I have found 23 species and some, in addition, which owing to very incomplete descriptions are not included here. I have found it necessary to describe each species as fully as possible. This is in the first place due to the fact that, the identification of cercariae being a puzzling task, the listing of species without descriptions and figures is in most cases valueless. I also hope that additional information on this object may be useful.

I have tried to identify my species with those previously described as far as possible, even if some minor differences exist. However, I have not seen in the literature any descriptions corresponding to 5 of my species. I have simply given them the names *Cercaria fennica I—V*. A similar mode of nomenclature has been used by many authors (e.g. DUBOIS, HARPER, KOBAYASHI, MILLER, NAKAGAVA, REES, SZIDAT, TSUCHIMOCHI and YEOHEDA). WESENBERG-LUND's (1934) excellent paper on Danish larval trematodes and DAWES' (1946) monograph on trematodes have been of great help to me.

It might be asked whether faunistic works on larval stages have any scientific value. It must be pointed out that from the purely taxonomic point of view the elaboration of complete life histories of trematode species is the only way in which an exact understanding of the correlations between the larvae and the adults can be achieved. The method of establishing relationships on purely morphological similarities could lead to little success, a fact which has already been stressed by DOLLFUS (1914), whereas a knowledge of larval forms gives us the basic information always needed. In countries where the larval trematode fauna is totally unknown, a preliminary faunistic study is, indeed, indispensable. The larval trematodes may also to some extent be regarded as a separate group of animals. They form a part of the pelagic fauna of our waters and they control, often decisively, the populations and the distribution of their host animals (primary and secondary intermediate hosts).

The list of material gives some information on the distribution of snails in the Tvärminne archipelago. This list is almost complete for the snails occurring in pools on skerries in the area indicated in fig. 1.

OWN INVESTIGATIONS

MATERIAL

Area investigated

Part of the snail material has been collected within the archipelago near the Tvärminne Zoological Station (fig. 1) and part from scattered localities. The list of localities investigated is given on p. 9—13. Here information is also given with regard to the distribution of snails in the pools. In all, snails were collected from 52 different localities. (See plates IV—VI.)

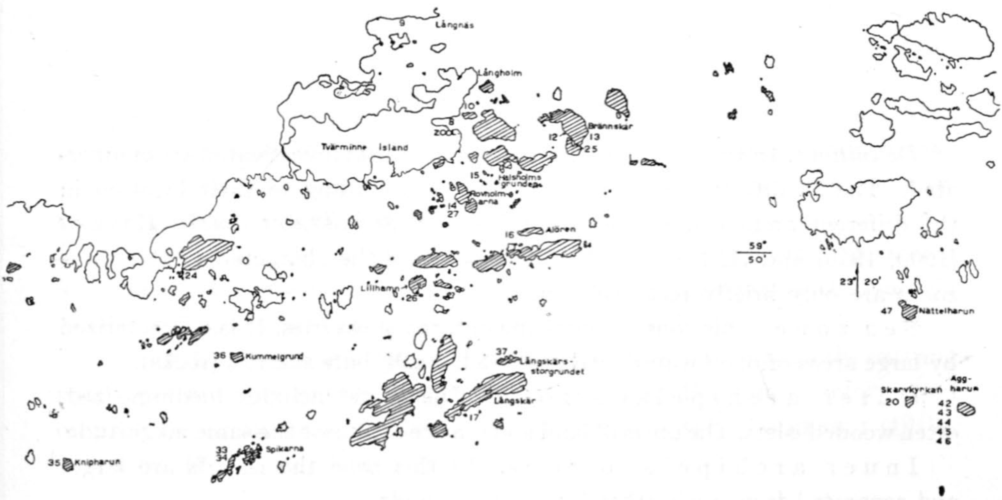


Fig. 1. Map of the main area investigated. The islets on which the occurrence of snail pools have been investigated are shaded. Only those islets from which snail material was collected are named. The numbers refer to the locality numbers in the list of material.

Snail species investigated

Snails of the following species were collected and studied:

1	*Lymnaea stagnalis* (L.)	(1400)
	L. peregra (Müller)	(1000)
	L. palustris (Müller)	(450)
	Bithynia tentaculata (L.)	(400)
2	*Lymnaea auricularia* (L.)	(30)
	Physa fontinalis (L.)	(50)
	Planorbarius corneus (L.)	(40)
	Anisus vortex (L.)	(90)
	Theodoxus fluviatilis (L.)	(60)

Snails belonging to group 1 have been the main objects of study, whilst snails belonging to group 2 have only occasionally been collected. The approximate number of snails of the different species collected is given in brackets. In all, about 3500 snails were investigated.

List of material

Definitions. In the list of material all the localities investigated are enumerated. The localities are divided into groups according to their location in the different archipelago zones as defined by Sundström (1927), Häyren (1900, 1940) and H. Luther (1946, 1951). Here the characteristics of these zones are only briefly recapitulated.

Sea zone. This zone includes the outermost skerries. It is characterized by large areas of open water with scattered, small, bare skerries (rocks).

Outer archipelago zone. This zone includes medium-sized, often wooded islets. The areas of land and sea are of almost the same magnitude.

Inner archipelago zone. In this zone the islands are larger and separated from each other by narrow sounds.

Coastal zone. This zone includes the mainland shore and the innermost large islands. These islands have a mainland character.

The localities investigated can also be grouped into two main groups, *viz.* A) shores and B) pools.

A) For the shores, the approximate wind and wave exposure has been noted.

Exposure 0: in sheltered bays and other well protected localities where the open water area is small.

Exposure 1: on shores where the adjacent open water area has in no direction a greater extent than about 100 m. Such a situation could not occur in the sea zone.

Exposure 2: on shores where the adjacent water area in at least one direction has an extent of about 1—2 km. This is a great exposure without swell-effect.

Exposure 3: normal on the shores of the skerries in the sea zone and on the seaward shores of the outer islets of the outer archipelago. The swell waves almost never cease.

B) I have divided the pools into groups, using a modification of LEVANDER's (1900) classification.

1) Intralittoral pools: This type corresponds most closely to LEVANDER's two groups: »Intralitorale Seewasserbassins» and »Spritzwasserlachen». In this type I have included large or medium-sized pools, which, at least during gales, are washed by waves or are exposed to strong spray. The water is colourless and very transparent. The salt concentration is almost the same as that of the sea water. The vegetation consists of algae, the most abundant of which are *Enteromorpha* and *Cladophora*. Usually there is no detritus on the bottom. These pools lie at a height of 0—2,5 metres above the normal sea-level, depending on the wind and wave exposure and on the character of the adjacent shore.

2) Adlittoral pools: In this type I have included medium sized pools near the shore-line which are protected from strong spray. *Enteromorpha* and *Cladophora* do not occur. The detritus layer is often very thin and only some centrimetres thick. Height above sea-level 0.5—5 m.

3) Supralittoral pools: These pools mostly contain pure rain water or else water with a very low salt content. The majority of them adjoin smaller or larger vegetation areas with moss or grass.

It must be pointed out that this classification does not cover all the existing pool types but only the snail pools here investigated. For further information on pools in the area investigated see also KUENEN (1939), JÄRNEFELT (1940), LINDBERG (1944), and DROOP (1953).

List

(—) = no infection observed. diss. = snails dissected. sep. = each snail separated. Exp. = exposition.

Shores

Coastal zone

No. 1. TROLLBÖLE: very shallow shore with Phragmites, the mouth of the Trollböle stream. Exp. 2. — L. stagn.: 10.VI. 1948 (—); L. pal.: 10.VI. 1948 (—); B. tent.: 10.VI. 1948 (—); P. corn.: 22.VII. 1947 (—).

No. 2. POJOVIKEN, BAGGBY GLOET: deep bay almost filled up with Phragmites. Exp. 0. — P. corn. 22.VII. 1947 (—), 30.VII. 1947 *Cercariaeum* sp.

No. 3. EKUDDEN (Porvoo/Borgå): shallow shore surrounded by large vegetation areas. Avifauna very rich. Exp. 1. — L. per. 4.VI. 1947 *C. Diplostomum spathaceum, C. limnaeae ovatae* (?); L. stagn. 4.VI. 1947 *C. Diplostomum spathaceum.*

No. 4. TARVO (Helsinki/Helsingfors): stony shore. Exp. 2. — L. pal. 20.X. 1947 *C. Diplostomum spathaceum.*

No. 5. MAJVIK (Sibbo/Sipoo): shallow shore with vegetation. Exp. 2. — L. stagn. 26.IX. 1946 (—); L. per. 26.IX. 1946 *C. Diplostomum spathaceum.*

No. 6. GULLÖ, N-shore: stony (rocky shore). Exp. 1. — T. fluv. 5.VIII. 1952 (15 diss. —).

Inner archipelago zone

No. 7. DANSKOGSFLADAN: stony shore. Extensive areas of vegetation in the neigbourhood. Exp. 1. — L. stagn. 5.VIII. 1952 (5 diss.) 1 very small Xiphidiocercaria.

Outer archipelago zone

No. 8 KROGARVIKEN: a shallow bay near the Zoological Station. Vegetation rich. Exp. 1. — L. stagn. 5.VI. 1947 (—), 9.VII. 1947 (—), 7.VI. 1954 (—); L. per. 5.VI. 1947 (—), 14.VIII. 1946 *Xiphidiocercaria* sp., 7.VI. 1954 (—); L. pal. 9.VII. 1947 *C. Diplostomum spathaceum, Tetracotyle,* 28.VII. 1947 *C. Azygia lucii,* 7.VI. 1954 *C. fennica III,* 17.VI. 1954 (15 diss.) 2 *C. fennica III,* 13 *Tetracotyle*; A. vortex 18.VII. 1947 *C. splendens,* 28.VII. 1947 (—), 23.VI. 1950 (—); B. tent. 19.VII. 1946 *C. Sphaerostoma bramae,* 9.VII. 1947 (14 sep.) 5 *C. Asymphylodora tincae,* 2 *C. Sphaerostoma bramae,* 7 double infection with these, 28.VII. 1947 (—), 23.VI. 1950 (—), 26.VI. 1952 (25 diss.) 1 *Gymnocephalous cercaria A* sp. + cysts, 2 cysts of *Gymn. cerc. A,* 2 cysts of *Asymphylodora tincae,* 7.VI. 1954 *C. Asymphylodora tincae.*

No. 9. LÅNGNÄS: stony and rocky shore. Exp. 2. — L. stagn. 8.VI. 1947 (—); L. per. 8.VI. 1947 (—).

No. 10. LÅNGHOLM: stony shore with small Phragmites beds. Exp. 1. — L. stagn. 2.VI. 1948 (—); L. pal. 2.VI. 1948 (—).

No. 11. DRUMSÖ (Helsinki/Helsingfors), S.W. shore: open shore with stones. Exp. 2—3. — L. stagn. 9.XI. 1948 *Xiphidiocercaria* sp., *C. Diplostomum spathaceum.*

No. 12. BRÄNNSKÄR, inner shore: shallow shore with gravel and small stones. Exp. 2. — L. stagn. 18.VI. 1950 (—); L. pal. 23.VIII. 1952 (15 diss.) 7 *Tetracotyle,* 1 *C. helvetica XXX.*

No. 13. See below between No. 16 and No. 17.

No. 14. ROVHOLMARNA: stony shore. Exp. 2. — L. per. 10.VI. 1950 (—).

No. 15. HALSHOLMSGRUNDEN: a small rock. Exp. 2. — L. stagn., L. per., L. pal. 15.VI. 1947 (—).

No. 16. ALÖRN, the shore toward Furuskär: stony shore. Exp. 1—2. — L. stagn. 18.VI. 1947 (—); L. per. 18.VI. 1947 *Furcocercaria I* W.—L.; L. pal. 18.VI. 1947 (—).

Sea zone

No. 13. BRÄNNSKÄR, outer shore: large stones on an open shore. Exp. 3. — L. per. 18.VI. 1950 (21 diss.) 1 *C. Apatemon gracilis.*

No. 17. LÅNGSKÄR, outer shore: an L-shaped bay at the S. end. Rocky and stony bottom. Max. depth about 0.6 m. Exp. 0—1. — L. stagn. 2.VI. 1948 *C. Notocotylus* sp., 12.VII. 1948 *C. Diplostomum spathaceum, Xiphidiocercaria* sp., 3.VIII. 1948 (5 diss.) 2 *Tetracotyle,* 1 *C. Diplostomum spathaceum,* 2.VII. 1950 *Xiphidiocercaria* sp., 7.VII. 1952 (10 diss.

—); L. p e r. 3.VIII. 1948 *C. fennica IV*, 7.VII. 1952 (20 diss.) 3 cysts of *Cercariaeum* sp., 3 *Tetracotyle*, 1 cysts of *Cercariaeum* sp. + *Tetracotyle*, 1 *C. Apatemon gracilis*, 1 cysts of *Cercariaeum* sp. + *C. Notocotylus* sp.; L. p a l. 12.VIII. 1948 *C. Apatemon gracilis;* B. t e n t. 2.VI. 1948 (26 diss.) 2 *C. Sphaerostoma bramae*, 4 *Gymnocephalous cercaria B.*, 1 Redia sp., 1 *Tetracotyle*, 3.VIII. 1948 *Gymnocephalous cercaria B.*, 12.VIII. 1948 *C. Sphaerostoma bramae*, *Gymnocephalous cercaria A.*

No. 18 Klobbskär: stony shore. Exp. 3. — L. p e r. 28.VI. 1947 (—).

No. 19. Segelskär: a deep and narrow bay S.W. of the old lighthouse. Steep rocks. Exp. 3. — L. p e r. 3.VIII. 1948 (—).

No. 20. Skarvkyrkan, W. shore: rocky shore. Exp. 3. — L. p e r. 18.VI. 1947 *Tetracotyle.*

No. 21. Ören, S.E. side: a narrow cleft in the shore with large stones. Exp. 3. — L. p e r. 18.VI. 1947 *C. Diplostomum spathaceum*, *Xiphidiocercaria* sp.

No. 22. Söderskär (Pörtö): a small bay with large stones. Exp. 3. — L. s t a g n. 9.X. 1946 *Xiphidiocercaria* sp.

Pools

Coastal zone

No. 23. Trollböle: a ditch near the shore. — L. p e r. 10.VI. 1948 (—); L. p a l. 10.VI. 1948 *C. ocellata;* P h y s a f o n t. 10.VI. 1948 (—).

Outer archipelago zone

No. 24. Petter Römans grund: a large, fenlike pool with rocky walls on three sides and grassy ground on the remaining side. At high water level in connection with the sea. Littoral. — L. s t a g n. 1.VII. 1948 *Xiphidiocercaria* sp., 16.VIII. 1948 (—), 11.VII. 1950 *C. strigeae tardae*, *Tetracotyle* (1 out of 6 diss.), 12.VII. 1952 (15 diss. —); L. p e r. 16.VIII. 1948 (—); B. t e n t. 1. VII. 1948 (—); 16.VIII. 1948 *Gymnocephalous cercaria A.*, 11.VII. 1950 (—); 12.VII. 1952 (15 diss.) 1 cysts of Gymnocephalous cercaria.

No. 25. Brännskär (Tvärminne No. 73): a pool at water level with putrescent Fucus. Snails occur here only occasionally. — L. s t a g n. 27.VI. 1948 (—); L. p a l. 27.VI. 1948 *C. chromatophora.*

No. 26. Lillhamn; a large pool in the middle of the islet: The pool is surrounded on three sides by steep rock walls, on one side by grassy ground. 25 m. × 12 m. Littoral. — L. s t a g n. 1.VIII. 1948 *C. cambriensis I;* L. p a l., A n i s u s v o r t e x 1.VIII. 1948 (—); B. t e n t. 29.VI. 1952 (25 diss.) 3 *Gymnocephalous cercaria B.*, 2 *C. fennica V*, 6 cysts of *Gymnocephalous cercaria B.*, 1 *C. fennica I*, 1 *C. fennica II*, 25.VI. 1954 C. *fennica V.*

No. 27. Island W. of the Station (Rovholmarna?) — 10.VI. 1947 *C. Diplostomum spathaceum.*

No. 37. Långskärstorgrundet: pool near the N. shore. Littoral. — L. s t a g n. 12.VIII. 1948 (—).

Sea zone

No. 28. South Porsskär (Koffertskär): a small pool with a rich algal vegetation. Littoral. — L. s t a g n. 2.VIII. 1947 (—), 27.VI. 1948 *C. chromatophora*, 1.VIII. 1948 (—); L. p e r. 27.VI. 1948 (—).

No. 29. Ören: a large but shallow pool. Supralittoral. — L. s t a g n. 27.VI. 1948 *C. Diplostomum spathaceum*, 22.VII. 1952 *C. Diplostomum spathaceum.*

No. 30. Svartgrund, a small pool in the E. corner: 7 m. × 3 m., 10 m. from the shore-line, 1.5 m. — 2.0 m. above the water-level. Littoral. — L. s t a g n. 4.VI. 1948 *C. ocellata* (10 diss. —), 12.VIII. 1948 (—), 18.VI. 1950 (—), 26.VII. 1952 (17 diss. —).

No 31. Svartgrund, a large pool in the E. corner: 25 m. × 7 m., max. depth 0.5 m. 0.5 m. above water-level. Lies near the shore. Littoral. Vegetation: Enteromorpha. Sticklebacks observed in the pool. — L. s t a g n. 27.VI. 1948 (—), 12.VIII. 1948 *C. Diplostomum spathaceum*, 26.VII. 1952 (20 diss. —); L p e r. 27.VI. 1948 *C. Apatemon gracilis*, 18.VI. 1950 *C. Diplostomum spathaceum*, 26.VII. 1952 *C. fennica III.*

No. 32. Svartgrund, a pool on the N.side: 15 m. × 8 m., max. depth 0.8 m., 6 m. from the shore line, 2 m. above water-level. Large stones on the bottom. Enteromorpha and Cladophora. Littoral. — L. s t a g n. 18.VI. 1947 (—), 3. X. 1947 *Tetracotyle*, 4.VI. 1948 (—), 18.VI. 1950 (—); *L.* p e r. 27.VI. 1948 *C. Hypoderaeum conoideum.*

No. 33. Spikarna (Tvärminne No. 4): 10.5 m. × 1—3 m., max. depth 0,65 m., 15 m. from shore-line, about 1 m. above water-level. Abundant Cladophora. Adlittoral. — L. s t a g n. 18.VI. 1947 (—), 18.VI. 1954 (10 diss. —); L. p a l. 18.VI. 1947 (—), 4.VI. 1948 (20 diss.) 4 *C. cambriensis I* + *Tetracotyle*, 16 *Tetracotyle*, 16.VIII. 1948 (6 sep.) 1 *C. cambriensis I*, 1 *C. Diplostomum spathaceum*, 18.VI. 1954 (3 diss.) 1 *Tetracotyle.*

No. 34. Spikarna: medium-sized pool with dy-bottom. Max. depth 0,6 m. Adlittoral (?). — L. s t a g n. 18.VI. 1947 (—).

No. 35. Knipharun: littoral pool. — L. s t a g n. 16.VIII. 1948 (—).

No. 36. Kummelgrund, pool on the W.side: 2 m. × 3.5 m., max. depth 0.4 m., distance from shore 4 m., 1 m. above sea-level. Adlittoral. — L. s t a g n. 18.VI. 1950 (10 sep.) 5 *C. Diplostomum spathaceum*, 1 *C. fennica III*, 16.VII. 1950 (9 diss. —); L. p e r. 16.VII. 1952 (5 diss.) 4 *Tetracotyle*, 2 *C. fennica III*, 1 *C. Apatemon gracilis;* L. p a l. 19.VII. 1947 (12 sep.) 6 *C. cambriensis I*, 4 *C. Diplostomum spathaceum*, 1 *C. Notocotylus sp.*, 1 *C. linearis*, 16.VII. 1952 (20 diss.) 5 *C. fennica III*, 5 *C. Diplostomum spathaceum*, 2 *C. chromatophora*, 1 *C. ocellata*, 20 *Tetracotyle.*

No. 37 see below loc. No. 27.

No. 38. Segelskär (Tvärminne No. 4): adlittoral. — L. s t a g n. 4.VIII. 1948 (12 diss.) 1 *C. fennica III*, 1 *Xiphidiocercaria* sp., 1 Redia sp., 18.VIII. 1948 *C. fennica III*, *Xiphidiocercaria* sp.; L. s t a g n. + L. p e r. 20.VII. 1952 *C. fennica III*, *C. Diplostomum spathaceum.*

No. 39. Segelskär (Tvärminne No. 6): 7 m. × 3 m., depth 1 m. Adlittoral. — L. s t a g n. 18.VIII. 1948 (—), 25.VI. 1950 *C. fennica III.*

No. 40. Segelskär (Tvärminne No. 9): 4 m. × 3 m., max. depth 0.7 m., at sea level, distance from shore 6 m. Littoral. — L. s t a g n. 25.VI. 1950 (10 sep.) 2 *C. fennica III*, 20.VII. 1952 (20 diss.) 5 *C. fennica III*, 1 *C. fennica III* + *Tetracotyle*, 1 *Tetracotyle.*

No. 41. Segelskär: a large pool on the E. side, with a very narrow connection with the sea. Littoral. — L. p e r. 4.VIII. 1948 (—), T h e o d o x u s f l u v. 4.VIII. 1948 (—).

No. 42. Äggharun (beneath Skarvkyrkan; Tvärminne No. 1): 16 m. × 3 m., max. depth 0.8 m. Adlittoral. With rich vegetation including Typha, Scirpus, Hippuris, Utricularia and Lemna. — L. p e r. 22.VI. 1947 *C. chromatophora*, *Xiphidiocercaria* sp., 3.VIII. 1947 (5 diss.) 4 *C. Diplostomum spathaceum*, 1 *Xiphidiocercaria* sp., 5 *Tetracotyle*, 4.VI. 1948 (10 sep. —), 11.VIII. 1948 (—), 1.VII. 1950 *C. chromatophora*, *C. fennica III*, 11.VII. 1950 *C. chromatophora*, 11.VIII. 1952 (15 diss.) 8 *C. fennica IV*, 3 *C. Hypoderaeum conoideum*, 2 *C. chromatophora*, 1 *C. strigeae tardae*, 1 *Echinostomous cerc.* sp., 15 *Tetracotyle.*

No. 43. Äggharun (Tvärminne No. 8): 4 m. × 5 m., max. depth 1.2 m., 5 m. above sea-level, distance from shore 30 m. Supralittoral or adlittoral. — L. p e r. 11.VIII. 1948 (—), 13.VIII. 1952 (10 diss. —).

No. 44. ÄGGHARUN (Tvärminne No. 26): Adlittoral. — L. p e r. 11.VII. 1950 *C. fennica III*.

No. 45. ÄGGHARUN (Tvärminne No. 31): 3 m. × 10 m., depth: 0.4 m. + 0.2 m. detritus. Adlittoral. — L. p e r. 11.VII. 1950 (10 sep.) 3 *C. fennica III*, 1 *C. Diplostomum spathaceum*, 1 *C. Hypoderaeum conoideum*.

No. 46. ÄGGHARUN (Tvärminne No. 38): 2.5 m. × 8 m., depth 0.45 m., distance from shore 50 m. Adlittoral. — L. p e r. 11.VIII. 1948 (—), 11.VII. 1950 (10 sep.) 5 *C. chromatophora*, 2 *C. fennica III* + *C. chromatophora*, 1 *C. helvetica XXX*, 1 *C. Hypoderaeum conoideum*, 11.VIII. 1952 (10 diss.) 4 *Tetracotyle*, 2 *Tetracotyle* + cysts of cestodes.

No. 47. NÄTTELHARUN: 5 m. × 5 m., max. depth 0.45 m., 0.5 m. above sea-level, distance from shore about 10 m. Supralittoral. Vegetation rich. — L. s t a g n. 23.VIII. 1952 *C. helvetica XXX*; L. p a l. 23.VIII. 1952 *C. Notocotylus* sp., *C. Diplostomum spathaceum*, *Tetracotyle*.

No. 48. KLOVASKÄR: 1.5 m. × 4.5 m., max. depth 0.55 m., 1.5 m. above sea-level, 20 m. from shore. Supralittoral. — L. s t a g n. (2 cm. — 2.5 cm. length) 23.VIII. 1952 (9 diss.) 7 *C. fennica III*, 1 *C. helvetica XXX*, 1 double infection with *C. Diplostomum spathaceum* and *C. fennica III*; L. s t a g n. (0.7 cm. — 1.2 cm. length) 23.VIII. 1952 (9 diss. —).

No. 49. KLOVASKÄR: a large, ramifying pool, 5 m. × 3 m., max. depth 0.6 m., 3 m. above sea-level, 10 m. from shore. Supralittoral. — L. p e r. (1 cm — 1.5 cm. length) 23.VIII. 1952 (10 diss.) 5 *C. fennica III*, 2 *C. Diplostomum spathaceum*, 1 *C. Notocotylus* sp., 1 *Xiphidiocercaria* sp., 5 *Tetracotyle*, 1 uninfected.

No. 50. MYGGAN: a large, intralittoral pool. — L. s t a g n. (1.7 cm. — 2.0 cm. length) 25.VIII. 1948 (15 diss.) 2 *C. fennica III*.

No. 51. KLOBBSKÄR (?): intralittoral pool. — L. s t a g n. 28.VI. 1947 *C. Diplostomum spathaceum*; L. p e r. 28.VI. 1947 *Xiphidiocercaria* sp., *Tetracotyle*; L. p a l. 26.VII. 1947 *C. Diplostomum spathaceum*, *Tetracotyle*.

No. 52 VÄSTERGADD (Jussarö): intralittoral pool. — L. s t a g n. 28.VI. 1947 (—); B. t e n t. 28.VI. 1947 *C. helvetica IX*, *C. Sphaerostoma bramae*, *C. imbricata* (?).

METHODS

Collecting method. From each locality, when visited, I collected 10—30 snails of the same species. Collecting was done by hand or with a shaft dredge. The snails were placed in ½—1 litre jars with water from the locality concerned.

Laboratory investigation. In the laboratory the material has been sorted according to species and sometimes also according to snail size into glass jars containing about 300—1000 cc. of water. In each jar 5—15 snails were kept. On some occasions the snails have also been separated in Opodeldoc bottles with 100—200 cc. of water. The water used was that from the collection locality or water with approximately the same salt concentration, *i.e.* brackish water, spring water or mixtures of these.

The presence of cercariae was usually checked both morning and evening. The contents of the jars were examined with the naked eye or with a hand lens. The identification of the species has always been made with the help of a low-power and/or a high-power microscope.

At dissection of snails the shell has been broken up with forceps and the snail drawn out and placed in a watch-glass with brackish water and crushed with the aid of dissection needles under a low-power microscope.

In most cases both cercariae and rediae have been studied only in the living state. Sometimes intra-vitam staining with Neutral Red has been tried. Other stains have also been tested but with little success.

Material for microscope preparations has been fixed with hot sublimate-acetic acid (LANG's solution) and stained with dilute Alum Haematoxylin (HANSEN's) and Eosin or with DOMINICI's Toluidine Blue — Orange G — Eosin staining method. Other staining methods have also been tried. Whole mounts, however, can scarcely add anything to the results obtained by studying living animals. I have not made sections.

The parthenitae were measured in the living state when subjected to moderate pressure by the cover-glass, or using the method described by BRUMPT (1920) and MANSON-BAHR and FAIRLEY (1920), *i.e.* killing the parthenitae with heat and measuring them under a cover-glass and very slight pressure.

In other particulars the methodological directions given by STUNKARD (1930) have been followed. For special methods see further information in the text.

Several different microscopes and preparation microscopes have been used during the investigation. A camera lucida has only occasionally been used. Most of the drawings are therefore freehand, but using the coordinates obtained by measuring the animals. In some cases several drawings were made which were then combined, but usually only one or a few drawings were made which were corrected and completed during the course of the investigation. The drawings were mostly made after observations on 25—100 cercariae.

SELINHEIMO'S INVESTIGATION

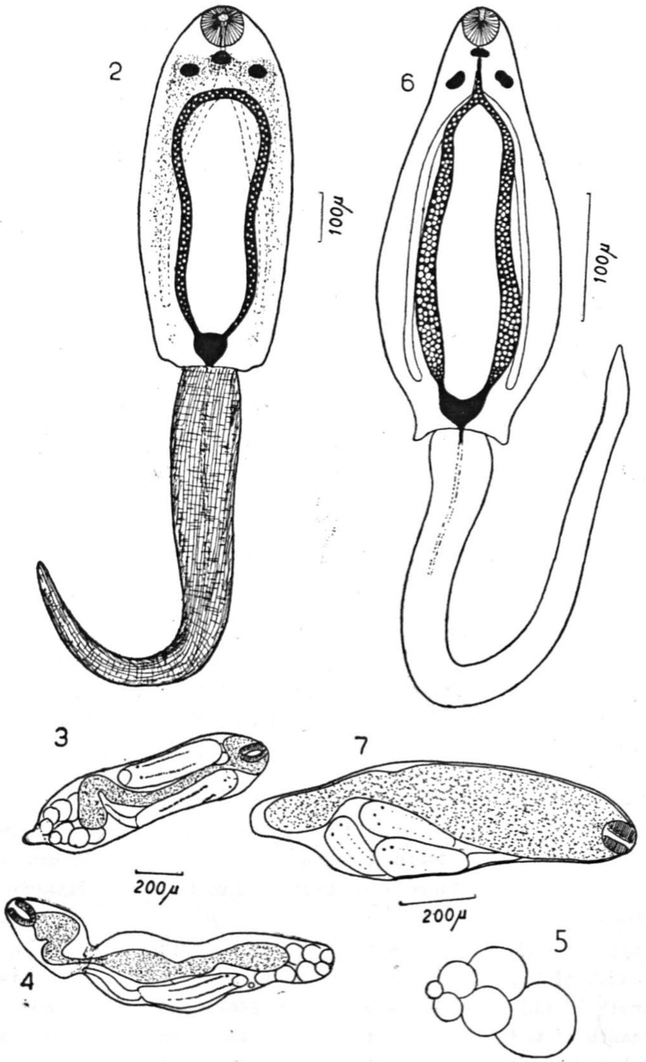
SELINHEIMO performed her study in the summer of 1933. The snail material is reckoned at about 200 snails. These were collected mainly from two localities, *viz.* Krogarviken (locality no. 8) and Baggby (a shore in the vicinity of the town of Ekenäs/Tammisaari). The manuscript contains descriptions of 10 cercariae, numbered from 1 to 10. Since I have met with some difficulty in identifying some of the species and since some closely resemble species also found by me, I have restricted the mention of SELINHEIMO's species nos. 1, 6, 8, 9 and 10 to short notes. The species nos. 2, 3, 4, 5 and 7 are described in full. SELINHEIMO's descriptions are shortened and brought into line with the form here used. Always when SELINHEIMO's observations are mentioned this is clearly indicated in the text.

SELINHEIMO has not noted the dimensions of the animals. Some approximate measures are given which are obtained by comparison with other species.

SPECIES DESCRIPTIONS

MONOSTOMOUS CERCARIAE

The main characters of the Monostomous cercariae (NOTOCOTYLOIDEA) have been listed by ROTHSCHILD (1938 a). Here some of these characters are mentioned: 1) Ventral sucker absent. 2) Body pigmented. 3) Two eyes and



Figs. 2—7. Fig. 2: Cercaria of *Notocotylus* sp. Fig. 3: Redia of *Notocotylus* sp. No constrictions and with very little yellow pigment. Fig. 4: Redia of *Notocotylus* sp. This redia was provided with a constriction and yellow pigment. Fig. 5: The typical arrangement of the germ balls in the posterior end of the redia of *Notocotylus* sp. Fig. 6: *Cercaria fennica I*. Fig. 7: Redia of *Cercaria fennica I*.

often a median pigment spot present in most species. 4) Pharynx wanting. 5) Penetration organs absent. 6) Excretory vesicle with an often rounded bladder and two wide tubes which reach the anterior end of the body, where they fuse forming a characteristic circuit. The tubes are filled with granules. 7) Cystogenous glands numerous. 8) Tail usually very muscular, undivided.

9) Development occurs in rediae. The cercariae complete their ripening free in the tissues of the snail-host. 10) Life-time of the cercariae usually short; encystment occurs either free or in a mollusc.

According to ROTHSCHILD, a subdivision into three groups can be made on the basis of the form of the anterior portion of the urinary vesicle (urinary tubes).

A. The *'Monostomi'* Group. The anterior transverse part of the vesicle lies posterior to the median eye-spot.

Cercaria of Notocotylus sp.

(*Cercaria imbricata* Wesenberg-Lund 1934 nec Looss)

B. The *'Imbricata'* Group. Not represented.

C. The *'Yenchingensis'* Group. The anterior transverse portion of the vesicle has an anterior finger-like diverticulum.

Cercaria fennica I n.sp.

CERCARIA OF NOTOCOTYLUS sp.

Figs. 2—5.

Adult: member of NOTOCOTYLINAE (*Notocotylus*).

Hosts: birds.

Snail host: *Lymnaea stagnalis, L. peregra,* and *L. palustris.*

Localities: No. 17 (28.VI. 1948, 7.VII. 1952), No. 36 (19.VII. 1947), No. 47 and No. 49 (23.VIII. 1952).

Description:

	Mean of 8 spec. killed with heat	Limits	Cerc. of *Notocotylus seineti* acc. to HARPER (1929)
Cercariae	μ	μ	μ
Length of body	655	520— 815	655
Breadth of body	234	195— 277	180
Length of tail	669	586— 781	600— 650
Breadth of tail	91	82— 98	56
Oral sucker, diam.	61	57— 65	50
Rediae	Mean of 6 spec.		
Length	1400	1025—1800	3000—4000
Breadth	250	210— 310	400— 500
Pharynx, length	80	65— 90	
Pharynx, breadth	73	65— 82	

Cercariae

Owing to the presence of pigment and the well developed cystogenous gland cells, only a few inner structures are visible. This makes the examination of the cercariae difficult. Shape: oval. Locomotoric pockets: not observed.

Colour: The cercariae are opaque, brownish. In unripe specimens the accumulation of pigment in two bands on the dorsal surface is conspicuous, but in fully mature specimens the pigment spreads out all over the body surface. Eyespots: Ripe cercariae possess three pigment spots, unripe cercariae only two. The median »eye-spot» is only an accumulation of pigment. Cuticle: smooth. Gut: In mature cercariae I have seen only the oesophagus. In encysted specimens a short oesophagus and thin diverticula are seen. The diverticula are of uniform breadth throughout and reach to $^2/_3$rds of the body length. Excretory system: The urinary bladder is rounded. The horns of the vesicle fuse behind the middle pigment spot. They are filled with small refractory bodies. Cystogenous glands: These form an unbroken layer below the epidermis. Tail: long, powerful and longitudinally striated. Behaviour: The cercariae are strongly positively phototactic. They encyst within 5—10 minutes after having emerged. Obviously whilst maturing the cercariae lie free in the tissues of the snail host.

Rediae

The rediae are sausage-shaped, and often somewhat bent. They occur in several forms, obviously depending on their age. Some are whitish, unpigmented and usually without constriction (fig. 3). In the same snail there may also occur rediae with yellow pigment and often with sharp constrictions (fig. 4). I think that the yellow rediae are the older. The gut is long, and usually thin and sack-shaped. The gut may also show conspicuous constrictions. The impression was gained that the rediae obtained from *L. peregra* were somewhat larger and less constricted than those obtained from *L. stagnalis* and *L. palustris*. The rediae do not contain more than 2—3 cercariae together with germ balls, of which the anterior are larger than the posterior (fig. 5).

Identification: I was first of the opinion that this cercaria could be identified with *Cercaria monostomi* v. Linstow 1896, which belongs to *Notocotylus seineti* Fuhrman 1919. The descriptions of different authors, however, differ from each other in many points, especially on the size of the cercaria, and on the size, shape and colour of the redia (cf. v. Linstow 1897; Wunder 1923; Dubois 1929; Harper 1929; Wesenberg-Lund 1934). Obviously »*Cercaria monostomi*» consists of several sibling species. I am not able to distinguish between them.

Occurrence: The cercaria of *Notocotylus* sp. has been found only from 4 localities, of which 3 are typical pools and one a deep, narrow bay on Långskär. In loc. No. 36 one out of 12 snails (separated) was infected with it and in loc. No. 49 one out of 10 snails dissected.

Cercaria fennica I n. sp.

Figs. 6 and 7.

Adult: member of *Notocotylidae* Lühe 1909 and perhaps of the genus *Paramonostomum* Lühe 1909 (cf. Rothschild 1941 c).

Hosts: birds?

Snail host: *Bithynia tentaculata.*

Location: digestive gland and gonads.

Locality: No. 26 (3.VII. 1952).

Description:

	Average of 5 specimens	Limits
Cercariae	μ	μ
Length of body	326	296— 351
Breadth of body	129	111— 148
Length of tail	326	259— 370
Breadth of tail	41	37— 44
Oral sucker, diam.	36	33— 37
Rediae		
Length	1080	900—1220
Breadth	270	212— 326
Pharynx, diam.	78	65— 82

Cercariae

Shape: very variable. Typical locomotoric pockets have been seen. Colour: Seen with the low-power microscope the cercaria appears yellow, with the high-power microscope dark brown. The whole body is very opaque owing to the presence of cystogenous glands. Suckers: The oral sucker is remarkably small. Gut: The oesophagus is short; the diverticula reach the posterior part of the body. Excretory system: The urinary bladder is globular; the main lateral collecting tubes form a loop forwards, typical of Monostomous cercariae; they are filled with refractive bodies. Anteriorly there is an unpaired long and slender diverticulum. The tail is fixed to the ventral surface of the body. On the tail are longitudinal striations. When passing from rest to activity several globular thickenings appear on the tail. Of these, the most proximal lies at the end of the tail, the next about halfway and the others beneath one another near the tip of the tail. I was not able to see whether these thickenings move along the tail during its rotatory movements. Eye-spots: In my material, obtained by dissection of snails, about $^2/_3$rds of the cercariae were furnished with three eye-spots and $^1/_3$rd with only two. This is only true of the ripe, swimming specimens.

Rediae

In the rediae I have observed only 2—5 cercariae or germ balls. The intestine is very voluminous and reaches the posterior part of the body. I have not observed any locomotoric appendages.

Occurrence: I have found this species only once in one snail from a large pool on Lillhamn.

Discussion: This cercaria belongs to the Monostomous cercariae without aural lappets or collar (NOTOCOTYLIDAE) and within these it may be placed in the *'Yenchingensis'* Group (created by ROTHSCHILD, 1938 a). A typical characteristic of these cercariae is that the anterior transverse portion of the vesicle horns extends anteriorly, forming an unpaired fingerlike diverticulum. My species differs from *Cercaria triophthalmia* Faust 1930 in being somewhat larger, and in the middle eye not possessing a white centre. My species is much larger than *Cercaria yenchingensis* Faust 1930, being otherwise of similar appearance. The diverticulum of the vesicle is slender and longer than that of *Cercaria lebouri* Stunkard 1932.

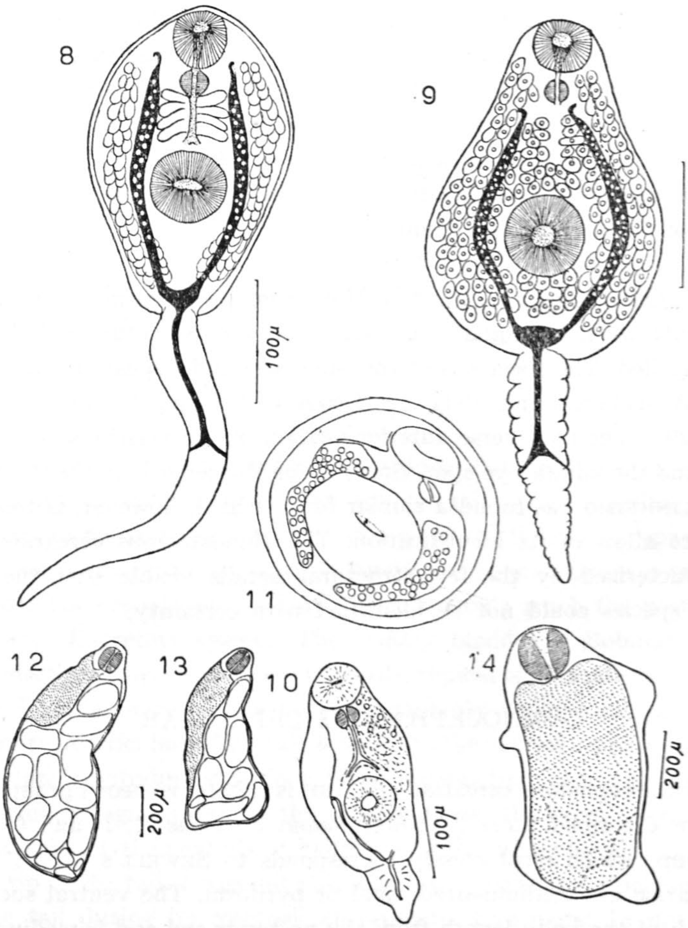
Note: On 3.VII.47 I found a Monostomous cercaria emerging from *Bithynia tentaculata*. Very little was seen of the inner structure and the rediae were not studied. The species is of the same size and appearance as *Cercaria imbricata* Wesenberg-Lund 1934 nec Looss 1893 (syn.? *Cercaria helvetica I* Dubois 1929). The transverse anterior portion of the vesicle is straight and passes behind the middle eye-spot, thus placing the cercaria in the *'Monostomi'* Group. SELINHEIMO has found a similar form, which, however, is too poorly described to allow of its identification. The Monostomous cercariae are so badly characterized by the few structural details visible that these last-mentioned species could not be identified with certainty.

GYMNOCEPHALOUS CERCARIAE

The Gymnocephalous cercariae of LÜHE is a heterogeneous group. Of the species here described three (*Gymnocephalous cercariae A*, *B* and *C*) belong to one group, which most closely corresponds to SEWELL's *'Agilis'* Group. These cercariae are medium-sized, oval or pyriform. The ventral sucker lies $^1/_3$rd to $^1/_4$th of the body length from the posterior end and is medium-sized. The tail lacks a fin-fold. These cercariae encyst in snails or on herbage etc. The fourth Gymnocephalous cercaria here described, the cercaria of *Metorchis* sp., belongs to SEWELL's *'Pleurolophocerca'* Group. The adults of these cercariae are members of the HETEROPHYIDAE and OPISTHORCHIIDAE. The cercariae usually possess a pair of eye-spots. The ventral sucker is absent or feebly developed. The anterior sucker is modified to a penetration organ. Penetration glands are present. The tail is powerful and provided with a fin-fold or a cuticular sheath. The Pleurolophocercous and Parapleurolophocercous cercariae penetrate into a second intermediate host, usually a fish.

The Gymnocephalous cercariae develop in rediae.

The identification of Gymnocephalous cercariae on morphological characters only presents great difficulties. The diagnosis is often dependent on special characters (ROTHSCHILD 1938 b).



Figs. 8—14. Fig. 8: *Gymnocephalous cercaria A*. Fig. 9: *Gymnocephalous cercaria B*. Fig. 10: *Gymnocephalous cercaria B*. An immature cercaria dissected from a redia. Fig. 11: Cyst of *Gymnocephalous cercaria B*. Figs. 12 and 13: Rediae of *Gymnocephalous cercaria B*. Fig. 14: A redia from *Bithynia tentaculata*. Perhaps a mother redia of *Gymnocephalous cercaria B*.

Gymnocephalous cercariae A and B spp.

Figs. 8—14.

The Gymnocephalous cercariae which I have found have given me great trouble with their identification. I think I have observed two species, but I am unable to identify them with certainty with any species known to me. My notes do not fulfil the requirements for a definite identification of Gymnocephalous cercariae, any more than do the descriptions of most authors. Rothschild (1938) has given a list of observations necessary to enable a separation of nearly related species. (*'Pleurolophocercous'* and *'Parapleurolophocercous'* cercariae). Most characters are not morphological but merely take account of differences in behaviour. As an example, one of the characters is the behaviour of the tail after having been cast off from the body. Since I was not acquainted with Rothschild's work, I have mainly noted morphological characters. When it is recalled that only a few morphological details are visible in these cercariae, the possibility of identification may be considered rather slight. I have therefore called the two species described below *Gymnocephalous cercariae A* and *B*.

Snail host: *Bithynia tentaculata.*
Localities: *Cercaria A:* No. 8 (27.VI. 1952), No. 17 (24.VIII. 1948), No. 24 (16.VIII. 1948). *Cercaria B:* No. 17 (3.VI., and 4.VIII. 1948), No. 26 (29.VI.1952).

Description:

	Cercaria A Average of 6 specimens	Limits	*Cercaria B* (one specimen)
Cercariae	μ	μ	μ
Length of body	251	215—305	max. 390
Breadth of body	150	117—195	min. 78
Length of tail	340	312—390	350
Breadth of tail	54	39— 59	39
Oral sucker, diam.	50	39— 59	39
Ventral sucker, diam.	74	66— 86	58
Rediae			
Length			1100
Breadth			410
Pharynx			100 × 140

Cercariae

The dimensions of the two species do not differ significantely from each other. Shape: variable, often pyriform. Suckers: The ventral sucker is much larger than the oral sucker; the ventral sucker lies nearly in the middle of the body. Gut: The praepharynx is very short and can only be seen when the body is extended; the pharynx is large and globular. It is possible to trace the oesophagus to the bifurcation point immediately in front of the ventral sucker. The rest of the gut has not been observed and does not stain specifically with Neutral Red. Excretory system: The urinary bladder is rectangular and large. The tubes of the urinary vesicle run to the pharyngeal region and return again. They are filled with great globules. In *Cercaria A* I have counted the number of globuli as 18—25 on each side. I do not think that any great significance could be accorded to the number and size of the globules. According to my observations the globules in young specimens are more numerous and smaller than in older specimens. In an immature cercaria, dissected from a redia, I have seen the main tubes as short thin canals and the excretory system was very primitive (resembling that of Xiphidiocercariae). The urethra divides about halfway down the tail. In *Cercaria A* the outlet tubes must be very thin, since it is easily seen how, on contraction of the bladder, the urine extends the distal end of the urethra. Tail: very muscular.

Cercaria A	*Cercaria B*
Cuticle: Especially in the posterior part of the body the cuticle is very thick. In the middle of the body I have seen some long bristles. Around the proximal end of the tail the cuticle is inverted, thus forming a diminutive pocket.	The cuticle is not remarkably thick. No bristles or caudal pocket have been seen.
Cystogenous glands: These form a broad band on either side, narrowest anteriorly.	It seems as if these cells fill all the free spaces between the middle and the sides.

The contents of the cystogenous gland cells are sharply stained with Neutral Red.

Cercaria A	*Cercaria B*
Oesophageal glands: Especially when stained with Neutral Red several gland cells appear around the oesophagus. The number cannot be given.	Not observed.

Rediae

Only rediae belonging to *Cercaria B* have been studied. They are very clumsy, equipped with a large pharynx and a short intestine. In one *Bithynia* I found only one redia, which perhaps belonged to *Cercaria B*. It lacked cercariae and germ balls and was filled with a granular, yellow mass with scattered dark particles. Size: 830 $\mu \times$ 360 μ, pharynx 165 μ. The redia had well developed locomotor appendages.

Cysts

Cysts are often seen in large conglomerates on dissection of snails.

Occurrence: Gymnocephalous cercariae are quite common but the degree of infection with them is usually low. The following observations are made: Loc. No. 17: 4 out of 26 *Bithyniae* dissected were infected with *Cercaria B*. In material from Loc. No. 8 I found parthenitae of *Cercaria A* in one out of 25 snails dissected and cysts in two more. In material from Loc. No. 26 3 snails out of 25 were infected with *Cercaria B* and 6 snails were infected with cysts.

GYMNOCEPHALOUS CERCARIA C sp.

Plate I, Fig. 2.

Snail host: *Bithynia tentaculata*.
Locality: Krogarviken (Loc. No. 8) (1933).

This interesting find has been reported by SELINHEIMO. It is a Gymnocephalous cercaria nearly related to the cercaria of *Fasciola hepatica* Linnaeus 1758. The main characters are the same but some striking differences also exist. SELINHEIMO herself assumes her species to be identical with the cercaria of *Fasciola hepatica*. The most striking difference is that SELINHEIMO has found her species in *Bithynia tentaculata*. *Fasciola hepatica* chiefly uses *Lymnaea truncatula* and other *Lymnaeidae* or at least snails of related genera. It is hardly possible that *Fasciola hepatica* here should use *Bithynia* as the first intermediate host, especially since in the same locality *Lymnaeidae* occur in great numbers. The similarities between the two species, on the other hand, are all main characters; especial mention may be made of the bilobed urinary vesicle and the short urethra, which reaches only to $^1/_3$rd the length of the tail. Further, the diverticula lacks a lumen and consists of large cells arranged in a row (see REES (1932 a) for *Fasciola hepatica*). Obviously a very characteristic feature of *Gymnocephalous cercaria C* is a circular, cuticular fold around the ventral sucker. To the inner surface of this fold many muscle fibres adhere. A detailed study of the histology of this species will be given separately. The cercaria encysts in snails (observation uncertain since the cysts may have been confused with cysts of other Gymnocephalous cercariae). The intestine of the redia is noted to be long. Two types of rediae occur, *viz.* smaller rediae with a large pharynx, a collar and locomotoric appendages and larger rediae with a small pharynx and poorly developed collar and locomotoric appendages. The intestine of the redia of *Fasciola hepatica* is very short.

Cercaria helvetica xvii Dubois 1929

Plate I, Fig. 1.

Synonym: *Cercaria obscura* Wesenberg-Lund 1934.
Snail host: *Bithynia tentaculata.*
Locality: Baggby (July, 1933).

Description: The following description is based on Selinheimo's notes.

Cercariae

The dimensions are not recorded. Shape: The very broad tail and the power to alter the form of both the body and the tail are characteristic of this species. Cuticle: smooth on the body. Gut: Only a small pharynx is visible; it is situated half-way between the oral and the ventral sucker. The body is very inconspicuous. Suckers: The two suckers are of nearly equal size; the ventral sucker lies at the posterior end of the body. Penetration glands have not been recorded. Excretory system: The bladder is bilobed and consists of a rounded vesicle in the posterior extremity of the body and a heart-shaped vesicle in the proximal end of the tail. The anterior bladder has remarkably thick, muscular walls. The urethra passes through the tail and ends at its tip. Of other parts only the middle parts of the vesicle tubes are seen. These are filled with granules. Genital anlage: Around the ventral sucker lies an irregular group of small cells which are assumed to be the anlage of the genital organs. Cystogenous glands: Laterally of the main collecting tubes are a number of great rod-cells which stain intensely with Haematoxylin. Tail: The tail is very muscular and provided with deep layers of circular and longitudinal muscle fibres. The longitudinal fibres are in fact oblique, passing from the cuticle to the urethra. The cuticle is provided with long, soft spines (papulae). Behaviour: The cercaria is a good swimmer displaying pronounced positive phototaxis.

Rediae

Around the oral opening the body wall of the redia is folded into several circular folds. Behind the muscular pharynx follows a thin intestine, which reaches the middle of the body. Posteriorly the body is provided with locomotor appendages, but it seems as if the movements of the redia are very slow and minimal. The rediae are filled with germs balls, ripe and unripe cercariae.

Identification: Selinheimo has assumed this species to be identical with Petersen's (1932) *Amphistome cercaria No. 2.* Even though Petersen's description is incomplete and the drawings in many respects incorrect, it could be assumed that these forms are identical. Wesenberg-Lund (1934) has, however, found a cercaria which he assumes to be identical with both *Cercaria helvetica XVII* Dubois 1929 and PETERSEN's *Amphistome cercaria No. 2*. WESENBERG-LUND writes that the cercaria is so peculiar that it must be given a normal systematic name and has used the name *Cercaria obscura*. This mode of nomenclature may, however, be said to be somewhat suspect since so many other cercariae lack normal systematic names, and I have therefore used DUBOIS' name. Since PETERSEN has apparently placed the cercaria in a wrong group his name could not be used.

CERCARIA OF METORCHIS sp.

Plate III, figs. 6 and 7.

Synonym: *Cercaria lophocerca* Filippi 1858.
Adult: *Metorchis (intermedius* Heinemann).
Hosts: sea-birds.
Snail host: *Bithynia tentaculata.*
Locality: Krogarviken (Loc. No. 8) July, 1933.

This species has been found by SELINHEIMO.

Cercariae

The dimensions are not recorded. Shape: oblong. Cuticle: smooth; bristles are not recorded. Gut: Only a short part of the oesophagus is visible. Suckers: The oral sucker is very large; not even rudiments of the ventral sucker have been seen. Penetration glands: invisible. The anterior part of the ducts are thin and pass straight to the vicinity of the anterior end of the body. Cystogenous glands: These fill most of the body spaces and make the inner organs invisible. Excretory system: not observed. Eyes: The cercaria is provided with two eye-spots with a crescent-shaped pigmented part and an anterior 'lens'. The eye-spots lie immediately behind the oral sucker. Tail: very long and fragile and provided with a broad fin-fold.

Rediae

The pharynx of the rediae is small and the intestine short. A collar is absent. The rediae contain a few large 'germ balls' arranged in a single row. The shape of the rediae is very characteristic (plate III, fig. 7).

Identification: The description and the drawings seem to justify the assumption that this cercaria is *Cercaria lophocerca* Filippi (redescribed by DUBOIS 1929). It must, however, be pointed out that ROTHSCHILD (1938) states that scarcely any description of these cercariae can be termed specific, since not all the necessary observations have been made. Following LÜHE (1909) and SEWELL (1922), SELINHEIMO placed it among the Monostomous cercariae. The cercaria belongs, however, without doubt to the Gymnocephalous cercariae. A ventral sucker occurs in younger individuals but it is nearly totally absent in older ones. HEINEMANN (1937) showed that *Cercaria lophocerca* Filippi belongs to *Metorchis intermedius*. *Cercaria lophocerca* Fil. includes, however, several nearly related species.

ECHINOSTOMOUS CERCARIAE

The following are among the features characterizing the Echinostomous cercariae: 1) Oral and ventral sucker of nearly the same size. 2) Pharynx present, but usually small. 3) A head collar occurs. This consists of a number of large spines arranged in a single or double row in the anterior end of the body. The collar spines may be lacking. 4) Urinary vesicle of rectangular form, often bilobed. The main lateral collecting tubes (urinary tubes), which are filled with small granules, reach the anterior end of the body where they form a characteristic loop and pass back again. 5) Tail powerful, undivided. 6) Development occurs in rediae. 7) Encystment occurs in a transport host, usually a mollusc.

The Echinostomous cercariae have been grouped in subgroups. SEWELL (1922) created the groups: *'Echinata'*, *'Coronata'*, *'Echinatoides'* and *'Megalura'*. FAUST (1922) created ten subgroups. The division is, however, rather vague.

The following two species are reported here:

Cercaria of *Echinostoma revolutum* (Frölich 1802) and

Cercaria of *Hypoderaeum conoideum* (Bloch 1782).

CERCARIA OF ECHINOSTOMA REVOLUTUM (FRÖLICH 1802)

Plate II, fig. 5.

Synonyms: *Cercaria echinata* Siebold 1837, *Cercaria A* Tsuchimochi 1926, *Cercaria No.* 7 Nakagawa 1915, *Cercaria limnicola* Faust 1924.

Adult: *Echinostoma revolutum* (Frölich 1802) Looss 1899.

Hosts: many aquatic birds.

Location: caeca and rectum.

Transport host: tadpoles.

Snail host: *Lymnaea stagnalis*.

Locality: Baggby (Tammisaari/Ekenäs).

Description: The description of this species is based on SELINHEIMO's notes.

Cercariae

The dimensions have not been recorded, but the cercaria is said to be very large. It is clearly visible with the naked eye. Shape: The body is of uniform breadth and about twice as long as broad. Collar: The number of spines in the head collar is not given; in the drawing 27 spines are visible. These are said to lie in a single row and only on the dorsal side (?). Suckers: The oral sucker is much smaller than the ventral sucker. The latter is oblong and lies a little behind the middle of the body. Gut: The pharynx is remarkably small and lies immediately behind the oral sucker; the oesophagus divides in front of the ventral sucker and the diverticula reach the posterior end of the body. Both oesophagus and diverticula are cellular. Cystogenous cells: These are small and fill all the free spaces of the body. Penetration glands: not observed. Excretory system: SELINHEIMO has seen only the rounded bladder and the cranial parts of the horns of the vesicle with the typical cranial loops. The horns are filled with small granules. Behaviour: The cercaria is positively phototactic, but not to the same degree as the Monostomous cercariae. Note: The reader is further referred to SELINHEIMO's microanatomical investigations on this species.

Identification: According to SELINHEIMO's notes this cercaria is probably identical with *Cercaria echinata* Siebold. Many facts support this assumption. The rediae, however, are not described, which makes the identification precarious.

CERCARIA OF HYPODERAEUM CONOIDEUM (BLOCH 1782)

Figs. 15—17.

Adult: *Hypoderaeum conoideum* (Bloch 1782) Dietz 1909.
Hosts: *Anas*, *Gallus* and different sea-birds.
Location: intestine.
Snail host: *Lymnaea peregra*.
Localities: No. 32 (27.VI. 1948), No. 42 (11.VIII. 1952), No. 45 and No. 46 (12.VII. 1950).

Description:

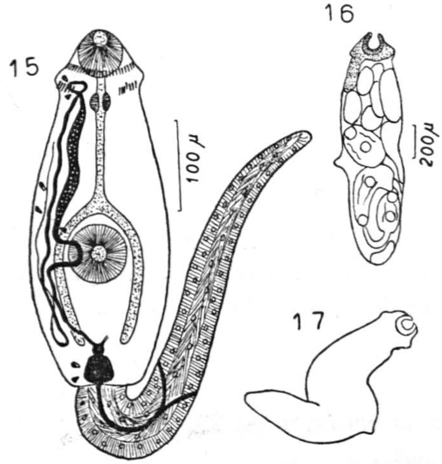
Cercariae	Average of 10 specimens, killed with heat μ	Limits μ
Length of body	400	272—494
Breadth of body	150	136—170
Length of tail	463	430—510
Breadth of tail	50	
Oral sucker, diam.	52	42— 56
Ventral sucker, diam.	80	76— 92
Pharynx	about 20	

Description: (continued)

Rediae	Two specimens
Length	1530—2880
Breadth	288— 425
Pharynx, diam.	119— 136

Cercariae

Cuticle: very thick. Suckers: The suckers are round. The ventral sucker is larger than the oral sucker and lies a little behind the middle of the body. Gut: The praepharynx is short, but is always clearly visible. The pharynx is globular. The oesophagus is long, but the point of bifurcation cannot be clearly seen. Collar: I have seen 25—26 spines on the ventral side in the cranial row, but perhaps there are a few more. The caudal (lateral) row bears 7 spines on each side. MATHIAS (1925) notes the total number of spines to be 50—54; DUBOIS (1929) gives the formula (5) × 13 × 13 × 13 × (5); REES (1932 b) reports as few as 43—45 spines and WESENBERG-LUND (1934) mentions 50 spines, of which 8 lie on each side in a separate row. Excretory system: The urinary bladder is divided into an anterior and a posterior part. These are connected by a narrow canal, in the walls of which I have seen structures which resemble two valves. The function of these is to direct the flow of urine on contraction of the bladder. The main lateral collecting tubes make a loop to the cranial end of the body and back again. Only 8 pairs of flame cells are clearly seen. Anterior and lateral to the bladder are structures which resemble two pairs of flame cells. Cystogenous glands: These lie as a uniform layer on the under surface of the body. Only the anteriormost tip is without these cells. Gonads: A small rounded structure behind the ventral sucker stains intensively with Neutral Red. The tail lacks a fin membrane; it is remarkably muscular. Behaviour: The cercaria shows positively phototactic responses to light. It swims continuously, but seems not to be able to move long distances,



Figs. 15—17. Fig. 15: Cercaria of *Hypoderaeum conoideum*. Figs. 16 and 17: Rediae of *Hypoderaeum conoideum*.

since the swarm of cercariae is always seen to circle around the same snail from which the cercariae emerged. When swimming the cercaria appears spherical.

Rediae

The rediae are sausage-shaped. Their intestine is very short.

Identification: In view of the number of spines, the bilobed bladder, the size and position of the ventral sucker together with the shortness of the redia's intestine, I think this cercaria must be referred to the cercaria of *Hypoderaeum conoideum*.

Occurrence: The cercaria of *Hypoderaeum conoideum* has been found in three snail samples from different localities. All these are pools on skerries in the outermost archipelago. In one sample 3 out of 15 and in another 1 out of 10 snails were infected with it.

XIPHIDIOCERCARIAE

The Xiphidiocercariae display the following characteristics: 1) Both the oral and the ventral suckers are well developed. 2) A penetration apparatus, consisting of a stylet and penetration glands, is always present. 3) The urinary bladder is mostly Y-shaped. The main lateral collecting tubes reach only to the level of the ventral sucker, dividing here into the anterior and posterior collecting tubes. 4) The tail is medium-sized, and undivided. 5) Development occurs in sporocysts. 6) Cercariae encyst in a transport host, often an invertebrate.

The Xiphidiocercariae are very numerous and differ considerably in anatomical structure. They have been taxonomically treated by many authors, and several modes of grouping them have been proposed (cf. *e.g.* LÜHE 1909; LEBOUR 1911; CORT 1915; SEWELL 1922; MCMULLEN 1937 b). The grouping is chiefly based on size-differences, the relative sizes of the suckers, the number and position of the penetration gland cells, the presence or absence of a fin-fold on the tail, and the virgula organ, etc. The groups mentioned below are here included:

'*Cercariae Microcotylae*' Lühe 1909. These are very small cercariae ($< 200\,\mu$) with a small ventral sucker which lies behind the middle of the body, and not more than 4 pairs of penetration gland cells. The gut is poorly developed, usually consisting of the pharynx alone. Development occurs in small, round or oval sporocysts (CORT 1915). The Microcotylous cercariae have been divided into subgroups. Here are described:

Cercaria fennica II n.sp. and

Cercaria cordiformis Wesenberg-Lund 1934.

Cercaria cordiformis Wesenberg-Lund 1934 belongs to SEWELL's (1922) subgroup *'Pusilla'*, characterized by the presence of three pairs of penetration gland cells. *Cercaria fennica II,* together with *Cercaria lophocauda* Faust 1930, possesses only one pair of penetration glands and could not be included in any of SEWELL's subgroups. Accordingly a new subgroup should be created for Microcotylous cercariae with only one pair of penetration glands. The name *'Monoadena'* is proposed. Many objections may, however, be raised against the creation of further subgroups. I cite MILLER (1936, p. 51): ». . . the separation of these subgroups (SEWELL's) by SEWELL's superficial characters is questionable.» A revision of the Microcotylous cercariae must be undertaken in order to obtain a more natural system.

'Cercariae Virgulae' Lühe 1909. These cercariae possess a characteristic virgula organ, consisting of two sac-like structures in the mid-line of the oral sucker (cf. KRUIDENIER 1947 a). To this group belongs *Cercaria helvetica IX* Dubois 1929.

'Cercariae Armatae' Lühe 1909. LÜHE's group *'Cercariae Armatae'* is obviously heterogeneous and may be divided into subgroups. The three species here described belong to the *'Polyadenous'* cercariae Cort 1915. McMULLEN (1937) states that this group is a natural one, seven members, the natural history of which is known at this time, belonging to the family PLAGIORCHIIDAE Lühe 1901 emend. As far as I know, none of the new findings are contradictory. That the identification and classification of species belonging to the *'Polyadena'* group is an extremely difficult task has been shown repeatedly. This is further proved by the simple fact that 67 species of the genus *Plagiorchis* and 60 genera of the family PLAGIORCHIIDAE are known (REES, 1952). Since all these species must also be closely related in the cercarial stage, the specific differences are only difficultly recognisable. In addition to this, the internal anatomy is difficult to work out because of the penetration glands and the cystogenous glands.

Of my three species I have identified two with previously known species and one is described as a new species. However, the two species identified differ slightly from the type species and the one new species shows in many characters great resemblances with other previously known species. Since it is as yet impossible to state what characters are species-specific and how large differences could be tolerated, each author must use his own discretion as to whether or not to create a new species. It thus seems necessary further to elaborate the specific descriptions of Polyadenous cercariae. It would, of course, be very valuable if all workers could agree on a standard method, thus making the descriptions comparable with each other.

To this group pertain:

Cercaria cambriensis I Wright 1927,
Cercaria helvetica XXX Dubois 1929, and
Cercaria fennica III n.sp.

Cercaria fennica II n.sp.

Figs. 18 and 19.

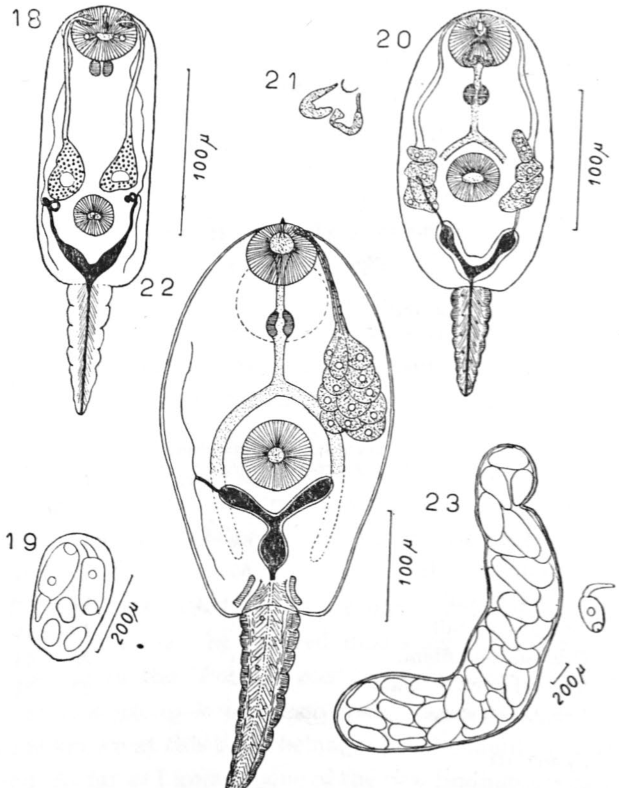
Snail host: *Bithynia tentaculata*.
Location: digestive gland.
Locality: No. 26 (30.VI. 1952).

Description:

	Average of 8 specimens, killed with heat.	Limits
Cercariae	μ	μ
Length of body	164	141—178
Breadth of body	63	52— 82
Length of tail	91	85—100
Breadth of tail	22	19— 26
Oral sucker, diam.	35	30— 44
Ventral sucker, diam.	23	22— 26
Length of stylet	about 15	
Sporocysts		
Length	318	244—407
Breadth	225	163—277

Cercariae

This cercaria is very minute. Shape: elliptical, but can be stretched out so that the body appears rod-shaped. Cuticle: smooth. Suckers: The oral sucker is rounded, and much larger than the ventral sucker. In the oral sucker are two small, light spots. The ventral sucker lacks spines. It is situated far behind the middle of the body. Gut: I have seen only the pharynx, which is very small and lies immediately behind the oral sucker. In Microcotylous cercariae the gut is usually absent or rudimentary. Penetration glands: The cercaria is provided with only one pair of penetration gland cells, situated anteriorly to the ventral sucker. Their content is coarsely granulated and of yellowish-brown tinge. The nuclei are large and vacuolated. The ducts are straight and end at the base of the stylet. The ends of the ducts have thicker walls than the other parts. Stylet: short, but powerful. Excretory system: The urinary bladder is bicornuate. The main lateral collecting tubes go straight to a point beneath the ventral sucker; here they make some loops without,



Figs. 18—23. Fig. 18: *Cercaria fennica II*. Fig. 19: Sporocyst of *Cercaria fennica II*. Fig. 20: *Cercaria helvetica IX*. Fig. 21: *Cercaria helvetica IX*. The virgula organ. Fig. 22: *Cercaria cambriensis I*. Fig. 23: Sporocyst of *Cercaria cambriensis I*.

however, forming a real glomerulus and give off the anterior and posterior collecting tubes. These tubes are very curved. I have seen some short tubules, but no flame cells. The urethra passes through the tail, ending at its tip. Cystogenous glands: Below the epidermis there is a continuous layer of cells with granulated protoplasm. The area between the ventral sucker and the urinary bladder lacks these cells. Tail: At rest the tail is short, but during swimming it is greatly extended. Within the tail is parenchyma. Behaviour: The cercaria swims continuously with rapid movements, being, however, able to move only slowly. Life-span: at least 24 hours.

Sporocysts

The sporocysts are rounded or elliptical. They contain only 2—6 cercariae and some germ balls.

Identification: I know of only one other species of Microcotylous Xiphidiocercariae with only one pair of penetration gland cells. This is *Cercaria lophocauda* Faust 1930 found in *Planorbis möllendorfi* from China. *Cercaria lophocauda* is extremely minute (31 μ long; 26 μ broad; tail 36 μ long with a diameter of 8 μ). The distal end of the tail has a fin-fold.

Occurrence: This species has been found only once and only in one snail.

Cercaria cordiformis Wesenberg-Lund 1934

Plate III, figs. 9 and 10.

Snail host: *Bithynia tentaculata.*
Locality: Krogarviken (Loc. No. 8) (August, 1933).

Description: Selinheimo has found this cercaria.

No dimensions are recorded, but the cercaria is said to be very small. Comparing with other cercariae, I have obtained some very approximate measurements.

Length of body	150—250 μ
Breadth of body	50—100 μ
Length of tail	150—200 μ

Cercariae

Shape: The cercaria is broadest anteriorly. When creeping under the cover glass, the form is very variable. The oral sucker protrudes, forming a tip to the body. Suckers: The oral sucker is much greater than the ventral one. According to the description the ventral sucker lies near the middle of the body, but judging from the drawing it is situated somewhat more posteriorly. Gut: The praepharynx is very short, the pharynx is large. The oesophagus can be followed to the ventral sucker, but diverticula are not seen. Penetration glands: There are four pairs of penetration glands in front of the ventral sucker. No dissimilarities in the granulation of the different pairs can be detected. The ducts are thin and go straight to the oral sucker. Excretory system: The urinary bladder alone has been observed. This is bicornuous with a flat middle part. Gonad anlage: Around the ventral sucker there are four cell groups. The tail is long and slender and is inserted in a caudal pocket of the body.

Sporocysts

These are stated to be elliptical. Judging from the drawings they are filled with a great number of cercariae. Small globular bodies are often connected to the outer side of the sporocysts. Under these bodies the sporocyst wall consists of a thick many-layered epithelium. I have no idea of the nature of these structures.

Identification: SELINHEIMO has made no proposals concerning the identification of the species. Under such circumstances it is very difficult to draw any definite conclusions. In many respects the cercaria resembles *Cercaria cordiformis* Wesenberg-Lund 1934. The only dissimilarity which could, perhaps, be given decisive significance seems to be that in *Cercaria cordiformis* only a few cercariae develop simultaneously in the sporocyst, but that in SELINHEIMO's species the number of cercariae in the sporocysts is apparently much greater. The species differs with regard to this same character from the very similar *Cercaria helvetica XII* Dubois 1929.

CERCARIA HELVETICA IX DUBOIS 1929

Figs. 20 and 21.

Snail host: *Bithynia tentaculata.*
Locality: No. 52 (2.VII. 1947).

Description:

Recorded on a few living specimens.

Cercariae	Extended μ	Contracted μ
Length of body	260	175
Breadth of body	70	158
Length of tail	195—210	52—70
Oral sucker, diam.	77	
Ventral sucker, diam.	35— 42	

Cercariae

Cuticle: thin and at least in the anterior end of the body furrowed concentrically to the oral sucker. Colour: whitish. Suckers: The oral sucker is much larger than the ventral one; the virgula organ is clearly seen. Gut: I have seen only a short praepharynx, a rounded pharynx and a part of the oesophagus, and the diverticula anterior to the ventral sucker. Penetration glands: The cercaria is provided with four pairs of penetration gland cells which lie laterally and posteriorly of the ventral sucker. The form of the cells is not quite elliptical. DUBOIS has described the two anterior cells as larger and more coarsely granulated than the two posterior cells. Stylet: large. Excretory system: The bladder is bicornuate and with thick walls. The ends of the horns are bladderlike. Of the tubes I have seen only the main lateral collecting tubes, which run straight forward to the level of the ventral sucker. The urethra passes through the tail and ends at its tip. Tail: very extensible.

Identification: The cercaria resembles in all essential points *Cercaria helvetica IX*, described by DUBOIS (1929).

Occurrence: This species has been found only once from *Bithynia tentaculata* collected from an intralitoral sea-water basin on a small skerry in the outermost archipelago.

CERCARIA CAMBRIENSIS I WRIGHT 1927

Figs. 22 and 23.

Adult: member of PLAGIORCHIIDAE.
Hosts: birds?
Larval hosts: *Lymnaea stagnalis* and *L. palustris*.
Localities: No. 26 (1.VIII. 1948), No. 33 (5.VI., and 16. VIII. 1948), No. 36 (19.VII. 1947).

Description:

	Measured on a few living specimens
Cercariae	μ
Length of body	350— 470
Breadth of body	240— 155
Length of tail	185— 470
Breadth of tail, contr.	60
Oral sucker, diam.	78
Stylet, length	22
Ventral sucker, diam.	78
Sporocysts	
Length	2600—3300 and more
Breadth	about 500

Cercariae

Shape: The body is oval. Colour: milky-white, owing to the presence of minute oil droplets. Cuticle: smooth. Suckers: The two suckers are of equal size. Gut: The praepharynx is short; the pharynx is small and rounded; the oesophagus bifurcates a short distance anteriorly of the ventral sucker. I am not quite certain regarding the length of the diverticula. In mature cercariae it seems as if these reach the posterior end of the body. On staining with Neutral Red, it seems that the lumen ends at the level of the horns of the urinary vesicle and that the diverticula continue as a compact (cellular) rope. In unripe cercariae prepared from sporocysts the intestinal lumen reaches only to the posterior edge of the ventral sucker. Stylet: This is very powerful, with proximal and distal projections. Penetrations glands: There is a compact bunch of penetration gland cells on each side situated anterolaterally of the ventral sucker. Their location changes in different extension and contraction stages of the body, but at rest the posterior edge of the bunch lies level with the anterior border of the ventral sucker. I have concluded that the number of cells in each bunch is 12, but the cystogenous cells make the study of the penetration gland cells rather difficult. The exact number may be 11—13. Cystogenous cells: Beneath the epidermis is an apparently homogeneous layer of granular cystogenous cells. Only a rounded region between the pharynx and the oral sucker is non-granulated and seems to lack such cells. Perhaps there are mucin glands here (Kruidenier 1947 b). Excretory system: Of the excretory system only the remarkably large trilobed vesicle and the short, straight main lateral collecting tubes with the anterior and posterior collecting tubes have been observed. In my annotations the rhythm of the urinary bladder is described in the following manner: the middle part contracts, whereupon it is immediately filled with the content of the horns. Tail: The tail is short when contracted, but is capable of enormous extension at swimming. A fin-fold has not been observed. The proximal end of the tail projects into a deep caudal incision. Around the caudal pocket appears a structure staining distinctly yellowish with Neutral Red. This structure resembles a sphincter muscle. I have not seen anything similar in other cercariae. Other characteristics: There are no large oil droplets such as occur in *Cercaria fennica III*. The cystogenous glands in *Cercaria cambriensis I* are prominent. Behaviour: The cercaria is a rather poor swimmer. Long resting periods (sinking) are followed by swimming periods (ascents). The sinking of the cercaria is remarkably slow. When sinking the body is bent: the dorsal surface is directed downwards and the ventral surface forms a shallow cup. The tail is directed upwards. In flat dishes the cercaria may be seen lying on the bottom in this position for some time until the swimming period begins. During swimming the tail performs propeller-like movements, driving the body straight upwards. The activity is increased by shadow stimulation.

Sporocysts

These are thick, sausage-shaped sacs which are filled with a great number of ripe and unripe cercariae. The shape is variable, but usually the sporocysts are slightly bent. The wall is thin and contains orange granules (droplets?) which give the sporocyst a clearly orange tinge.

Identification: This cercaria resembles in many details *Cercaria cambriensis I* Wright 1927, which has been redescribed by Rees (1932 a). Wright found it in *Lymnaea truncatula* and Rees in this same snail species and in *L. peregra*. The dimensions of both cercariae and sporocysts, the colour of the sporocysts and all the main characters of the cercariae are the same. The small spines in the subcuticle and the bristles recorded by REES have perhaps been overlooked by me. It may be noted that WRIGHT has not mentioned the presence of such structures. In *Cercaria cambriensis I* the urethra is said to be short and to open on the dorsal side of the caudal incision. In *Cercaria fennica III* I have seen a similar structure, but in my drawings of the species here referred to *Cercaria cambriensis I* the urethra is seen to pass through the tail. Perhaps my drawing is on this point incorrect. According to HUSSEY (1941) the excretory tubes in developing stylet cercariae never enter the tail. He assumes that muscular elements have been mistaken for an excretory tube and figured as such. Thus this character is of little or no value. In my specimens the bunch of penetration gland cells lies somewhat more posteriorly than in *Cercaria cambriensis I*. REES has observed the cercaria encysting in tadpoles of *Rana temporaria*. My specimens showed no affinity for Chironomid larvae, which perhaps may indicate that their second intermediate host is not an invertebrate. According to REES (1931) *Cercaria cambriensis I* emerges from the snail hosts during the whole twenty-four hours, but in considerably greater numbers during the night-time.

The species here described may also be identical with *Cercaria helvetica V* (= *VII*) Dubois 1929. DUBOIS found this species from *L. stagnalis, L. palustris* and *Planorbis planorbis*. He mentions that there are differences in size between the cercariae emerging from different snail species. The cercaria is nearly related to *Cercaria polyadena* Cort 1915, which may be identical with the cercaria of *Plagiorchis proximus* Barker 1915 (cf. MCMULLEN 1937). It must be refered to CORT's group *'Polyadenous'* cercariae.

Occurrence: In my notes this cercaria has been to some extent confused with other species. It is known with certainty to occur in two small pools, of which, curiously enough, at least one contained tadpoles (compare p. 83). In the one case 4 out of 20 and in the other case 6 out of 12 snails were infected with it.

CERCARIA HELVETICA XXX DUBOIS 1929

Figs. 24—26.

Adult: member of PLAGIORCHIIDAE, probably a parasite of birds.

Snail hosts: *Lymnaea stagnalis, L. peregra,* and *L. palustris.*

Localities: No. 12 (5.VIII. 1952), No. 46 (13.VII. 1950), Nos. 47 and 48 (23.VIII. 1952).

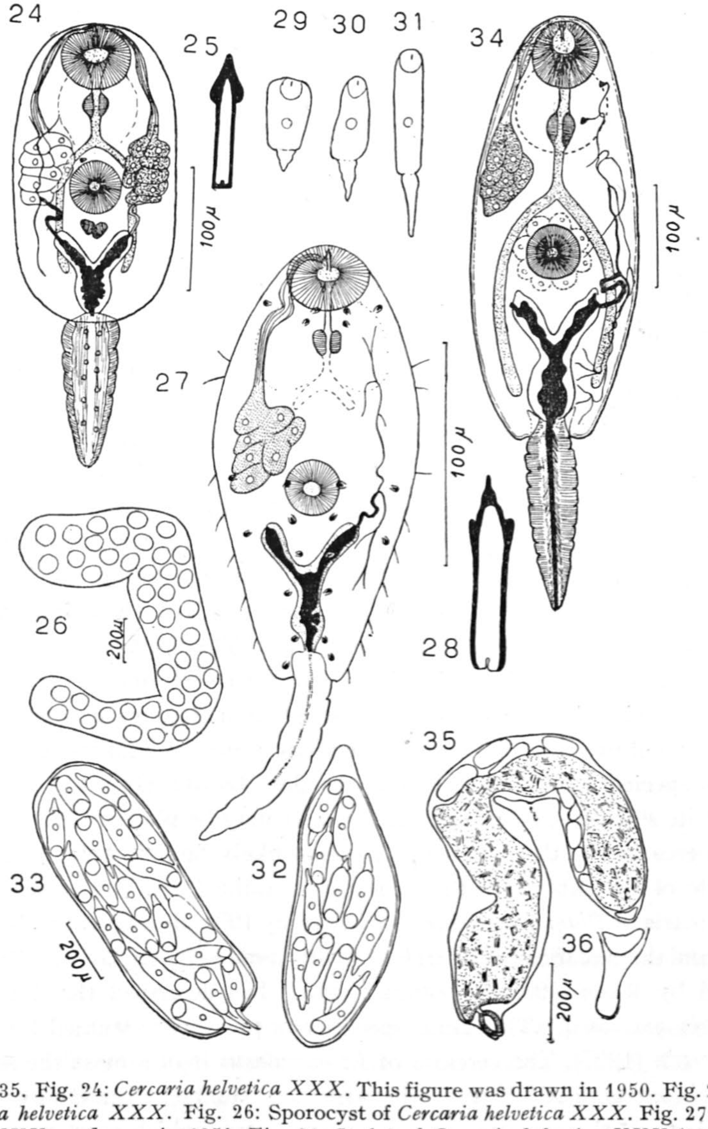
Description:

	Own measurements Mean of 6 specimens killed with heat.	Limits	According to DUBOIS
Cercariae	μ	μ	μ
Length of body	239	222— 252	150— 350
Breadth of body	106	96— 115	45— 120
Length of tail	185	155— 212	50— 270
Breadth of tail	30	26— 33	20— 36
Oral sucker, diam.	53	52— 56	50— 54
Ventral sucker, diam.	32	30— 33	30— 36
Stylet, length		26	{26— 30 / 30— 36}
Sporocysts	Mean of 5.		
Length	2170	1960—2450	500—1500
Breadth	294	261— 310	160— 225

Cercariae

Shape: elliptical. The power of altering the body form is great. Colour: transparent to white. Cuticle: The surface is cross-striated by two perpendicular sets of striae. No spines or bristles have been observed. Suckers: The oral sucker is much larger than the ventral one. Otherwise the suckers are of usual structure: rounded and very little protrusible. No spines have been seen on them. Gut: The praepharynx is remarkably extensible, but is not seen when the body is contracted; the pharynx is small and globular; the oesophagus reaches the ventral sucker in front of which it bifurcates into the diverticula. The diverticula are probably very thin and I have been able to follow them with certainty only to the level of the ventral sucker, but I think that they continue as compact ropes of cells, reaching the posterior extremity of the body. Penetration glands: 8 pairs of penetration gland cells occur. They form a compact bunch on each side, situated laterally and laterocaudally of the ventral sucker. The protoplasm is finely granulated and the nuclei are small. The cells are oblong transverse (to the long axis of the body); this being a good character for the species. The ducts consist of several finer ducts, presumably one for each gland cell. Cystogenous glands: These lie scattered in the body and do not form a continuous layer. A rounded area between the suckers is without these cells. Stylet: powerful in comparison with the body size (fig. 25). Excretory system: The urinary vesicle is bicornuate, consisting of an unpaired posterior part and the two, large horns. The vesicle does not reach the ventral sucker. Between the horns and the unpaired part is an effective sphincter. The rhythm of the contraction seems to be as follows:

the horns empty their contents into the middle part, whereupon this immediately contracts. I have not been able to detect the urethra and it is possible that this is very short, since it could easily be seen that the furrow between the caudal incision and the tail expands on contraction of the bladder (cf. p. 37).



Figs. 24—35. Fig. 24: *Cercaria helvetica XXX*. This figure was drawn in 1950. Fig. 25: Stylet of *Cercaria helvetica XXX*. Fig. 26: Sporocyst of *Cercaria helvetica XXX*. Fig. 27: *Cercaria helvetica XXX* as drawn in 1954. Fig. 28: Stylet of *Cercaria helvetica XXX* (1954). Figs. 29—31: Different stages of contraction of *Cercaria helvetica XXX* (1954). Figs. 32 and 33: Sporocysts of *Cercaria helvetica XXX* (1954). The tails of three cercariae protrude through a pore at one end (fig. 32). Fig. 34: *Cercaria fennica III*. Fig. 35: Redia of *Cercaria fennica III*. Fig. 36: The protrusible caudal end of the redia of *Cercaria fennica III*.

The main lateral collecting tubes are short and only very little coiled. They bifurcate laterally to the ventral sucker into the collecting tubes, which are only slightly curved. I have been able to detect only two pairs of flame cells; these lie immediately in front of the ventral sucker. Gonad anlage: Behind the ventral sucker are seen two bodies with a homogeneous appearance. Around the ventral sucker there is similar tissue. Tail: To the outside is a circular muscle layer, beneath it a longitudinal layer and innermost loose parenchyma. The proximal end of the tail is inserted into an incision. Other character: No large oil droplets occur in the body. Behaviour: In 1952, when the species was studied, cercariae were obtained only from dissection of snails. Most probably each snail host produces large amounts of cercariae.

Sporocysts.

The sporocysts are tinged yellowish-brown. They are filled with a great number of unripe cercariae and germ balls.

Identification: The cercaria described agrees very well with *Cercaria helvetica XXX* Dubois 1929. The size, the number of penetration gland cells, and the size and the position of the Y-shaped urinary vesicle are the same. Slight differences that may be mentioned are that in my specimens the bunch of penetration gland cells lies somewhat more posteriorly than in Dubois' specimens, and that the sporocysts measured by me are larger than those measured by Dubois. According to Dubois individuals with both smaller (26—30 μ) and larger (30—36 μ) stylets occur. The specimens measured by me possessed a short stylet (26 μ). The cercaria is extremely common in the region of Neuchâtel and Dubois has studied its biology extensively. Dubois has experimentally infested *Asellus aquaticus, Chauborus* larvae and tadpoles with this species. The cercaria belongs to the *'Armata'* Group in spite of the fact that its size exceeds the critical 250 μ. It may be placed with the *'Polyadenous'* cercariae of Cort (1915). It seems likely that it belongs to a bird trematode of the subfamily Plagiorchinae Lühe 1901. It is nearly related to the cercaria of *Plagiorchis microcanthus* Macy 1931, described by McMullen (1937 a) and the cercaria of *Plagiorchis (Multiglandularis) megalorchis* Rees 1952, described by Rees (1952). Strenzke (1952) has described the life cycle of *Plagiorchis maculosus*. The same species was previously studied by Nöller and Ullrich (1927). The cercaria of *P. maculosus* is of almost the same size as *Cercaria helvetica XXX* and otherwise, too, similar. Strenzke only gives a microphoto of the cercaria, a mode of description which must be said to be virtually useless, since a microphoto can never give all the information needed. It would, however, in many cases be valuable if a drawing were supplemented by a microphoto. Further *Cercaria helvetica XXX* shows many resemblances with *Cercaria sudanensis No. 2* Archibald and Marshall 1931, *Cercaria cambriensis III* Rees 1932, *Cercaria intermedia* Wunder 1923, *Cercaria steganocoela* E. L. Miller 1935, *Cercaria acanthocoela* E. L. Miller 1935, *Cercaria tricystica* E. L. Miller 1935, *Cercaria holthauseni* Rankin 1939, *Cercaria diamondi* Brooks 1943, and *Cercaria goodmanni* Najarian 1952.

Occurrence: This cercaria has been found in only two localities: the one being an open shore in the outer archipelago (Brännskär) where only one out of 15 snails was infected with it, and the other a pool on Äggharun (1 out of 10 infected).

Addenda: In 1954 I found a Xiphidiocercaria emerging from *Lymnaea palustris* taken in Loc. No. 8. This cercaria closely resembles *Cercaria helvetica XXX* Dubois 1929 as described above. There are, however, some differences which may or may not be due to earlier insufficient observations on *Cercaria helvetica XXX*. The cercaria found in 1954 was carefully examined and I give a partial description on points differing from the above description of *Cercaria helvetica XXX* (see figs. 27—33).

	Mean of 7 specimens killed with heat	Limits
Cercariae	μ	μ
Length of body	176	160— 198
Breadth of body	94	77— 107
Length of tail	135	111— 149
Breadth of tail	28	23— 32
Oral sucker, diam.	48	38— 53
Ventral sucker, diam.	31	30— 32
Stylet	30	
Sporocysts	Mean of 5 specimens	
Length	940	715—1070
Breadth	335	330— 358

Cercariae

It is seen that the cercaria found in 1954 is smaller than that above described.

Shape: The body shape varies between rounded or quadrangular to rod-shaped at different stages of contraction or extension. Colour: The bunches of penetration glands appear slightly yellowish in the otherwise milky-whitish body. Cuticle: 5—10 long (sensory) hairs have been seen on each side. Gut: At maximal extension the length of the praepharynx is about half the diameter of the oral sucker. The pharynx is relatively large. The oesophagus is very short, bifurcating about halfway between the oral and ventral suckers. The visible parts of the diverticula are very short. In an unripe cercaria the diverticula were seen to reach the posterior extremity of the body. Penetration glands: 7—9 gland cells on each side. In the contracted stage these are about 3—4 times broader than long. The bunches reach to the level of the ventral sucker. Stylet: with small shoulders and no basal thickenings. Excretory system: The walls of the bicornuate vesicle are thick, and granulated, and form projections into the lumen. The main lateral collecting tubes are short and curved. They divide into the lateral collecting tubes, which in turn divide into several tubules. The flame cells are partly covered by the cystogenous glands, so that it proved very difficult to follow all the finer details. The flame cells observed appear from the figure. Probably there are 16 flame cells, as in most *'Polyadenous'* cercariae. The urethra was not seen. In the proximal $^2/_3$rds of the tail there seems to be a narrow canal, which, however, ends without any signs of lateral outlet tubules, nor it is possible to see the urine flow through this canal on contraction of the bladder. It thus seems as if the urethra were very short, perhaps opening in the caudal incision. Behaviour: The cercariae emerge chiefly in the afternoon and in the night hours. After emergence, the cercariae swim continuously with very vigorous movements in the upper water layers. Apparently after about 12 hours the swimming movements slow down and the cercariae begin to sink. Later they are found creeping on the bottom, now and then ascending by swimming a few centimetres above the bottom. The life-span of the cercariae is at least 24 hours.

Sporocysts

Shape: oval to sausage-shaped. Colour: light yellowish. The sporocyst wall is very thin. I have seen 15—20 cercariae in the sporocysts. At one end of one sporocyst I saw an opening, perhaps a birth pore. One end of the sporocyst usually protrudes in a small tip.

Discussion: This cercaria differs from *Cercaria helvetica XXX* (as described above) mainly in its smaller size and its shorter oesophagus. The bunch of penetration gland cells lies somewhat more anteriorly than in *Cercaria helvetica XXX*. The shape of the stylet is also different. All other differences may be due to insufficient observations. If this cercaria in turn is compared with one typical Plagiorchid cercaria, such as the cercaria of *Plagiorchis megalorchis* Rees 1952, as this was described by Rees in 1952, it is obvious that all the main characters are identical in these species, only the sizes being somewhat different, the cercaria of. *P. megalorchis* being somewhat larger. It seem almost impossible to make a definite identification.

Occurrence: 2 out of 15 *L. palustris* were infected with this trematode.

CERCARIA FENNICA III n.sp.

Figs. 34—36.

Adult: member of PLAGIORCHIIDAE.

Hosts: birds.

Larval hosts: *Lymnaea stagnalis*, *L. peregra*, and *L. palustris*.

Localities: No. 8 (7.VI., 17.VI. 1954), No. 31 (26.VII. 1952), No. 36 (18.VI. 1950, 16.VII. 1952), No. 38 (4.VIII., 18.VIII. 1948, 20.VII. 1952), No. 39 (25.VI. 1950), No. 40 (29.VI. 1950, 20. VII. 1952), No. 42 (1.VII. 1950), No. 44 (11.VII. 1950), No. 45 (11.VII. 1950), No. 46 (11.VII. 1950), No. 48 (23.VIII. 1952), No. 49 (23.VIII. 1952), and No. 50 (25.VIII. 1948).

Description:

Cercariae	Mean of 5 specimens, killed with heat. μ	Limits μ	*Cercaria helvetica IV* according to DUBOIS μ
Length of body	394	340—425	170—450
Breadth of body	194	170—221	55—160
Length of tail	248	238—255	60—350
Breadth of tail	34	34	45
Oral sucker, diam.	89	84— 92	60
Ventral sucker, diam.	70	68— 72	35

Cercariae

Shape: elliptical. Colour: Some differences exist between the cercariae emerging from different snail hosts. Those from *L. stagnalis* are often more transparent than those from *L. peregra*. Seen with lower magnification the cercariae appear milky-whitish or at least the bunch of penetration glands stands out as white spots in the otherwise nearly translucent body. Cuticle: The cuticle is remarkably thick and of characteristic structure. It consists of two layers, an outer hyaline layer and an inner layer, which is apparently prismatic, with the prisms (cells) arranged perpendicularly to the surface. It is, however, possible that this effect is due of the presence of minute pores penetrating the inner layer. Similar structures in related cercariae have often been explained as minute spines, not reaching the surface (cf. DUBOIS 1929; REES 1932; SELINHEIMO, in press). The outer layer is often seen to swell enormously at points where it has been damaged by the pressure of the cover-glass. This phenomenon seems to me to lend support to the assumption of a pore structure. Small papillae or spines are seen at least in the anterior part of the body. Furthermore there are some bristles (4—7 simultaneously visible on each side) corresponding in length to 5—6 times the thickness of the cuticle. Suckers: The oral sucker is much larger than the ventral one. The ventral sucker bears a row of very small spines near its periphery. Around the ventral sucker lie a circle of large cells. Gut: The praepharynx is long; the pharynx is globular and large; the oesophagus bifurcates about halfway between the pharynx and the ventral sucker. The diverticula reach the posterior extremity of the body and are of uniform thickness throughout. Especially in young, not quite mature, specimens it could be observed that the lumen reaches only halfway down the diverticula. On staining with Neutral Red the narrow lumen of the diverticula is clearly seen. Probably the diverticula are of cellular structure, as in many Xiphidiocercariae. Penetration glands: The exact number of penetration gland cells is difficult to count, though it is fairly low. After careful observation I think there are 8 pairs. The 8 cells on each side lie in a close bunch, situated between the pharynx and the anterior border of the ventral sucker. When the cercaria contracts the bunch shifts posteriorly. All the cells are similar and are filled with very fine granules. The nuclei are large. The ducts are short and obviously composed of several finer ducts (one from each gland cell). Beneath the oral sucker the ducts enlarge, the walls are thick and finely granulated. Nuclei have not, however, been seen here. Perhaps the single ducts unite here, since each bunch seems to open with a single opening. Stylet: large. Cystogenous glands: Beneath the epidermis lies a thick layer of cystogenous gland cells. Only a small area behind the oral sucker lacks such cells. Excretory system: The urinary vesicle is very large, consisting of an unpaired posterior part and two large horns which reach the ventral sucker. The walls are thick and granulated, obviously of cellular structure. The inner surface forms small folds projecting into the lumen. Contraction begins with the emptying of the middle part, which is then filled up with the content of the horns. I have not seen any urethra in the tail, but I have observed that the furrow between the tail and the caudal incision widens at emptying of the vesicle. Perhaps the urethra is short, opening in the caudal incision (cf. p. 37). The main lateral collecting tubes are short and make a characteristic S-shaped curve before branching into the anterior and the posterior collecting tubes. I have seen at least the main part of the tubules (cf. figure), but only two flame-cells in the anterior end of the body. Other characteristics: In the body large oil droplets occur. Tail: The tail is very muscular, provided with a thick circular and a thinner longitudinal muscle layer. Behaviour: The cercaria swims vigorously and without fixed resting periods. When the cercaria is exhausted the active periods are followed by irregular sinking periods, the cercaria often sinking to the bottom of the vessel. The swarm of cercariae is then seen to move near the bottom. From one snail only a few cercariae (20—50) emerge each morning. The life-time of the cercaria is at least 60—70 hours. The cercaria has been observed to penetrate into Chironomid larvae.

Sporocysts and rediae

The Xiphidiocercariae usually develop into sporocysts. Rediae do, however, also occur (cf. AZIM 1935 and MCMULLEN 1937 b, p. 249). My notes regarding *Cercaria fennica III* have given me very much trouble, since it seems to be convincingly stated that rediae of this species have also been found. The first note is from 1948 when a 'redia' was drawn (fig. 35) and in 1950 measurements on 7 'rediae' were made. In 1952 this species was frequently found. In this year I have noted that on dissection of a snail a sporocyst was observed »which closely resembles the rediae, but lacks pharynx and intestine». Thus it seems as if in this species both sporocysts and rediae occur. If I succeed in finding this species again I shall correct this statement if necessary. The rediae observed are short and clumsy and of nearly equal breadth throughout. On 7 specimens I have observed the following sizes: Length 1010 μ (765—1530), breadth 270 μ (204—425). The pharynx is large and the intestine long and broad, reaching to the posterior end of the redia. The sporocyst is similar, and sac-like. Both sporocysts and rediae are of a greyish tinge. The rediae are filled with a few ripe cercariae and a small number of germ balls.

Identification: The cercaria here reported is very similar to, if not identical with, *Cercaria helvetica IV* Dubois 1929. The dimensions of the body and the tail are the same, but the suckers of *Cercaria helvetica IV* are smaller. The oil droplets in the body (»gouttelettes») are also said to be very characteristic of *Cercaria helvetica IV*. DUBOIS reports that the different penetration gland cells stain in a different manner with Carmine; at least in the living state all the penetration gland cells of my species appear similar. *Cercaria fennica III* is also nearly related to *Cercaria cambriensis III* Rees 1932, being, however, somewhat smaller. There exist a large number of Polyadenous Xiphidiocercariae with 8 pairs of penetration gland cells (cf. p. 40).

Occurrence: *Cercaria fennica III* was, together with the cercaria of *Diplostomum spathaceum*, the commonest species found. It occurs only in pools. It must be kept in mind, however, that some of the recordings of *Cercaria fennica III* may be erroneous and that a confusion with other related species occurred in 1947—48. The degree of infection with *Cercaria fennica III* varies within wide limits. I refer the reader to the list of material.

Note: SELINHEIMO has found a large Xiphidiocercaria of the '*Polyadena*' Group (plate II, fig. 4). The main characters given are: The ventral sucker is much smaller than the oral sucker. Seven pairs of penetration gland cells are present. The oesophagus is short, dividing about halfway between the oral and the ventral suckers into long, slender diverticula. The urinary bladder is Y-shaped. The sporocysts are large, of varying length and breadth. They contain large numbers of cercariae and germ balls.

This cercaria is said to have been the commonest species occurring in SELINHEIMO's material and it was found mainly in *Lymnaea stagnalis*, but also in *L. peregra* and *L. palustris*. In the bay of Baggby it was also common in *L. auricularia*.

The identification of this species with the aid of SELINHEIMO's description is somewhat difficult, especially since the dimensions are not given. SELINHEIMO herself writes that this species strongly resembles *Cercaria Limnaeae ovatae* v. Linstow.

PENETRATION OF XIPHIDIOCERCARIAE INTO THEIR SECOND INTERMEDIATE HOSTS.

Only some scattered observations have been made on the penetration of Xiphidiocercariae into Diptera larvae. These observations are in full concordance with the numerous previous investigations on this subject. In summer 1947 I made some experiments with a Xiphidiocercaria, the species being, however, at this time so poorly described that a definite identification could not be made. The cercaria is a medium-sized Polyadenous cercaria. All the following experiments were performed in small watch-glasses, containing some 3 cc. of water.

1. 30 cercariae were placed in a watch-glass together with a stickleback (*Gasterosteus aculeatus* L.) of 1 cm. length. No orientated movements could be recognized, but owing to the movements of the fish some cercariae fastened on it without, however, trying to penetrate.

2. 10 cercariae were placed in a watch-glass together with a living *Chironomus* larva (sp. indet., length about 1 cm.). Three cercariae immediately fastened on the larva. Within about 2 min. one of them had penetrated and was seen to creep between the muscles of the larva. The other two were cast off by the vigorous lashings of the larva.

3. 10 cercariae + a small *Chironomus* larva (sp. indet., length about 0.7 cm.). Immediately many cercariae sprang at the larva and penetrated easily. Some cercariae penetrated within 1 1/2 min.

4. A great, red *Chironomus* larva (sp. indet., length more than 1.5 cm.) which had previously been narcotized with chloral hydrate and then well rinsed in running tap water was placed in a watch-glass with 10 cercariae. In the course of the experiment the larva awakened, but moved only slowly. Before the larva moved the cercariae showed no interest in it. It even happened that cercariae crawled on the larva without making any attempts to penetrate. Two hours after the larva had awakened, all cercariae had penetrated.

These observations are nearly identical with those of WUNDER (1923 a) on *Cercaria intermedia* Wunder 1923, a related species. The most interesting point is that the cercariae showed no tendency of chemotaxis and especially that the movements of the Chironomid larvae seemed to be of decisive importance as a releasing stimulus for the penetration movements. WUNDER has, however, seen *Cercaria intermedia* making attempts to pierce even *Planorbarius* shells.

Some other observations were made with another Polyadenous Xiphidiocercaria. In this case 15 cercariae were placed in a watch-glass with a *Chaoborus* larva. No accumulation of cercariae could be recognized, but soon one cercaria fastened on the larva and presumably tried to penetrate, since the larva began to move vigorously, with the result that the cercaria was cast off. Now the head of the larva was crushed and held with forceps, the movements of the larva thus being slowed. 30 min. later a new cercaria fastened and penetrated within about 7 min. The cercaria encysted rapidly; the tail was cast off at penetration.

The above example shows that animals with very vigorous movements may be well protected against cercaria invasion. This observation is not in full concordance with REES's (1952, p. 111) statement on a Polyadenous Xiphidiocercaria: »Cercariae do not seem to be dislodged by the flexions of the body (*Chironomus riparius* Meigen) once the suckers have gained a firm hold.»

I have also made some experiments with a glass tube, in which the cercariae could be placed in the middle and press juice of fish or chironomid larvae could be added at one end. No orientated distribution of the cercariae within the glass tube was recognized. It seems as if chemotactic responses were only poorly developed in cercariae (WUNDER 1923 a, b, DAWES 1946). Light, shadow and touch stimuli, on the other hand, play a great rôle in the orientation of cercariae (MILLER 1926 a, 1928; MILLER and MAHAFFY 1930; RANKIN 1939). I have frequently observed on various cercariae that shadow stimuli activated the natatory movements (especially the transition from rest to swimming).

FURCOCERCOUS CERCARIAE

The Furcocercous cercariae are characterized by their bifurcate tail. The oral sucker is a muscular and spinous organ for penetration (»anterior organ» according to MILLER 1926 b). Penetration glands usually occur. The development occurs in sporocysts.

Different modes of division into smaller groups have been proposed. LÜHE's (1909) subdivision is here followed, with references to H. M. MILLER's (1926) subdivision.

Representatives of the following groups have hithertho been found in Finland.

The *'Ocellata'* Group (apharyngeal, brevifurcate Distome cercariae according to MILLER). These cercariae are large and provided with two eye-spots and large penetration gland cells (5 pairs). A pharynx is lacking. They develop into blood parasites (Schistosomatids). This group is represented by *Cercaria ocellata.*

The *'Strigea'* Group (pharyngeal, longifurcate Distome cercariae according to MILLER). Cercariae with penetration glands placed in front of the ventral sucker. They use invertebrates as the second intermediate host. Encysted stage: Tetracotyle. As adults intestinal parasites. This group is represented by

Cercaria strigeae tardae Mathias 1925, and

Cercaria linearis Wesenberg-Lund 1934.

The *'Proalaria'* Group (pharyngeal, longifurcate Distome cercariae according to MILLER). Cercariae with penetration glands placed behind the ventral sucker. Second intermediate host a vertebrate, where they develop into a Diplostomulum stage. As adults intestinal parasites. To this group belong:

Cercaria of *Diplostomum spathaceum* (Rudolphi 1819),

Cercaria chromatophora Brown 1931,

Cercaria fennica IV n. sp.,

Furcocercaria I Wesenberg-Lund 1934, and

Cercaria of *Apatemon gracilis* (Rudolphi 1819).

The *'Vivax'* Group (pharyngeal, longifurcate Monostome cercariae according to MILLER). Cercariae with ventral sucker rudimentary. The furcae are provided with fin-folds. Second intermediate host: fishes (?). Here is described:

Cercaria fennica V n. sp.

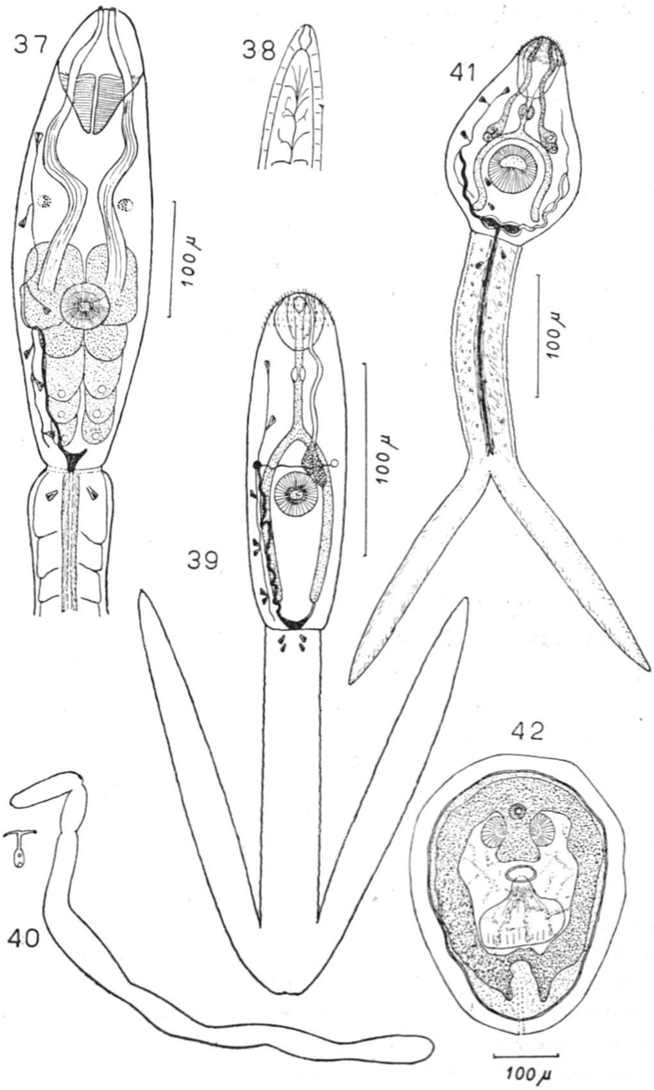
»CERCARIA OCELLATA»

Figs. 37 and 38.

Adult: *Trichobilharzia* sp.
Hosts of adults: sea birds.
Location of adults: blood-vessels.
Larval hosts: *Lymnaea stagnalis* and *L. palustris.*
Localities: No. 23 (10.VI. 1948), No. 30 (7.VI. 1948), and No. 36 (16.VII. 1952).

Description and identification:

Cercariae	Measured on two living specimens μ
Length of body	380—425
Breadth of body	90
Length of tail-stem	525—540
Breadth of tail-stem	59— 60
Length of furcae	310—320
Length of anterior organ	98—117
Breadth of anterior organ	58— 59
Ventral sucker, diameter	43



Figs. 37—42. Fig. 37: »*Cercaria ocellata*». Fig. 38: »*Cercaria ocellata*». The end of the furca. Fig. 39: *Cercaria strigeae tardae*. Fig. 40: Sporocyst of *Cercaria strigeae tardae*. Fig. 41: *Cercaria linearis*. Fig. 42: *Tetracotyle typica*? (The tetracotyle stage of *Cotylurus cornutus*.)

The main characters of this cercaria are 1) its large size, 2) two clearly visible eye-spots, 3) five pairs of large penetration gland cells with broad, curved ducts, and 4) a very protrusible ventral sucker. The two anteriormost pairs of penetration gland cells are more coarsely granulated than the three other pairs. There are separate ducts from each gland cell. When the cercaria rests on the bottom of containers, etc., its appearance is very peculiar: The cercaria is fixed by the small, protruded ventral sucker and both its ends are held upwards; the posterior end with the tail is directed almost straight upwards, while the anterior end points obliquely upwards. A similar position may also be seen under the microscope between the slide and the coverslip.

The excretory system is simple: a small slit-shaped urinary vesicle, two straight main lateral collecting tubes and posterior and anterior collecting tubes. I have seen 6 pairs of flame cells in the body and one pair in the proximal end of the tail-stem.

The tail-stem is muscular, consisting internally of several large bodies. On the ends of the furcae a peculiar end organ is observed (fig. 38). The distal parts of the furcae are provided with a fin-fold.

The sporocysts are filiform.

This cercaria may be identified with *Cercaria ocellata* La Valette 1854, the larval stage of *Trichobilharzia ocellata* (La Valette 1854) Brumpt 1931, a parasite of the blood vessels of several sea-birds. Wesenberg-Lund (1934) has not noted the fin-fold on the furcae or the end organ. Both these structures were seen by Mathias (1930). The chitinous fold behind the anterior organ reported by some authors has not been observed by me (cf. Pirilä and Wikgren 1955). According to Miller, hirudinoid movements are characteristic of *Cercaria elvae,* but I have not observed such movements in my specimens. In the last few years many new, nearly related species have been described; in 1950 Cort recorded eighteen species of related schistosome larvae. Szidat (1942) and Emmel (1947) showed that the larvae referred by various authors to *Cercaria ocellata* actually belonged to several distinct species. My notes do not allow a definite identification between these.

Occurrence: I have found this species in material from three localities, of which two are small pools on skerries in the sea zone and one the mouth of a ditch near a shallow, vegetation-rich shore. »*Cercaria ocellata*» thus seems to be widely distributed, but not especially common in the Finnish archipelago. The degree of infection of snails with »*Cercaria ocellata*» seems to be quite low. In one case I found cercariae in a jar, but none of the 10 snails in it were infected with sporocysts. In another case only one out of 20 snails dissected was infected with sporocysts.

Note: »*Cercaria ocellata*» is also able to penetrate the human skin, producing a dermatitis called »swimmer's itch». I have produced primary papules (?) on myself by inverting a test tube filled with water containing cercariae over the forearm (Wikgren 1953 b). A very copious literature has accumulated about schistosome dermatitis and dermatitis-producing species. Here it may be mentioned that the first cases from Finland have been reported by Pirilä and Wikgren (1955). The causative agents were a member of the »*Cercaria ocellata*» Group and the cercaria of *Bilharziella polonica* (Kowalewsky 1895).

Cercaria strigeae tardae Mathias 1925

Figs. 39 and 40.

Synonyms: *Cercaria helvetica XXXIV* Dubois 1929 (?) and *Cercaria sanjuanensis* Miller 1927.

Adult: *Cotylurus* sp. (Related to, if not identical with, *Cotylurus cornutus* (Rudolphi 1808) Szidat 1928).

Hosts: birds.

Location: intestine.

Larval hosts: *Lymnaea stagnalis* and *L. palustris*.

Localities: No. 24 (11.VII. 1950), and No. 42 (11.VIII. 1952).

Description:

	Own measurements: Mean of 5 specimens	Own measurements: Limits	Acc. to Mathias	*Cercaria A* acc. to Dubois
Cercariae	μ	μ	μ	μ
Length of body	175	159—185	80×100	162—216
Breadth of body	56	51—59	80—100	61
Length of tail-stem	165	155—185	160—210	216
Breadth of tail-stem	31	26—33		36
Length of furcae	196	193—204	160—210	216
Oral sucker	30	30—33	35—90× 35	
Ventral sucker	30	26—33	35—39	29
Sporocysts				
Length		1400—4950		
Breadth		117—188		

Cercariae

Shape: elliptical. The anterior organ protrudes in the form of a distinct tip when the cercaria lies under the pressure of the cover-glass. Cuticle: At least the anterior part of the body is covered with fine spines which are larger on the anterior end of the body. The mouth opening is also spinous. Suckers: The anterior organ is of almost the same size as the ventral sucker. The ventral sucker bears two or three rows of spines. Gut: The praepharynx is short, but always clearly visible; the pharynx is small; the oesophagus is short and divides about halfway between the anterior organ and the ventral sucker. The diverticula are tubular and do not show any marked incisions. They reach the urinary bladder. Penetration glands: The cercaria has two pairs of penetration gland cells. These lie anteriorly of the ventral sucker, but on slight contraction of the body the posterior cells come to lie along the anterolateral border of the ventral sucker. The protoplasm is coarsely granular. The ducts make a characteristic curve outwards just behind the anterior organ. Excretory system: The urinary bladder is small and provided with two small horns. The main lateral collecting tubes are very curved and they form a »glomerulus» laterally of the ventral sucker. A transverse commissure in front of the ventral sucker connects the two glomeruli with each other. The collecting tubes seem to arise from the glomeruli, but this observation may be erroneous (cf. DUBOIS 1929, pl. IV, fig. 13). The anterior collecting tube bears two flame cells, the posterior tube at least five flame cells. In the tail I have seen two pairs of flame cells, which seem to be directly connected to the urethra. The urethra passes as a straight tube through the tail-stem branching into the furcae. Tail: Circular and longitudinal muscles have been observed. Innermost there is a loose parenchyma. I have not seen any large bodies. On the sides of the tail-stem I have observed 6—12 long bristles on each side. The length of these correspond to half the breadth of the tail-stem. Behaviour: The fully mature specimens swim almost continuously. I have not observed any typical floating position.

Sporocysts

The sporocysts are milky-white. Their ends are very mobile. The sporocysts are filled with germ balls and unripe cercariae together with a few apparently mature cercariae.

Identification: DUBOIS (1938, p. 127) seems to regard *Cercaria A* Szidat and *Cercaria strigeae tardae* Mathias as identical, but on p. 128 points out the differences between these cercariae. *Cercaria strigeae tardae* is in turn nearly related to, if not identical with, *Cercaria helvetica XXXIV* Dubois 1929; the only real difference is that *Cercaria helvetica XXXIV* is somewhat larger. It seems to me clear that *Cercaria A* and *C. strigeae tardae* are not identical, in spite of the fact that in rearing experiments (SZIDAT 1924; MATHIAS 1925; HARPER 1931) they have both been found to develop into the same species, *Cotylurus cornutus* (Rud.) Szidat. (MATHIAS and HARPER have used the synonym *Strigea tarda* (Steenstrup).) The adult species must have been erroneously identified or they are so closely similar that a distinction between them is extremely difficult. DUBOIS (1938) in fact mentions that a subdivision of *Cotylurus cornutus* may be necessary. I do not know if this has been made later. *Cercaria A* and *C. strigeae tardae* differ from each other in many respects. The descriptions by different authors of the same species also differ from each other, however. Here some differences may be mentioned:

Bifurcation of the oesophagus. In *Cercaria A* the oesophagus divides immediately in front of the ventral sucker. In *C. strigeae tardae* the bifurcation point lies some distance from the ventral sucker.

Formation of a »glomerulus». No glomerulus-like structure seems to exist in *Cercaria A*, and it was not noted for *C. strigeae tardae* by MATHIAS, but was clearly seen by WESENBERG-LUND.

The flame cells in the tail-stem. *Cercaria A.:* Draining tubules have not been seen by SZIDAT and DUBOIS, but according to WESENBERG-LUND these flame cells are connected to the posterior collecting tube and according to HARPER they connect directly to the urethra. *C. strigeae tardae:* MATHIAS regards these flame cells as connected to the posterior collecting tube, but according to WESENBERG-LUND they open directly into the urethra. In my specimens no connection with the tubes in the cercaria body could be detected.

Tail. *Cercaria A:* Globular bodies are present. *C. strigeae tardae:* The tail is surrounded by parenchymatous tissue, but larger cells do also occur. I could not detect any caudal bodies.

The long bristles on the tail-stem of *C. strigeae tardae* which I have observed do not seem to have been mentioned earlier. It is questionable whether much value is to be accorded to this difference. Such bristles occur, for instance, on the tail-stem of the related cercaria of *Cotylurus flabelliformis*. This, however, differs in other points, e.g. in the presence of 4—5 rows of spines on the ventral sucker, from *C. strigeae tardae.*

As far as I can see, my species shows sufficient resemblances to *Cercaria strigeae tardae* Mathias to allow its inclusion in it. It is, however, possible that several similar species exist. These may only with difficulty be distinguished in the cercarial stage.

Occurrence: In the summer of 1950 I found only two specimens in a bottle immediately after returning from an excursion. All the snails were dissected, but sporocysts could not be found. In the summer of 1952 this species was found again, but only one out of 15 snails was infected with it.

CERCARIA LINEARIS WESENBERG-LUND 1934

Fig. 41.

Snail host: *Lymnaea palustris.*
Locality: No. 36 (25.VII. 1947).

Description:

Cercariae		Own records on two living specimens μ	μ	WESENBERG-LUND μ
Length of body	contr.	105	105	205
	extended	190	245	
Breadth of body	contr.	70	95	50
Length of tail-stem		140	175	170
Breadth of tail-stem		35	42	40
Length of furcae		175	225	210
Breadth of furcae		25		
Length of anterior organ		42	46	40
Breadth of anterior organ		35	21	25
Ventral sucker, diam.		35	35	45

Cercariae

Shape: When contracted, the body is nearly globular, but when extended, of almost the same breadth as the tail-stem. Cuticle: At least the anteriormost end is covered with fine spines; the rest of the body surface seems to be smooth. WESENBERG-LUND has seen the spinous area extending more posteriorly than I have seen, but I do not think that this difference is decisive. Suckers: The anterior organ is longer than broad, not divided into a muscular and a non-muscular part. The ventral sucker bears a single row of spines. Gut: The praepharynx is short; the pharynx is small; the length of the oesophagus is very dependent on the extension stage of the body. The oesophagus divides in front of the ventral sucker into thin diverticula which reach the urinary bladder. The ends of the diverticula curve outwards, which is very characteristic of *Cercaria linearis*. This curving is especially clearly seen when the body is contracted. Penetration glands: There are three pairs of small penetration glands, situated in front of the ventral sucker; their position is also maintained in the contracted stage. The ducts make a typical curve, noted also by WESENBERG-LUND. Excretory system: The bladder is small and bicornuate. The main lateral collecting tubes run straight forward and divide beneath the ventral sucker into the collecting tubes. The anterior collecting tube bears three flame cells, the posterior two. In the proximal part of the tail I have seen only two asymmetrically placed flame cells. WESENBERG-LUND has seen two pairs of flame cells in the tail. Perhaps I have overlooked two flame cells. The urethra passes through the tail-stem, but the branches in the furcae could not be seen. Behaviour: The cercaria swims continuously with vigorous movements. In swimming the cercaria behaves as an oscillating rod, the posteriormost end of the body and the end of the tail-stem being the nodal points around which the other parts oscillate. The ends of the furcae are bent inwards. The cercaria is presumably slightly negatively phototactic. Some observations indicate that the cercaria encysts shortly after having emerged from the first intermediate snail host and that the encystment may occur in the same snail. As a free-swimming organism the cercaria lives a very short time.

Identification: A comparison between the above description and that of WESENBERG-LUND (1934) for *Cercaria linearis* makes it extremely likely that my species is identical with *Cercaria linearis*. One difference is, however, that WESENBERG-LUND found his species emerging from *Planorbarius corneus,* whilst my specimens, on the other hand, emerged from *Lymnaea palustris*. Even if this is a rather rare situation, it is, however, in no way impossible, both snails being Pulmonates. DUBOIS (1929) obtained several species both from Lymnaeids and Planorbids. In any case, the difference in host species does not justify the creation of a new species.

Occurrence: I have found this cercaria only once, when only one out of 13 separated snails was infested with it.

TETRACOTYLE CYSTS

Tetracotyle cysts are commonly found on dissecting snails. Their great frequency appears from the following list of find localities, but it should be remembered that snails have been dissected only occasionally and that Tetracotyle has thus not been observed in the majority of snail samples.

Localities: No. 8 (9.VII. 1947, and 17.VI. 1954), No. 12 (23.VIII. 1952), No. 17 (2.VI., and 3.VIII. 1948, 7.VII. 1952), No. 20 (18.VI. 1947), No. 24 (11.VII. 1950), No. 32 (3.X. 1947), No. 33 (4.VI. 1948, and 18.VI. 1954), No. 36 (16.VII. 1952), No. 40 (20.VII. 1952), No. 42 (3.VIII. 1947, and 11. VIII. 1952), No. 46 (11.VIII. 1952), No. 47 (23.VIII. 1952), No. 49 (23.VIII. 1952), No. 51 (28.VI., and 26.VII. 1947).

Both shores and pools are represented by these localities. The degree of infection with Tetracotyle is usually high, as is seen from the list of material (p. 8).

Hosts: Tetracotyle was found in all the *Lymnaea* species dissected and once in *Bithynia tentaculata*. The discovery of Tetracotyle in *Bithynia* is rather unusual; WESENBERG-LUND never found it in this snail in spite of his numerous dissections of *Bithynia*, including 1785 specimens from 20 localities. There could, however, be no error in my observation; in fig. 59 a Tetracotyle is pictured in the interior of a redia of *Sphaerostoma bramae*. MATHIAS (1925) has shown that it is possible to infect *Bithynia* experimentally with *Cercaria strigeae tardae* Mathias 1925.

The Tetracotyle cysts have been only superficially studied and not all the species occurring could be identified. I think that the commonest species is identical with *Tetracotyle typica* Diesing (the larva of *Cotylurus cornutus* (Rudolphi 1809) Szidat 1928), but I am not quite certain. I refer to fig. 42. This cyst shows similarities with *Tetracotyle typica* as described by HARPER (1931) and WESENBERG-LUND (1934). SZIDAT's (1924) drawing shows a thicker cyst covering than occurs in my specimens. I have, however, included *Cotylurus cornutus* in my list of species (cf. *Cercaria strigeae tardae*, p. 51). *Cotylurus cornutus* is fairly common in Europe. In addition to this species I have observed smaller cysts with a thinner cyst covering which in many respects resemble the Tetracotyle of *Cercaria F.I.* Harper 1931. Further, cysts with yellow pigment are mentioned in my notes. The pigment occurs in the creeping larva, too.

D i s c u s s i o n: The fact that the Tetracotyle stage is common though the cercaria stage rarely occurs has given me much trouble. Only in two samples have I found a simultaneous infection with Strigeid sporocysts and cercariae and Tetracotyle cysts. WESENBERG-LUND (1934) has also observed that the parthenitae are very rare. I cite (p. 148): »Wherever *Limnaea* have been strongly infected by larvae of Holostomes the percentage of snails infected by Tetracotyle has always been much larger than of those infected by Sporocysts. Of the first-named often almost 100 per cent. have been infected, of the last-named commonly only a few per cent. The Tetracotyle can be found the whole year round, the Sporocysts occur mainly in the winter months, the Cercariae chiefly in spring and summer» and ». . . . the Miracidia and the Cercariae attack snails from two different years; the result of this being that Tetracotyle and Sporocysts of the same Trematode are only rarely found in the same snail.»

The fact that I have only occasionally collected snails of the smallest size-class may account for the sporocysts being very rare.

Tetracotyle cysts may also occur in other invertebrates than molluscs and sometimes in vertebrates. JÄÄSKELÄINEN (1910) has reported obtaining *Tetracotyle percae fluviatilis* v. Linst. from a perch caught in the Leppäjärvi Bay of Lake Ladoga. (According to MATHIAS (1925) this species has been described by MOULINIÉ.)

TETRACOTYLE STAGE OF COTYLURUS CORNUTUS (RUDOLPHI 1809)

Fig. 42.

A d u l t: *Cotylurus cornutus* (Rudolphi 1809) Szidat 1928.
H o s t s: many sea birds.
L a r v a l s t a g e s: *Cercaria A* Szidat
Tetracotyle typica
L a r v a l h o s t s and l o c a l i t i e s: see above.

One Tetracotyle cyst was measured in 1954. The following measurements were obtained:

	μ
Length with cyst covering	437
Length without cyst covering	333
Breadth with cyst covering	380
Breadth without cyst covering	276
Thickness of cyst covering	48

Compare with fig. 42.

Cercaria of Diplostomum spathaceum (Rudolphi 1819)

Plate I, Fig. 3; and text-figs. 43, 44, and 47.

Synonym: *Cercaria C* Szidat 1924.

Adult: *Diplostomum spathaceum* (Rudolphi 1819) Olsson 1876, emend.

Hosts: sea-birds, especially gulls.

Location: intestine.

Snail hosts: *Lymnaea stagnalis, L. peregra* and *L. palustris.*

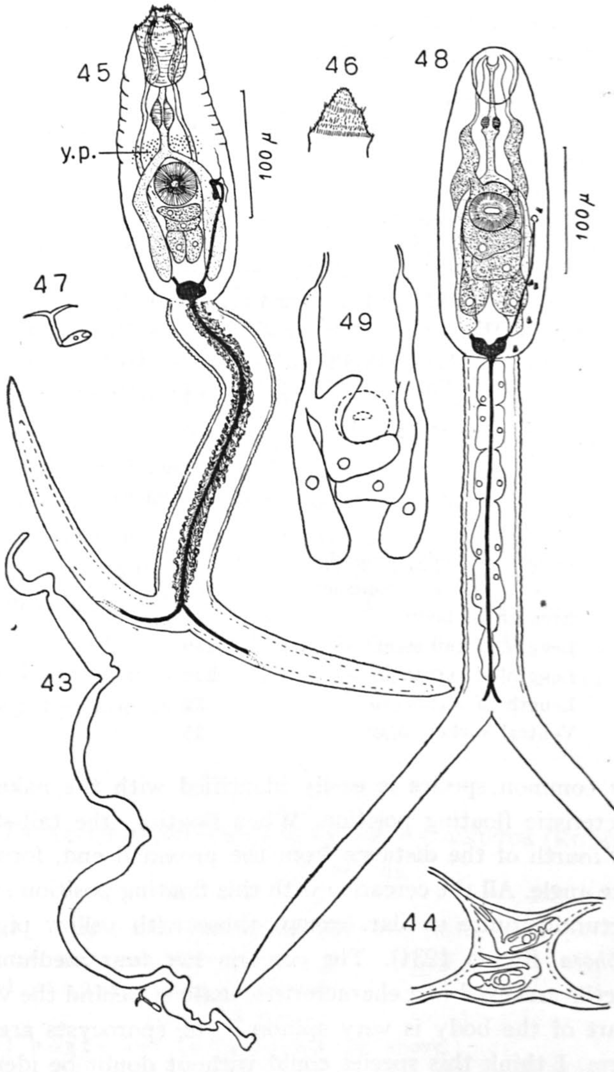
Localities: No. 3 (4.VI. 1947), No. 4 (20.X. 1947), No. 5 (26.IX. 1946), No. 8 (9.VII. 1947), No. 11 (9.XI. 1948), No. 17 (12.VII., and 3.VIII. 1948), No. 21 (18.VI. 1947), No. 27 (10. VI. 1947), No. 29 (27. VI. 1948 and 22. VII 1952), No. 31 (12.VIII. 1948, 18.VI. 1950), No. 33 (16.VIII. 1948), No. 36 (19.VII. 1947, 18.VI. 1950, and 16.VII. 1952), No. 38 (20.VII. 1952), No. 42 (3.VIII. 1947), No. 45 (11. VII. 1950), No. 47 (23. VIII. 1952), No. 48 (23.VIII. 1952), No. 51 (28.VI. 1947, and 26. VII. 1947).

Description:

Cercariae	Measured on a few living specimens μ
Length of body, extended	260
» » » , contracted	160
Breadth of body	88
Length of tail-stem	280
Length of furcae	230
Length of ant.organ	52
Ventral sucker, diam.	35

This extremely common species is easily identified with the naked eye by its very characteristic floating position. When floating, the tail-stem is bent at about one-fourth of the distance from the proximal end, forming a right-angle or acute angle. All the cercariae with this floating position studied by me were structurally quite similar (except those with yellow pigment: *Cercaria chromatophora* Brown 1931). The cercaria has four medium-sized penetration gland cells arranged in a characteristic manner behind the ventral sucker. The forepart of the body is very spinous. The sporocysts are long, whitish, and filiform. I think this species could without doubt be identified with *Cercaria C* Szidat 1924 (1923?), which develops into *Diplostomum spathaceum* (Rudolphi 1819) Olsson 1876 (life-history by Szidat 1924). My specimens have all the main characters in common with this. Since this cercaria is very well studied I will not give any further description. Similar cercariae have frequently been reported; many of them are probably identical. I refer to the investigations of Miller (1926), Dubois (1929), Rees (1932 a), and Wesenberg-Lund (1934).

Occurrence: The cercaria of *Diplostomum spathaceum* is one of the commonest cercariae found. It occurs both in pools and on shores and in all archipelago zones. The degree of infection of snails with it is usually high.



Figs. 43—49. Fig. 43: Sporocyst of *Diplostomum spathaceum*. Fig. 44: Part of a sporocyst of *Diplostomum spathaceum,* showing two immature cercariae between two Tetracotyle cysts. Fig. 45: *Cercaria chromatophora.* y.p. = yellow pigment. Fig. 46: The protruded anterior end of *Cercaria chromatophora.* Fig. 47: Floating position of *Cercaria chromatophora* and the cercaria of *Diplostomum spathaceum.* Fig. 48: *Cercaria fennica IV.* Fig. 49: The arrangement of the penetration gland cells of *Cercaria fennica IV.*

N o t e: SELINHEIMO has found a Furcocercous cercaria which is most probably identical with the cercaria of *Diplostomum spathaceum* (plate I, fig. 3.). Curiously enough, she writes that this species is mainly found in *Bithynia tentaculata* but also frequently in *Lymnaea stagnalis.* Obviously this note is due to a confusion between two species with somewhat similar floating position, perhaps the cercaria of *Diplostomum spathaceum* and a cercaria of the *'Vivax'* Group.

Cercaria chromatophora Brown 1931

Figs. 45—47.

Snail hosts: *Lymnaea stagnalis* (once), *L. peregra* (five times), and *L. palustris* (twice).

Localities: No. 25 (30.VI. 1948), No. 28 (30.VI. 1948), No. 36 (16.VII. 1952), No. 42 (25.VI. 1947, 1.VII., and 11.VII. 1950), No. 46 (13.VII. 1950).

Description and discussion: The dimensions of this species have not been recorded. Most probably it is of exactly the same magnitude as the cercaria of *Diplostomum spathaceum*.

In my notes this cercaria is to some extent confused with the cercaria of *Diplostomum spathaceum*. This is due to the fact that the morphological characters as well as the behaviour seem to be exactly the same in the two species. According to my observations the only difference is the yellow (yellowish-green) pigment occurring in the *Cercaria chromatophora*. I find it difficult to believe that these two forms really belong to different species, and I supposed for a long time that the snail species in which the parthenitae develop in some way determined the presence or absence of pigmentation. I have, moreover, obtained *Cercaria chromatophora* more frequently from *L. peregra* than the cercaria of *Diplostomum spathaceum*. I have also observed that *Cercaria chromatophora* chiefly occurs in pools rich in vegetation. However, in view of my findings of *Cercaria chromatophora* from all the three *Lymnaea* species, and of the fact that a separate species has been created for an apparently quite similar form, I have regarded my specimens as *Cercaria chromatophora* Brown 1931. It is, however, very questionable if this species should be separated from *Diplostomum spathaceum*.

The cercariae and the sporocysts coincide well with the description given by Brown for *Cercaria chromatophora*. The colour of the sporocysts is not, however, pure white, as Brown states, but light yellowish-brown. The pigment of the cercariae is concentrated at the bifurcation point of the gut, but it occurs in other parts of the body, too. The pigment granules are diminutive and consist, perhaps, of lipoid droplets. They move in the same manner as small suspended particles when influenced by molecular movements. Brown has seen several long bristles on the tail-stem, but I have apparently overlooked them. On *Cercaria chromatophora* I have observed that the branches of the urethra open on the median border of the furcae and not on the lateral border, as depicted by Wesenberg-Lund in his figure of the cercaria of *Diplostomum spathaceum*.

Occurrence: Owing to the confusion with the cercaria of *Diplostomum spathaceum*, causing findings of *Cercaria chromatophora* to be noted as those of the cercaria of *Diplostomum spathaceum*, *Cercaria chromatophora* has certainly been observed oftener than appears from the list of localities. The degree of infection in the samples analysed are: 2 out of 15, 5 out of 10, and 2 out of 20.

CERCARIA FENNICA IV n. sp.

Figs. 48 and 49.

Adult: member of DIPLOSTOMIDAE Poirier 1886 (*Diplostomum* v. Nordmann 1832).
Hosts: birds.
Snail hosts: *Lymnaea stagnalis* and *L. peregra.*
Localities: No. 17 (3.VIII. 1948) and No. 42 (12.VIII. 1952).

Description: The cercaria is of almost the same size as the cercaria of *Diplostomum spathaceum*, perhaps a little larger.

Cercaria fennica IV resembles morphologically the cercaria of *Diplostomum spathaceum* (p. 57). These two species are best distinguished by their different floating positions, but the anatomy of the inner organs also show some distinctive dissimilarities. In the following description I have made a through comparison with the cercaria of *D. spathaceum.*

Cercariae

Shape: The body is oval and closely resembles that of the cercaria of *D. spathaceum.* In *C. fennica IV* the body is more rounded and the transverse furrows typical of the cercaria of *D.s.* do not appear as markedly. Below the cover-glass, the cercaria of *D.s.* usually holds the tail-stem bent near its proximal end, whereas the tail of *C. fennica IV* is held straight. Colour: The body is unpigmented and more transparent than the body of the cercaria of *D.s.* Cuticle: The anterior end of the body is provided with spines. These spines are not drawn in my figure. Suckers: The anterior organ is less powerful than in the cercaria of *D.s.* and only a little larger than the ventral sucker. The ventral sucker bears 3—4 rows of spines. Gut: The pharyngeal part of the gut is typical of *Cercaria fennica IV*. The praepharynx is short and remarkably thin; the pharynx is small and rounded; the oesophagus is long and its anterior end is bulbous, being here of the same thickness as the pharynx. The anterior part of the oesophagus also refracts the light in a different manner from the other parts of the gut, appearing as a bright spot. The oesophagus divides immediately in front of the ventral sucker into two diverticula, which reach the urinary bladder. The diverticula are broad and very clearly visible. Penetration glands: This cercaria possesses two pairs of penetration glands, situated behind the ventral sucker. The position and the main shape of these cells are the same as in the cercaria of *D.s.*, the differences being:

1) The cells are larger, 2) the anterior pair extends around the ventral sucker, and 3) the contents are very finely granulated. In *C. fennica IV* it is clearly seen how the processes of the two cells on each side connect (fig. 49). Apparently the protrusions of the anterior pairs pass on the ventral side of the diverticula and those of the posterior pairs on the dorsal side. It is very clearly seen that the cytoplasmic processes extend far forwards and that the real ducts are very short. When the cercaria moves, it can be seen how the nuclei now and then are forced into the processes. I cannot state with certainty whether or not the protoplasm of the processes fuses. In the anterior organ the ducts are surrounded by a thick sheath. Excretory system: This seems to be identical in structure with that of the cercaria of *D.s.* The urinary bladder is rectangular with conspicuous horns; the main lateral collecting tubes extend to the level of the ventral sucker, where they divide. Some flame cells are drawn in the figure, but some (especially in the anterior end) are certainly lacking. The urethra passes through the entire length of the tail-stem, but the branches in the furcae have not been seen. Tail: The urethra is not surrounded by parenchymatous tissues as in the cercaria of *D.s.*, but there are 5—7 globular bodies on each side. Behaviour: The floating position of *Cercaria fennica IV* is characteristic. When floating, the tail-stem is straight and the furcae are held perpendicular to the tail-stem. The posterior $^{2}/_{3}$rds of the body is straight, too, but the anterior end is bent so that the anterior organ lies at the same level as the ventral sucker. The swimming movements are similar to those of the cercaria of *D.s.* and also the periods of rest and swimming seem to be of the same duration.

Sporocysts

The sporocysts are very long with thicker and thinner parts. They are transparent and unpigmented.

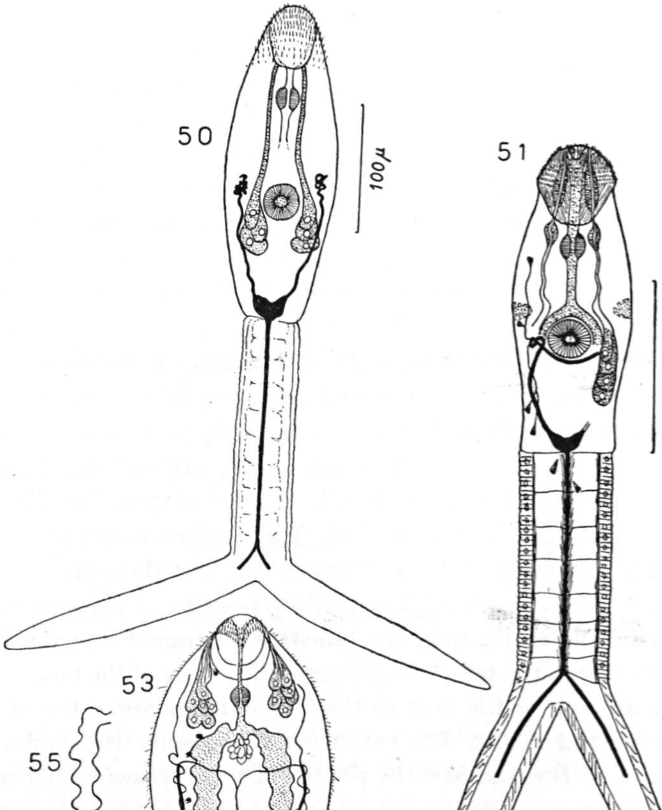
Identification: I have not seen a description of any very similar cercaria of the *'Proalaria'* Group. In the size of the penetration glands, as in most other characters, *Cercaria fennica IV* resembles *Cercaria helvetica XV* Dubois 1929, but the ventral sucker of *C. helvetica XV* is larger.

Occurrence: This cercaria has been found only twice: 1) from a deep bay (Långskär) and 2) from the largest pool on Äggharun (8 out of 15 dissected *L. peregra* were infected with it).

Furcocercaria I Wesenberg-Lund 1934 nec Petersen 1931

Fig. 50.

Snail host: *Lymnaea peregra.*
Locality: No. 15 (23.VI. 1947).



Figs. 50—55. Fig. 50: *Furcocercaria I* Wesenberg-Lund. Fig. 51: Cercaria of *Apatemon gracilis*. Fig. 52: *Apatemon gracilis*. The anterior end of a sporocyst showing the birth-pore. Fig. 53: *Cercaria fennica V*. Fig. 54: *Cercaria fennica V*. Part of the tail-stem, showing the urethra, the oblique, longitudinal muscles and the pear-shaped myoblasts. Fig. 55: *Cercaria fennica V*. The figure shows the appearance of the diverticula when the cercaria is extended.

Description:

Cercariae	Own measurements on living specimens μ	According to WESENBERG-LUND μ
Length of body	140—265	200
Breadth of body	25— 80	45
Length of tail-stem	175	160
Breadth of tail-stem	53	40
Length of furcae	210	180
Anterior organ		30 × 50
Ventral sucker, diam.		35

I have found this cercaria only once and then obtained only very few specimens of it. The description and drawing are thus incomplete.

PETERSEN (1931) has described a Furcocercous cercaria with 6 penetration gland cells behind the ventral sucker. WESENBERG-LUND (1934) describes a similar form as *Furcocercaria I* Petersen. Since, however, the description given by PETERSEN is incomplete and perhaps in some details erroneous, and since the penetration gland cells of his species are located in a bunch behind the ventral sucker, while in WESENBERG-LUND's and my species they are situated in two rows of three glands each, I have considered it more correct to follow the description given by WESENBERG-LUND. PETERSEN's species may or may not be identical with WESENBERG-LUND's and my own.

I have based my identification mainly on the following characters: 1) The dimensions are in accordance with those given by WESENBERG-LUND. 2) The cercaria possesses three pairs of small penetration gland cells behind the ventral sucker. 3) The ventral sucker is smaller than the anterior organ and is situated a little behind the middle of the body. 4) The main lateral collecting tubes form glomeruli beneath the ventral sucker. The commissure between these has not been seen. 5) The floating position of the cercaria is identical with that described and pictured by WESENBERG-LUND for *Furcocercaria I*. *Cercaria riponi* Brackett 1939 is a very nearly related species.

CERCARIA OF APATEMON GRACILIS (RUDOLPHI 1819)

Figs. 51 and 52.

Synonym: *Cercaria burti* Miller 1923.

Adult: *Apatemon gracilis* (Rudolphi 1819) Szidat 1928.

Hosts: several sea-birds.

Snail hosts: *Lymnaea peregra* and *L. palustris*.

Localities: No. 13 (18.VI. 1950), No. 17 (12.VIII. 1948, and 7.VII. 1952), No. 31 (27.VI. 1948), No. 36 (18.VII. 1952).

Description:

	Own measurements		*C. burti* acc. to MILLER	*C. helvetica XXXI* according to	
	Mean of 10 spec. killed with heat	Limits		DUBOIS	WESEN-BERG-LUND
Cercariae	μ	μ	μ	μ	μ
Length of body	175	152—195	125—240	65—200	180
Breadth of body	46	38— 59		30— 80	45
Length of tail-stem	139	128—175	165	135—180	180
Breadth of tail-stem	37	35— 43		36	40
Length of furcae	175	156—183	181	160—180	175
Length of ant. organ	46	39— 59		diam. 25—30	45
Breadth of ant. organ	26	24— 27			30
Ventral sucker, diam.	22			25— 27	30

Cercariae

Shape: When resting the body is broader than the tail, but when extended it is longer and thinner than the tail. Colour: milky-white. Cuticle: The anterior part of the anterior organ is covered with spines, but on other parts of the body the cuticle is smooth. Suckers: The anterior organ is large and consists of an anterior part with thinner walls and a very muscular posterior part. The anterior organ seems to be only slightly protrusible. The ventral sucker is relatively small and is situated a little behind the middle of the body. There are two rows of very small spines near the centre of the sucker. Gut: The praepharynx is short; the pharynx is remarkably broad, muscular, staining bright red with Neutral Red; the oesophagus is long and divides in front of the ventral sucker into two diverticula, which I could follow only a short distance. Penetration glands: There are four penetration gland cells arranged in a row on each side. The gland cells are filled with fine granules, which stain red with Neutral Red (acidophilic?). The ducts have a characteristic incurvation (see figure). The duct walls thicken in the region of the pharynx and when passing through the anterior organ. Excretory system: The urinary bladder is small with two small horns from which the main lateral collecting tubes arise. These tubes are long and form a double loop beneath the ventral sucker. Here the anterior and posterior collecting tubes are given off. The anterior tube carries two flame cells, as does the posterior tube also. In the related species mentioned below the posterior tube is provided with four flame cells. I cannot convince myself that I have overlooked two flame cells. In the tail there are two flame cells which are asymmetrically placed. Behind the ventral sucker a commissure runs between the main collecting tubes. I have searched for a commissure anteriorly to the sucker without, however, finding it. The urethra passes through the tail-stem and divides in the furcae, but the openings have not been seen. Other characters: A distinct rounded structure craniolaterally of the ventral sucker, seen both in unstained and stained specimens is very characteristic of my specimens. Tail: muscular. Around the central core with the urethra are 6—9 large globular bodies. Behaviour: The cercaria swims continuously close beneath the water surface. The swimming behaviour resembles that of *Cercaria linearis* (p. 54). Probably the anterior end of the body is bent under the posterior part during swimming.

Sporocysts

The sporocysts are long (more than 2 cm.), filiform with broader and narrower parts. The colour is white, chiefly owing to the presence of lipoid droplets in the walls. The cranial end is very protrusible with a conspicuous birthpore.

Identification: MILLER (1923) has described a species, *Cercaria burti*, and DUBOIS (1929) a very similar one, *Cercaria helvetica XXXI*. WESENBERG-LUND has found a cercaria which resembles both of these, but differs from them in some points. WESENBERG-LUND is inclined to regard all these as identical and has used the name *Cercaria helvetica XXXI* Dubois 1929 for his species. My specimens, again, differ in some points from all these. According to DUBOIS the only difference between *Cercaria burti* Miller and *Cercaria helvetica XXXI* Dubois is that MILLER's species has only one commissure between the main lateral collecting tubes behind the ventral sucker, whereas DUBOIS reports two commissures, one in front of and one behind the sucker. WESENBERG-LUND, again, reports only one commissure in front of the sucker. The penetration glands of MILLER's, DUBOIS' and my specimens are arranged in single rows, the formula being 2+2+2+2, but WESENBERG-LUND reports the formula to be 3+3+2. The dimensions of all the above-mentioned species are almost the same, only the tail-stem of my specimens seems to be somewhat shorter than that of the other species. Apart from the different flame cell formula, which may be due to my inadequate observations, my species resembles *Cercaria burti* Miller 1923 in so many details that I have considered it most correct to refer it to *Cercaria burti* Miller. Whether DUBOIS' and WESENBERG-LUND's species are identical with *Cercaria burti* Miller is a matter of doubt. *Cercaria burti* is the larval stage of *Apatemon gracilis* (Rudolphi 1819) Szidat 1928 (cf. PATTEN 1952).

Occurrence: The cercaria of *A. gracilis* has been detected in four localities, of which two are shores and two rock pools. *Lymnaea peregra* seems to be the favourite host species, since the cercaria of *A. gracilis* has been found in this snail on four occasions out of five. The degree of infection with *A. gracilis* is low. From loc. nos. 13, 17, and 36 only one out of 21, 20, and 5 snails respectively were infected with it.

CERCARIA FENNICA V n. sp.

Figs. 53—55.

Adult: member of CYATHOCOTYLIDAE Poche 1925.
Hosts: probably birds.
Snail host: *Bithynia tentaculata.*
Locality: No. 26 (4.VII. 1952, 25.VI. 1954).

Description:

Cercariae	Own measurements Mean of 5 spec. μ	Limits μ	Cerc. of *Cyathocotyloides curonensis* acc. to SZIDAT (1933) μ
Length of body	216	190—276	200
Breadth of body	114	95—133	100
Length of tail-stem	290	276—314	250
Breadth of tail-stem	47	38— 57	40
Length of furcae	270	248—295	200
Breadth of furcae			25
Anterior organ, length	63	60— 64	50
Anterior organ, breadth	46	38— 53	30
Pharynx			10×15

Cercariae

Shape: oval; the anterior organ is often somewhat protruded. Colour: yellowish. Cuticle: The cuticle is covered with very small spines on about the anterior half of the body. They lie closer anteriorly than posteriorly. Some very fine short hairs were seen at least on the anterior end of the body. The cuticle folds at contractions. It is obviously very thin. Anterior organ: rounded, small. It is apparently not very muscular and consists mainly of parenchymatous tissue. Only the anteriormost end, which is armed with strong spines, is slightly protrusible. The ducts of the penetration glands and the very narrow praepharynx pass through the anterior organ. The ventral sucker is wholly absent externally, but internally there seem to be some rudiments of it. Gut: The pharynx is globular, small. The oesophagus is short; the diverticula are large and filled with fluid. In this fluid some particles, obviously not derived from the cercaria, are seen. At the peristaltic movements of the walls the content is often seen to pass from one side to the other. The diverticula walls are constricted, the constrictions corresponding to about $^1/_4$ of the maximal breadth. Penetration glands: These lie close beneath the anterior organ, extending about half the distance to the bifurcation point of the gut. The number of these gland cells is difficult to count, but there are about 5—7 cells on each side. The cells are rather small and somewhat more coarsely granulated than the other adjacent cells. Apparently each gland cell opens with its own duct. Immediately behind the bifurcation point of the gut is some tissue which many authors seem to regard as glandular. Excretory system: This is of the usual *'Vivax'* type. The bladder is very small and often seen only as a thin slit. Compare further with the figure. There are 7 pairs of flame cells in the cercaria body and 2 pairs in the tail-stem. The flame cells in the tail-stem are directly connected with the urethra. The urethra passes through the tail-stem and it could be followed in the furcae to a point very near the tip of these. Other characteristics: A yellowish brown pigment is sparsely scattered below the epidermis and somewhat condensed in the region of the rudimentary ventral sucker. Tail: The cuticle of the tail-stem is very thin and folded. No bristles have been observed. In the middle there is a strand of condensed tissue surrounding the urethra. Between this strand and the epidermis run oblique, longitudinal muscles. Below the cuticle are seen small, sac-shaped bodies, probably myoblasts. No larger bodies occur in the tail, but when compressed the interior of the tail is seen to be filled with vacuoles, which I do not think are present in the intact tail. The furcae lack a fin-fold. Behaviour: The sinking periods are long, the swimming periods, on the contrary, very short. The cercaria swims rapidly. On sinking the tail is slightly curved.

Identification: This cercaria seems not to be identical with any other species known to me. It shows many resemblances, however, with the cercaria of *Cyathocotyloides curonensis* (Szidat 1933) Szidat 1936, found in Kurisches Haff. The dimensions are approximately the same and also the typical floating position. Perhaps the sole significant differences are that the cercaria of *Cyathocotyloides curonensis* is provided with only 5 pairs of flame cells in the body and that in the tail its flame cells are connected by ducts to the urinary bladder. *Cercaria fennica V* must be referred to the *'Tetis'* subgroup with regard to the following characters: No fin-fold on the furca, acetabulum lacking and two pairs of flame cells in the tail-stem (cf. CABLE 1938). ANDERSON (1944) combines the two subgroups, the *'Vivax'* Group and the *'Tetis'* Group into one (*'Vivax'* Group). The number of flame cells in the body should apparently not be accorded much value as a separatory character.

Occurrence: This cercaria has been found in only one pool (Lillhamn). In 1952, 2 out of 25 dissected snails were infected.

Note: SELINHEIMO has found a cercaria of the *'Vivax'* Group which I could not identify. The size is noted to be somewhat larger than that of the cercaria of *Diplostomum spathaceum*. The oesophagus is clearly visible and the diverticula are thin. SELINHEIMO has not seen penetration glands. It may be pointed out that the unpaired part of the median tubes of the excretory system is very short, in which feature the cercaria differs from most other related cercariae.

CYSTOCERCOUS CERCARIAE

E. L. MILLER (1936) has divided the Cystocercous cercariae of LÜHE (1909) into three groups, *viz.* the *'Cystophorous'*, *'Cystocercous'*, and *'Macrocercous'* Groups. Only species belonging to the *'Cystocercous'* Group have been found in Finland. Here are described:

Cercaria of *Azygia lucii* (Müller 1776) and

Cercaria splendens Szidat 1932.

Other species of this group have not been reported from Europe.

The Cystocercous cercariae are the giants among cercariae (Germany: »Riesencercarien»). The anterior end of the tail swells enormously on coming in contact with water and develops into a large chamber which harbours the cercaria body. The genital anlage of the cercaria are more developed than in most other cercariae. Development occurs in sporocysts. The tail of the *'Cystocercous'* cercariae is distally bifurcated. Especially when immature the cercariae show sufficient resemblances with the Furcocercariae to justify the inclusion of the *'Cystocercous'* Group among these. With reference to DAWES' suggestion (1946, p. 429) I consider it most practical to separate these giant cercariae from the true Furcocercariae and place them within the Cystocercous cercariae of LÜHE.

CERCARIA OF AZYGIA LUCII (O. F. MÜLLER 1776)

Plate III, Fig. 8.

Synonym: *Cercaria mirabilis* Braun 1891.

Adult: *Azygia lucii* (O. F. Müller 1776) (many synonyms, see DAWES 1946, p. 251).

Hosts: *Esox lucius* L., *Perca fluviatilis* L., *Lota vulgaris* Jenyns, *a.o.*

Location: stomach, oesophagus and intestine.

Snail host: *Lymnaea palustris.*

Locality: No. 8 (28.VII. 1947).

This giant among cercariae is so unique that I give no description of it. No similar cercariae have been reported from Europe. The cercaria may be as large as 7 mm. in total length, but the specimens found by me measured only somewhat more than 5 mm.

In 1910—1911 JÄRVINEN performed an investigation on the morphology and histology of *Cercaria mirabilis.* The results have not been published. Some observations are cited here:

The snail material (*L. palustris*) has been collected on the shores in the vicinity of Tvärminne Zoological Station, the major part apparently from locality no. 8 (Krogarviken). The degree of infection has not been noted, but JÄRVINEN assumes it to be fairly low. In plate III, fig. 8, JÄRVINEN's drawing of *Cercaria mirabilis* is given. In infection experiments it was observed that

Phoxinus aphya (L.) eagerly swallowed swimming cercariae, but that *Leuciscus rutilus* (L.) and *L. erythrophthalmus* (L.) paid no attention to them at all. It was, however, possible to infect them with the aid of a syringe. A few days after the fish had been infected they were dissected and immature trematodes were found in the alimentary canal of all. Unfortunately the experiments were not prolonged and the life-history of *Cercaria mirabilis* could not be worked out. JÄRVINEN assumed, however, on anatomical and histological grounds, that *Cercaria mirabilis* is a larval stage of *Azygia lucii* (*Distoma tereticolle* (Rudolphi)). As far as I am able to discover, it was SZIDAT who in 1932 for the first time demonstrated that *Cercaria mirabilis* belongs to the cycle of development of *Azygia lucii* (Müller). According to COIL (1954), WAGENER in 1857 stated that the gorgoderid *Cercaria duplicata*, developed into *Distomum tereticolle.*

Occurrence: It is very surprising that the cercaria of *Azygia lucii* has only rarely been found. I myself have found it only once and JÄRVINEN obviously had some difficulty in obtaining enough of them. Prof. ALEX. LUTHER has seen this cercaria now and then when collecting snail material for zoological courses. In spite of this, *Azygia lucii* seems to be common in pike caught in the adjacent waters (cf. p. 88).

CERCARIA SPLENDENS SZIDAT 1932

Figs. 56 and 57.

Adult: member of AZYGIIDAE Odhner 1911.
Hosts: fishes *(Gasterosteus?)*.
Snail host: *Anisus vortex*.
Locality: No. 8 (9.VII. 1947).

Description:

Cercariae	Own measurements µ	Acc. to SZIDAT µ	Acc. to WESENBERG-LUND µ
Length of house	510	900	760
Breadth of house	260	400	500
Length of tail-stem	480	560	770
Breadth of tail-stem	260	300—400	100
Length of rami	240	450	450
Breadth of rami	240	410	480
Length of distomulum		650	
Breadth of distomulum		270	
Oral sucker	length 175	diam. 170	
Ventral sucker, diam.	105	150	
Pharynx		40	

It is necessary to distinguish between the distomulum and its house. When immature, the cercaria closely resembles true Furcocercariae, but on

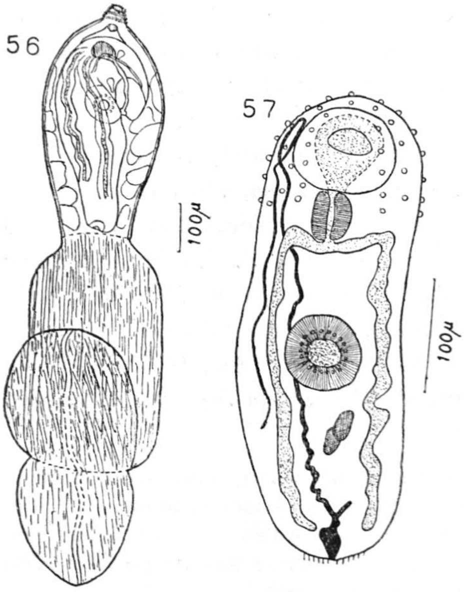


Fig. 56—57. Fig. 56: *Cercaria splendens.* Fig. 57: *Cercaria splendens.* The distomulum dissected from its house. About the knobs, see text.

coming in contact with water the tail, especially at its proximal end, swells enormously so that ultimately it surrounds the distomulum.

Colour: The tail-stem is dark, the other parts being rather transparent. The cuticle of the house is smooth, but is provided with a few large knobs. The cuticle of the distomulum is longitudinally striated. In my figure of the outdissected distomulum several knobs are drawn on the cranial end of the body. As far as I am aware the presence of such knobs has not previously been mentioned by any author. It seems most probable that my figure is incorrect and the presence or absence of such knobs must be confirmed later. Suckers: The oral sucker is almost twice as large as the ventral sucker. The ventral sucker bears a single row of small papules. Gut: The praepharynx is short and funnellike; the pharynx is large and oblong; the oesophagus is short. The diverticula are long, thin and somewhat curved; they reach the posterior extremity of the body. The diverticula are filled with a dark mass. Excretory system: The urinary bladder is minute and nearly spherical. The main lateral collecting tubes run to the anterior end, where they form a loop and pass back again. They fuse before opening into the bladder. The urethra passes through the tail-stem and the rami, ending on the tip of these. Behaviour: The floating position, which strongly resembles that of Furcocercariae, and the always slightly bent tail-stem are good characters. Also the sudden, slow jumps of the cercaria are typical (cf. BERG 1949).

Identification: *Cercaria mirabilis* and *Cercaria splendens* are the only representatives of their group in Europe. The morphology and the swimming behaviour of the cercaria thus seem to constitute satisfactory criteria for its proper identification. It must, however, be pointed out that my measurements have throughout given much lower values than those indicated by SZIDAT (1932) and WESENBERG-LUND (1934). SZIDAT found the species emerging from *Planorbis umbilicatus* Müller (= *Planorbis planorbis* (L.)), which is about twice as large as *Anisus vortex.* BERG (1949) found it from the minute

Acroloxus lacustris (L.), but he gives no exact measurements of the house and tail. On comparing the scale of the figures, it seems, however, that the specimens found by him were considerably larger than my specimens. It is possible that the differences in size are coupled with differences in the size of the snail host, although it must be remembered that the immature cercaria inside the snail is much smaller than the swollen, free-living cercaria, and that the size of the snail could not directly limit the size of the cercaria.

Occurrence: The species has been found only once. It may, however, be pointed out that Planorbids have only occasionally been collected.

MICROCERCOUS CERCARIAE

The Microcercous cercariae are chiefly characterized by their rudimentary tail. The tail is a short, cup-like organ. Only few species are reported from Europe and only one (?) species from fresh water, *i.e. Cercaria micrura* Filippi 1857, the cercaria of *Sphaerostoma bramae* (O. F. Müller 1776). I have found this species in brackish water (about 6 ‰).

Cercaria of Sphaerostoma bramae (O. F. Müller 1776)

Figs. 58 and 59.

Synonym: *Cercaria micrura* Filippi 1857.

Adult: *Sphaerostoma bramae* (O. F. Müller 1776).

Hosts: many fish species, *f.i. Perca fluviatilis* L., *Acerina cernua* (L.), *Esox lucius* L., *Cyprinus carpio* L., *Tinca vulgaris* Flem., *Phoxinus aphya* (L.), *Leuciscus rutilus* (L.), *Leuciscus erythrophthalmus* (L.), *Abramis blicca* (Bloch), and *Cobitis barbatula* L.

Location: intestine.

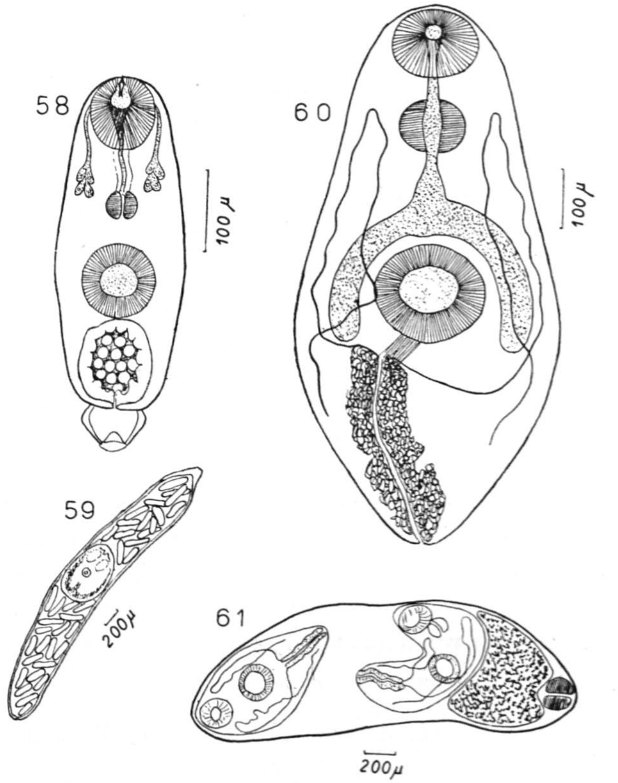
Snail host: *Bithynia tentaculata*.

Transport host: *Herpobdella* species.

Localities: No. 8 (19.VII. 1946, and 10.VII. 1947), No. 17 (9.VI., and 19.VIII. 1948), No. 52 (2.VII. 1947).

Cercariae

The dimensions have not been recorded; the length is a little over 400 μ. This Microcercous cercaria could scarcely be confused with any other species. Its main characters are: 1) The suckers are large; the ventral sucker is somewhat larger than the oral one. 2) Below the cuticle lies a thick layer of cystogenous cells, which makes the inner organs, especially the gut, nearly invisible. 3) The praepharynx is long; the pharynx is very muscular. 4) Beneath the pharynx on either side lie 4 small penetration gland cells. 5) A stylet is present.



Figs. 58—61. Fig. 58: Cercaria of *Sphaerostoma bramae*. Fig. 59: Sporocyst of *Sphaerostoma bramae* from *Bithynia tentaculata*, containing an encysted Tetracotyle. Fig. 60: Cercaria of *Asymphylodora tincae*. Fig. 61: Redia of *Asymphylodora tincae*.

6) The urinary bladder is large and elliptical; its walls are thick. 7) The cercaria creeps with hirudinoid movements.

The species is fairly common and the cercaria has been frequently described. I refer the reader to the description given by WESENBERG-LUND (1934). It may be added that I have seen these cercariae creeping on the walls of the containers, below the water-surface as well as on the tentacles of snails.

Occurrence: The *Bithyniae* are fairly heavily infected with this species, which occurs in both the inner and the outer zones of the archipelago. Our fish are also heavily infected with *Sphaerostoma bramae* (p. 87).

Note: SELINHEIMO has found *Cercaria micrura* once. The cercariae were not observed creeping on the snails, but were found on dissection. SELINHEIMO's description and drawing make it certain that her species is *Cercaria micrura*, as she herself assumed.

CERCARIAEA

In these cercariae the tail is totally absent. Here only the cercariaeum of *Asymphylodora tincae* (Modeer 1790) is described, which according to SEWELL's (1922) classification belongs to the *'Mutabile'* Group. DUBOIS (1929) placed it in the *'Squamosum'* Group, created by him.

CERCARIAEUM OF ASYMPHYLODORA TINCAE (MODEER 1790)

Figs. 60 and 61.

Synonym: *Cercariaeum paludinae impurae* (Filippi 1854).
Adult: *Asymphylodora tincae* (Modeer 1790).
Hosts: *Tinca vulgaris* Flem., *Cyprinus carpio* L., etc.
Location: intestine.
Snail host: *Bithynia tentaculata.*
Locality: No. 8 (10.VII. 1947, 7.VI. 1954).

Description: Dimensions: 900 $\mu \times$ 400 μ. This well known and rather common species and its behaviour have been thoroughly studied by WUNDER (1924), WESENBERG-LUND (1934), and others. I have nothing new to add. It may however, be noted that I have seen cercariae creeping not only on the tentacles of snails, but also on the bottom and sides of the containers. This behaviour was observed by LOOSS (1894), but not seen by WUNDER or WESENBERG-LUND.

The cercaria lacks a tail and is characterized by: 1) Two suckers of equal size. 2) A remarkably large pharynx, broader than long. 3) Very broad diverticula which reach the level of the posterior margin of the ventral sucker. 4) A thick-walled tubular urinary bladder. 5) When the cercaria has made its way out of the snail (through the spiracle?) it creeps to the end of the tentacles of the snail. When many cercariae aggregate here the tentacles and especially their tips may have a fluffy appearance.

Discussion: According to FUHRMANN (1916) and DUBOIS (1929) it is not *Cercaria paludinae impurae* but *Cercaria squamosum* Fuhrmann 1916 which is the larval stage of *Asymphylodora tincae. Cercaria squamosum* differs from *Cercaria paludinae impurae* among other things in its small rounded urinary vesicle. DAWES (1946) accepts *Cercaria paludinae impurae* as the larval stage of *A. tincae.*

Occurrence: The cercaria of *Asymphylodora tincae* has been seen only twice and both times on snails from the same locality, *viz.* Krogarviken. In 1947, 5 out of 14 separated *Bithyniae* were infected with *Cercariaeum*, 2 with the cercaria of *Sphaerostoma bramae* and the other 7 snails were doubly infected with these two species. In 1952 only 2 out of 25 snails dissected were infected with *Cercariaeum*. The cercaria of *Sphaerostoma bramae* was not found at all. The distribution of *Cercariaeum* seems to be limited to bays with a rich vegetation, where Cyprinids occur in large numbers. The cercaria of *Sphaerostoma bramae* has been found in the outer archipelago, too.

ECOLOGICAL ASPECTS

NUMBER OF SPECIES

Here descriptions are given of 23 species according to my own observations and 5 species found by SELINHEIMO. All these were found in the area described on p. 7. Within this area I have visited almost all pools with snails and many of them were visited frequently. It may be added that in some cases the trematode fauna in the same locality has been studied during 2—4 summers. Since the infection of snails with trematodes must have a random character, it is impossible to give a complete list of species, even for a restricted area. It must, however, be stated that the trematode fauna here reported gives a representative picture of the trematodes occurring in our archipelago.

It goes without saying that a greater amount of material from the same localities would introduce a number of new species. This is shown by the fact that SELINHEIMO, studying material from only two localities, found 10 species, 6 of which I have not been able to find again. In spite of this I think that the composition of the trematode fauna is more constant than could be expected, as also appears from table 1. This holds true for the material as a whole, but examining the composition of the trematode fauna of one locality from one year to the other we may find very great fluctuations.

Table 1. Comparison between the number of localities investigated, the number of species found and the number of new species for the years 1947, 1948, 1950 and 1952. Tetracotyle has been included as a separate species.

	1947	1948	1950	1952
Number of localities investigated	21	25	15	20
Number of species found	14	12	7	15
Number of new species	14	5	2	2
New species as percentage of species found	*100*	*42*	*29*	*13*

DEGREE OF INFECTION

GENERAL ASPECTS

I distinguish in the following between 1) the degree of infection of the snail populations, defining the term population as the snail fauna in a pool or pond or on a short strip of shore, and 2) the individual infection of the snails within a population, *i.e.*, the percentage of infected snails.

It was established that trematode infection occurs in most snail populations. In total, 62 different localities have been studied and an infection with parthenitae or cysts has been observed in 38 of these, or in 73 per cent. It is furthermore very probable that in some cases a weak infection was not observed at all. Further investigation would doubtless show that nearly all snail populations are infected with trematodes.

The individual infection of snails varies within wide limits from no infection to 100 per cent infection.

Comparison between the infection of the snail populations on shores and in pools

The difference in infection between the snail populations of the shores and the pools appears from table 2. From this I have excluded locality no. 17 (Långskär), since this curved bay resembles the pools with regard to its trematode fauna. It is seen that the degree of infection on the shores is much lower than in the pools. The table also gives some idea of the ease with which the presence of infection could be overlooked if only one snail sample was collected from each locality.

Table 2. Degree of infection of snail populations on shores and in pools.

	Shores	Pools
Number of localities investigated	21	30
Number of localities infected	12	25
Infected localities as percentage of all localities	*57*	*83*
Number of snail samples collected	47	84
Number of snail samples infected	19	49
Infected snail samples as percentage of all samples	*40*	*58*

Infection of shores

Apparently the degree of infection on shores depends mainly on 1) the density of miracidia hatched, which in turn depends on the number and the degree of infection of host animals, 2) the density of the snail population, and 3) the water movements, *i.e.*, waves and currents.

It is a hard task to elucidate the influence of the two first-named factors. Letting the degree of exposure serve as a measure of the water movements, it is found that the degree of infection is conversely proportional to exposure (table 3). It may, however, be noted that the number of infected hosts may

Table 3. Comparison between infection and exposure on shores.

Degree of exposure	Number of localities investigated	Number of localities infected
0	1	1
1	5	4
2	10	5
3	5	2

be greater in the inner archipelago (with lower exposures throughout) than in the outer. HOFF (1941) found a direct correlation between the degree of infection of snails and the habits of gulls.

The few values on the degree of infection of the snails in the populations of shores show clearly that as a rule this is very low. One exception is the 100 per cent infection which was observed in 1947 in *Bithynia tentaculata* from locality no. 8 (Krogarviken). In the year 1952 only one out of 25 *Bithyniae* was infected there. Other records are: loc. no. 6: none infected out of 15 *Theodoxus fluviatilis;* loc. no. 7: one out of 5 *Lymnaea stagnalis;* loc. no. 12: one out of 15 (*L. palustris*); loc. no. 13: one out of 15 (*L. peregra*). Often a somewhat higher degree of infection with Tetracotyle is found.

INFECTION OF POOLS

The degree of infection of the snails in pools varies greatly. The results are summarized in table 4.

Table 4. Degree of infection of snails in pools. D = snails dissected, S = each snail separated.

Loc. No.	Snail species	No. of snails	No. of snails infected with cercariae	No. of snails infected with Tetracotyle or cysts	Percentage infection with cercariae
24	L.stagn.	6 D	0	1	0
24	L.stagn.	15 D	0	0	0
24	B.tent.	15 D	0	1	0
26	B.tent.	25 D	6	5	24
30	L.stagn.	10 D	0	0	0
30	L.stagn.	17 D	0	0	0
31	L.stagn.	20 D	0	0	0
33	L.stagn.	10 D	0	0	0
33	L.pal.	20 D	4	20	20
33	L.pal.	6 S	2		30
36	L.stagn.	10 S	6	.	60
36	L.stagn.	9 D	0	0	0
36	L.per.	5 D	3	4	60
36	L.pal.	12 S	12		100
36	L.pal.	20 D	13	20	65
38	L.stagn.	12 D	3	0	25
40	L.stagn.	10 S	2		20
40	L.stagn.	20 D	6	2	30
42	L.per.	5 D	5	5	100
42	L.per.	10 S	0	0	0
43	L.per.	10 D	0	0	0
45	L.per.	10 S	5		50
46	L.per.	10 S	10		100
46	L.per.	10 D	0	6	0
48	L.stagn. (2—2.5 cm).	9 D	9	0	100
48	L.stagn. (0.7—1.2 cm.)	9 D	0	0	0
49	L.per.	10 D	9	5	90
50	L.stagn.	18 D	2	0	11

From the ratio of infected snail samples to the total number of samples collected, it appears that the heavily infected pools are localities nos. 36, 40, 42, 45, 46, 48, and 49. These lie on the skerries of Kummelgrund, Segelskär, Äggharun and Klovaskär. The pools nos. 24, 30, and 31, situated on Petter Römans grund and Svartgrund, may be considered to be usually slightly infected. On Ören, too, the trematode fauna is rather poor. According to AHLQVIST and FABRICIUS (1938) on Segelskär, Äggharun and Klovaskär there breed 21, 34 and 10 bird pairs respectively, whereas only two pairs breed on Svartgrund and Ören. Very similar data are given by LAMPIO (1946). The correlation between the bird fauna and trematode infestation is evident.

The immediate surroundings of the pools are important, too. Two factors are essential, *viz.* 1) the slope of the adjacent rock walls toward the pool or away from the pool, and 2) the attractiveness of the surroundings to birds.

1) It is evident that the inclination of the rock walls toward the pools determines the amount of excrement which is washed by rain into the pools. Two extreme cases are: loc. no. 36 (fig. 62), where the pool lies, as it were, at the end of a funnel and where infection has always been heavy, and loc. no.43, where trematode infection was not recognised and where the rock walls slope away from the pool (fig. 63).

2) Loc. no. 42 (Plate V, Fig. 13) and similar pools, which are surrounded by vegetation, are usually heavily infected, apparently because many bird species visit them.

A comparison between infection and pool type (p. 9) is not possible, since the infection in snail pools is solely dependent on the number of miracidia hatching (and the density of snails). Moreover, many types of pools, especially the older ones in the inner archipelago, always lack snails. For further information, see WIKGREN 1953 a.

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Fig. 62. Diagrammatic drawing of loc. no. 36 (Kummelgrund) to exemplify pools with walls sloping towards the pool. In such rock pools the infection of the snails with trematodes is usually high.

Fig. 63. Diagrammatic drawing of loc. no. 43 (Äggharun) where the walls slope away from the pool. The infection in such pools is usually low.

SPECIES COMMON ON SHORES AND IN POOLS.

On shores I have found 14 species and in pools 20 species. Species common to both shores and pools are:

Cercaria of *Notocotylus* sp.

Gymnocephalous cercaria A and *B*

»Cercaria ocellata»

Cercaria of *Apatemon gracilis*

Cercaria of *Diplostomum spathaceum*
Cercaria helvetica XXX
Cercaria fennica III and *IV*
Tetracotyle

Only four species have been found solely on shores, *viz.* Cercaria of *Azygia lucii, C. splendens,* C. of *Asymphylodora tincae,* and *Furcocercaria I* Wesenberg-Lund. The cercaria of *Sphaerostoma bramae* has been found on shores and in an intralittoral sea-water basin. *Sphaerostoma bramae* is known to occur in our fresh waters, too (p. 87).

Even though the possibility exists that the distribution of some species is determined by their ability to tolerate fresh or brackish water, it may on good grounds be assumed that this generally plays a minor rôle. I have made few experiments to ascertain the viability of cercariae in different salt concentrations. These experiments were performed on a *Xiphidiocercaria* sp. and on the cercaria of *Diplostomum spathaceum.* It was found that there is no significant difference in viability in fresh and brackish water and that the animals could also live for a considerable period of time in distilled water (with traces of fresh water). STUNKARD and SHAW (1931) have investigated the effect of dilution of sea water on the viability of some marine cercariae. The degree of tolerance found is very surprising. Most species tolerate $^1/_8$ sea water even though longevity in this is reduced.

DEGREE OF INFECTION OF EACH SNAIL SPECIES

In table 5 the percentage of infection with parthenitae for each snail species is given. The differences in infection are rather small, the figures showing mainly that each species is heavily infected. No significant difference in the degree of infection of the Lymnaeids and *Bithynia tentaculata* could be detected.

Table 5. Degree of infection with cercariae for each snail species.

Snail species	No. of snails dissected.	No. of snails infected	Percentage infection
Lymnaea stagnalis	182	30	17
Lymnaea peregra	126	49	39
Lymnaea palustris	91	34	36
Bithynia tentaculata	105	28	27
Total	519	141	27

HOST SPECIFICITY

It was for a long time believed that each trematode species was strictly host-specific regarding the first intermediate host. As a result of this belief, identical species that had emerged from different snail hosts were described as different species. Nowadays it may be regarded as an established fact that the miracidia are not as a rule strictly host-specific, though often a marked predilection for one snail species can be recognized. Usually, however, the miracidia show marked specificity as to the group (family or order) of snail so that trematodes parasiting Pulmonates do not occur in Prosobranchiates and vice versa. The cercariae of species which use snails as the second intermediate host show a less marked host specificity. MATHIAS (1925, p. 61) showed that the miracidia of *Strigea tarda* (compare p. 52) normally penetrate into Pulmonate snails, but that *Bithynia tentaculata* could be infected experimentally. MATHIAS (l.c.) discovered another very interesting fact, *viz.* that in nature *Lymnaea peregra* is less heavily infected with Tetracotyle than *L. stagnalis*, owing to the different behaviour of the snails, *L. peregra* living in deeper water than *L. stagnalis*. The cercariae move near the surface. I suppose that similar factors are in many cases responsible for an ostensible host specificity of the miracidia, since these may show preferences for different depths. Especially in this study, in which snails of both shores and pools have been collected from a depth not exceeding one metre, it would be expected that the host-specificity within the snail groups would be very little marked. It may be added that usually only one snail species lives in each pool and that the miracidia have very limited opportunities to find the preferred species.

In table 6 I have listed the cercariae and their snail hosts. The species found by SELINHEIMO are not included. Of the trematodes parasitising the Lymnaeids, 6 have been found in all three species, and 5 occur in two species. Of the 4 species found in only one snail species, 3 have been found only from one locality and one (*C. Hypoderaeum conoideum*), from four localities. The trematode fauna found in *Bithynia* is specific. It may be noted, however, that Tetracotyle is found in this snail. SELINHEIMO's note that her *Cercaria no. 8* (the cercaria of *Diplostomum spathaceum*) occurred in both *L. stagnalis* and *B. tentaculata* is very remarkable. This observation is presumably due to a confusion of two different trematode species with somewhat similar floating positions (the cercaria of *Diplostomum spathaceum* and a cercaria of the *'Vivax'* Group?).

Table 6. The cercariae and their snail hosts.

Cercaria species	L. stagnalis	L. peregra	L. palustris	Spir. vortex	B. tentaculata	No. of snail hosts	No. of localities	No. of findings
C. of Notocotylus sp.	+	+	+			3	4	5
C. fennica I					+	1	1	1
Gymnocephalous c. A					+	1	3	3
Gymnocephalous c. B					+	1	2	3
C. of Hypoderaeum conoideum ..		+				1	4	4
C. fennica II					+	1	1	1
C. helvetica IX					+	1	1	1
C. cambriensis I	+		+			2	3	4
C. helvetica XXX	+	+	+			3	4	4
C. fennica III	+	+	+			3	13	18
»C. ocellata»	+		+			2	3	3
C. strigeae tardae	+	+				2	2	2
C. linearis			+			1	1	1
C. of Diplostomum spathaceum	+	+	+			3	18	24
C. chromatophora	+	+	+			3	5	7
C. fennica IV	+	+				2	2	2
Furcocercaria I		+				1	1	1
C. Apatemon gracilis		+	+			2	4	5
C. fennica V					+	1	1	2
Tetracotyle cysts	+	+	+		+	4	14	20
C. of Azygia lucii			+			1	1	1
C. splendens				+		1	1	1
C· of Sphaerostoma bramae					+	1	3	5
C. of Asymphylodora tincae					+	1	1	2
No. of trematode species	10	11	11	1	9			

DOUBLE INFECTION

Cases of simultaneous infection of one snail with parthenitae of more than one trematode species are, as a rule, rather rare (cf. WINFIELD 1932, CORT, McMULLEN, and BRACKETT 1937). In my material only 9 cases are recorded. Of these, 7 were found in *Bithynia tentaculata* from loc. no. 8 (9. VII. 1947), which were doubly infected with parthenitae of *Asymphylodora tincae* and *Sphaerostoma bramae*. Cases of double infection with these two species seem to be commoner than double infections with other species (cf. WESENBERG-LUND 1934, p. 163). In the two other cases *Cercaria fennica III* was found together with Holostomid cercariae (cercaria of *Diplostomum spathaceum* and *Cercaria chromatophora*). These three species are the commonest species occurring in the area investigated and consequently the chance of double infection is greatest with them.

No case of triple infection has been noted.

Simultaneous infection with parthenitae of one species and cysts of another species is much commoner (cf. List of material).

TREMATODES AND THE INVERTEBRATE FAUNA

Since trematodes use invertebrates as the first and often also as the second intermediate host, it seems justified to deduce that the trematodes must play an important rôle in population dynamics and to some extent also in the distribution of some invertebrate species. The number of both miracidia and cercariae per unit volume of water rises to considerable values, especially in pools with their limited space, and hence the effect of trematodes, especially in pool faunas, must be taken into account. Some shallow bays with a rich snail fauna may in this respect be comparable with the pools.

It is a well known fact that snails are severely damaged by trematodes and that trematodes control the populations of snails (c. FAUST 1917; AGERSBORG 1924; DUBOIS 1929; REES, F. C. 1931, 1934; REES, W. J. 1936; WESENBERG-LUND 1934; ROTHSCHILD 1936, 1941 a, c; RANKIN 1939; ROTHSCHILD and ROTHSCHILD 1939; NEUHAUS 1942; CREWE 1951, and OLIVIER, BRAND and MEHLMAN 1953). Especially snails of small rock pools, such as occur in the Finnish archipelago and form ideal trematode nurseries, are strongly affected by trematodes (WIKGREN 1953 a).

Many species, especially those belonging to the Gymnocephalous, Echinostomous, Strigeid and Microcercous cercariae, and the Cercariaea also use snails as the second intermediate host. Special mention may be made of the Tetracotyle cysts, which often occur in large numbers and which severely damage their host animals.

Of trematodes which use invertebrates other than snails as the second intermediate host, the Xiphidiocercariae are the most important. The cercariae usually show no very exclusive host specificity, being mostly specialised on groups of related animals rather than on species. Examples could, however, be given which show that cercariae may penetrate into and encyst in a great variety of animals. Thus DUBOIS (1929, p. 67) reports that his *Cercaria helvetica XXX* encysts in *Asellus aquaticus*, *Chauborus* larvae and tadpoles. The most important second intermediate hosts of the Xiphidiocercariae are insect larvae, crustaceans and tadpoles (MCMULLEN 1937 b; see also DAWES 1946). I think that the Diptera larvae, which occur in many pools in large number, must be at least to some degree infected with trematode cysts. Such animals as some Chironomids and *Limnophilus* species do not usually occur in snail pools, but here at least two factors other than trematodes must be taken into account, *viz.*, that these animals perhaps do not thrive together with snails and that snails do not occur in those older pools in the inner archipelago zones which are preferred by Chironomids and *Limnophilus*.

TREMATODES AS PATHOGENS IN VERTEBRATES

The pathogenic effect of the intestinal trematodes is usually fairly slight. The blood and liver parasites, however, can cause severe disease, greatly increasing the mortality and shortening the life-time of the hosts. These problems have been investigated by parasitologists and the diseases caused by *Fasciola hepatica, Dicrocoelium dendriticum* and by *Schistosomatids* have been extensively studied. The records regarding the trematode infection in Finland show that trematodes usually only occur in small numbers and that their harmful effect has obviously been negligible. It should, however, be born in mind that reports concerning other than intestinal parasites are very few and that therefore an extended investigation would without doubt give us a somewhat different picture of the harm done by the trematodes.

It may be especially pointed out that severe diseases and death in fish are produced by cercariae which use fish as a second intermediate host (transport host). The best-known representatives of these are the cercaria of *Diplostomum spathaceum* and the related Holostomids. With slight infection they cause blindness and certainly also decreased vitality and with heavy infection death (Wunder 1926; Cornelius 1935). I have myself found *Zoarces viviparus* (L.) which was totally blinded by *Diplostomum*. Rushton (1937, 1938) reports that about 5 per cent of the rainbow trout investigated by him were blinded by *Diplostomum*. Szidat (1924, p. 265) summarizes his observations on the injuriousness of *Cercaria C* in the following manner:

»Die Versuche zur Erforschung des Entwicklungszyklus von *Cercaria C* zeigen, dass diese Cercarie unter für sie günstigen Umständen zu einem ausserordentlich gefährlichen, bisher nicht beachteten Fischschädling werden kann.»

Wesenberg-Lund (1934, p. 204) is also of the opinion that the trematodes play an important rôle in the population dynamics of fishes. He writes:

»Without going into detail there is no doubt that in the world-wide economy of freshwater fishes the molluscs play a rôle which can hardly be overrated», and

»Further it must be remembered that not only may the life of the fish be threatened by Trematoda attacks and now and then a general destruction of the fish in the water-body be the consequence, but the Trematoda may also be of economic significance in other respects. It may be regarded as an established fact that strong parasitic infection may produce retardation of early growth, retention of juvenile characters and an increase in the number of scales.»

As has been noted (p. 57) the cercaria of *Diplostomum spathaceum* is the commonest species in my material. It occurs on nearly 40 per cent of the shores investigated. If a larger material had been collected, this cercaria would certainly have been found even oftener. Without doubt, the cercaria of *Diplostomum spathaceum* and the related Holostomids are very harmful to swarms of young fish, which display a preference for shallow water and especially for vegetation-rich shores, *i.e.* where these cercariae occur, too.

Of the many observations on the damage done by trematode larvae to fish, some additional ones may be cited here. BLOCHMAN (1910) observed death in aquarium fishes caused by the strigeid *Cercaria fissicauda* La Valette. BROOKS (1946) showed experimentally that certain Xiphidiocercariae could be lethal to sunfish, perch and large-mouthed bass. CROSS (1938) found that heavily parasitized fish tended to be smaller than those with a light infection or none. A similar correlation was found by HUNTER and HUNTER (1938). ELLIOTT and RUSSERT (1949), however, could not find any correlation between the condition of *Perca flavescens* and the number of metacercariae of *Clinostomum marginatum*. CHANDLER (1951) observed as many as 8 species of metacercariae in *Perca flavescens* in Lake Itasca. FERGUSON (1943) showed that the cercariae of *Diplostomum flexicaudum*, whose normal transport hosts are fishes, could penetrate and grow into metacercariae in the lenses of tadpoles, frogs, turtles, chicks, ducklings, mice, rats, guinea pigs, and rabbits. He hints the possibility that holostomid trematodes can cause disease in man, too.

Of the trematode larvae occurring in pools some (Strigeids, Echinostomous cercariae, Xiphidiocercariae) are certainly able to penetrate into frog tadpoles and the newt (*Triturus vulgaris* (L.)) (cf. DAVIS 1936; NIGRELLI and MARAVENTANO 1944). Thus trematodes probably control the distribution of these species. In the Tvärminne archipelago I know only two pools with *Triturus* populations; both of these lack snails. As far as I remember I have only twice found tadpoles in snail pools (Spikarna and Äggharun).

In this connection the schistosome species may be mentioned (*»Cercaria ocellata»*). These avian parasites cause a severe dermatitis in man. Further dogs (HERBER 1938) and many laboratory animals (e.g. hamsters, guinea pigs, rabbits, mice and rhesus monkeys; OLIVIER 1953) can be infected with them.

FINNISH DIGENETIC TREMATODES

The 28 digenetic trematodes known to occur in Finland are listed below. The list is chiefly based on the collections in the Zoological Museum of the University of Helsinki/Helsingfors and on perusal of the literature. The collections have not been revised.

It may be mentioned that the identification of some species may be erroneous. The Museum samples are mostly very old and very few species mentioned in the literature are described.

A separate list has been prepared for the samples in the Museum collections. Further, the trematodes have been listed according to the vertebrate class they parasitize. There the literature references are to be found.

Crepidostomum farionis (Müller 1784)
Bucephalus polymorphus Baer 1827
Sphaerostoma bramae (Müller 1776)
*)*Asymphylodora tincae* (Modeer 1790)
Azygia lucii (Müller 1776)
Bunodera luciopercae (Müller 1776)
Gorgodera cygnoides (Zeder 1800)
Posthogonimus ovatus (Rudolphi 1803) Lühe 1899
Haplometra cylindracea (Zeder 1800) Looss 1899
Plagiorchis cirratus (Rudolphi 1802)
Pleurogenes claviger (Rudolphi 1819)
Lypersomum corrigia Braun 1901
Dicrocoelium dendriticum (Rudolphi 1819) Looss 1899
Philophthalmus lucipetus (Rudolphi 1819) Looss 1899
(*Catatropis verrucosa* (Frölich 1789) Odhner 1905)
Leucochloridium macrostomum (Rudolphi 1803) Poche 1907
Echinostoma revolutum (Frölich 1802) Looss 1899
*)*Hypoderaeum conoideum* (Bloch 1782) Dietz 1909
Stephanoprora denticulata (Rudolphi 1802)
Fasciola hepatica Linnaeus 1758
*)*Cotylurus cornutus* (Rudolphi 1809) Szidat 1928
Apatemon gracilis (Rudolphi 1819) Szidat 1928
Cardiocephalus longicollis (Rudolphi 1819) Szidat 1928
Diplostomum spathaceum (Rudolphi 1819) Olsson 1928
Tylodelphys clavata (v. Nordmann 1832) Diesing 1850
Posthodiplostomum cuticola (v. Nordmann 1832) Dubois 1936
Bilharziella polonica (Kowalewsky 1895)

Distoma mesostomum (The current synonym could not be found in the reference literature used.)

*) Added by this investigation.

Museum collections

The digenetic trematode material in the Zoological Museum of the University of Helsinki/Helsingfors consists of 71 samples of 25 species and a large number of undetermined samples. Most of the material is more than 50 years old.

The collections further include 24 species obtained from Prof. v. Siebold in 1858, and 2 species obtained from Dr. Lundahl in 1852, and a sample of *Schistosoma haematobium* obtained from Prof. Bilharz. Furthermore the collection of Dr. J. M. af Tengström, consisting of 20 type species, is included in the collections. These samples are provided with very incomplete notations, but most of the samples have obviously been obtained from Prof. Mehlis.

The Finnish finds have been listed below. The valid names of five species could not be found in the reference literature used.

Allocreadiidae

Crepidostomum farionis (Müller 1784). Synonym used: *Distomum laureatum* Zeder. 4 finds: 3 finds by A. R-mi (A. Rantaniemi) in 1898 from Tuntsajoki (*Salmo trutta fario*), one find by Eskelin from Jorois (*Salmo salar*) in 1888.

Sphaerostoma bramae (Müller 1776). Synonyms used: *Distomum globiporum* Rud. and *Sphaerostomum bramae* (Rud.). 8 samples: one find by V. J. (V. Jääskeläinen) in 1915 from Laatokka (*Abramis blicca*), one find by G. Schneider in 1901, and 6 anonymous samples from 1903 and 1904 from Sibbo (*Abramis brama* (2), *A. blicca*, *Leuciscus grislagine*, *L. idus*, and *L. rutilus*).

Azygiidae

Azygia lucii (Müller 1776). Synonym used: *Distoma* (*Distomum*) *tereticolle* Rud. 25 samples. In *Esox lucius*: Elfving, 1849; Rosqvist and Eskelin, 1887, Lovisa; A. Rantaniemi, 1898, Temiojärvi, Salla and Sallajoki; A. R-mi (A. Rantaniemi), 1897, Kemi; Fontell, 1897, Jakobstad; A. Luther, 1900, 2 finds from Lojo sjö; A. L. Forsell, 1903, Sibbo; G. Schneider, 1902 and 1903, Tvärminne, and 2 finds from 1904, Sibbo; Aarne Palmen, 1903, Helsingfors; E. Munsterhjelm, 1904, Vanajavesi; T. Hintikka, 1909, Joroinen; K. E. Ehrström, 1915, Helsingfors; N. Kanerva, 1921, Tvärminne; V. Jääskeläinen, 1912, 1915 and 1924, Laatokka. In *Perca fluviatilis*: A. Luther, 1900, Lojo sjö. In *Silurus glanis*: V. Jääskeläinen, 1924, Suojujoki.

Bunoderidae

Bunodera luciopercae (Müller 1776). Synonym used: *Distoma nodulosum*. One find by Eskelin, 1888, Jorois in *Perca fluviatilis*. Furthermore there is a sample from Obersee, Reval, from 1904 donated by G. Schneider.

GORGODERIDAE

Gorgodera cygnoides (Zeder 1800). Synonym used: *Distomum cygnoides* Zeder. 3 finds from *Rana temporaria:* ROSQVIST and ESKELIN, 1887, Helsingfors; A. LUTHER, 1902; K. E. EHRSTRÖM, 1913, Helsingfors.

PLAGIORCHIIDAE

Posthogonimus ovatus (Rudolphi 1803) Lühe 1899. Synonym: *Distomum ovatum.* One find by D. J. MICKVITZ in 1863 from Helsingfors (*Gallus*, ex ovo?) (cf. NORDMANN 1864).

Haplometra cylindracea (Zeder 1800) Looss 1899. Synonyms used: *Distoma cylindraceum* Rud. and *D. cylindraceum* Zed. 3 finds from *Rana temporaria:* J. M. af TENGSTRÖM; ROSQVIST and ESKELIN, 1887, Lovisa; K. M. L. (LEVANDER), 1920.

Plagiorchis cirratus (Rudolphi 1802). Synonym: *Distoma cirratum* Rud. Two finds by ESKELIN in 1888 from Jorois, the one from *Corvus cornix*, the other from *Pica pica.*

LECITHODENDRIIDAE

Pleurogenes claviger (Rudolphi 1819). Synonym: *Distomum clavigerum* Rud. One find by ROSQVIST and ESKELIN in 1887 from Lovisa (*Rana temporaria*).

PHILOPHTHALMIDAE

Philophthalmus lucipetus (Rudolphi 1819) Looss 1899. Synonym: *Distomum lucipetum.* One find by ESKELIN in 1888 from Helsingfors (*Larus argentatus*).

NOTOCOTYLIDAE

Notocotylus attenuatus (Rudolphi 1809) Kossack 1911. Synonym: *Monostomum attenuatum* Rud. One find by ROSQVIST and ESKELIN in 1887 from Helsingfors (*Mergus merganser*).

Catatropis verrucosa (Frölich 1789) Odhner 1905. Synonym used: *Monostoma verrucosum* Zed. One find from *Branta bernicla* without further notes. Perhaps not a Finnish find.

BRACHYLAEMIDAE

Leucochloridum macrostomum (Rudolphi 1803) Poche 1907. Synonym: *L. paradoxum.* Three finds by A. LUTHER from *Succinea putris:* 1898, Lojo; 1898, Reval; 1908, Kotka.

ECHINOSTOMATIDAE

Echinostoma revolutum (Frölich 1802) Looss 1899. Synonym used: *Distomum echinatum* Zeder. One find by ROSQVIST and ESKELIN in 1887 from Helsingfors (*Anas platyrhynchos*).

Stephanoprora denticulata (Rudolphi 1802). Synonym: *Distomum pseudoechinatum.* One find by A. L. FORSELL in 1904 from *Larus fuscus.*

FASCIOLIDAE

Fasciola hepatica Linnaeus 1758. Synonym: *Distomum hepaticum.* 4 finds: J. A. WIGELIUS, 1869, Mustiala (*Equus*); ESKELIN, 1888, Jorois (*Ovis*); FEDERLEY, 1898, Helsingfors; J. M. AF TENGSTRÖM (*Equus*). Furthermore one sample without other notes than name of species.

STRIGEIDAE

Apatemon gracilis (Rudolphi 1819) Szidat 1928. Synonym used: *Holostomum gracile* Duj. One find from *Mergus merganser* by ROSQVIST and ESKELIN, 1887, Helsingfors.

Cardiocephalus longicollis (Rudolphi 1819) Szidat 1928. Synonym: *Holostomum longicolle.* One find from *Larus argentatus* by ESKELIN, 1888, Helsingfors.

DIPLOSTOMATIDAE

Diplostomum spathaceum (Rudolphi 1819) Olsson 1876 together with *Tylodelphys clavata* (v. Nordmann 1832) Diesing 1850. Synonyms: *Diplostomum volvens* and *clavatum* Nordm. 4 finds by A. LUTHER in 1900 from Lojo sjö (*Perca fluviatilis, Leuciscus erythrophthalmus* and *L. rutilus* (2)).

SYNONYMS UNKNOWN

Distoma mesostomum from *Turdus musicus:* ESKELIN, 1888, Jorois.

Distoma macrouroides Tengström from *Lullula arborea:* J. M. AF TENGSTRÖM.

Monostoma perpusillum Tengström n.sp. from *Larus argentatus:* J. M. AF TENGSTRÖM.

Holostomum insigne Tengström n.sp. from *Stercorarius parasiticus:* J. M. AF TENGSTRÖM.

Tetracotyle percae fluviatilis v. Linst. from *Perca fluviatilis:* V. JÄÄSKELÄINEN, 1910, Laatokka (cf. p. 56).

PARASITES OF FISH

Sphaerostoma bramae (Müller 1776)

H o s t s: many fish species.[1])

L o c a t i o n: intestine.

Sphaerostoma bramae seems to be our commonest digenetic trematode parasitising fishes. To the host species listed by DAWES (1946, p. 208) may be added: *Leuciscus idus* (L.), *Abramis vimba* (L.), *Abramis brama* (L.), *Alburnus lucidus* Heck., *Gasterosteus aculeatus* L. and *Gobius niger* L. In table 7 I have

Table 7. Percentage infection of fish with *Sphaerostoma bramae*. The number of fish investigated is given in brackets.

Species of fish	Degree of infection according to			
	SCHNEIDER	LEVANDER	JÄÄSKELÄINEN	JÄRNEFELT
Phoxinus aphya (L.)	25 (4)	11 (9)		
Leuciscus rutilus (L.)	10 (21)	24 (38)	15 (13)	3 (425?)
Leuciscus erythrophthalmus (L.)	6 (35)	25 (42)		3.5 (46)
Leuciscus idus (L.)	8 (37)	35 (37)	8 (13)	
Abramis vimba (L.)	50 (2)	50 (4)		
Abramis brama (L.)	12 (8)	23 (17)	25 (4)	2 (362?)
Abramis blicca (Bloch)	16 (25)	32 (25)	21 (19)	2 (260?)
Alburnus lucidus Heck.	12 (26)	27 (55)		
Esox lucius L.		5 (41)		
Gasterosteus pungitius L.		6 (17)		
Gobius niger L.		25 (4)		
Perca fluviatilis L.				0.5 (?)

summarized the records given by SCHNEIDER (1902), LEVANDER (1909), JÄÄSKELÄINEN (1917) and JÄRNEFELT (1921) on the degree of infection with *Sphaerostoma bramae.* SCHNEIDER's and LEVANDER's investigations were

[1]) The lists of host species are for the most part directly cited from the publications of DUBOIS (1936) and DAWES (1946).

performed on material from coastal waters (brackish water), JÄÄSKELÄINEN's work on material from Lake Ladoga and JÄRNEFELT's on fish caught in Lake Tuusulanjärvi (fresh waters).

Sphaerostoma bramae is further noted by SCHNEIDER (1901) from *Leuciscus idus, L. rutilus* and *Alburnus lucidus,* by LEVANDER (1902) from *Leuciscus erythrophthalmus, Abramis brama,* and *A. blicca,* and by FORSELL (1905, p. 19) from *Leuciscus idus.*

The Museum collections include 8 samples from Lake Ladoga and from Sibbo.

Azygia lucii (Müller 1776)

Hosts: *Esox lucius* L., *Perca fluviatilis* L., *Lota vulgaris* Jenyns, *Leuciscus cephalus* (L.), various Salmonidae.

Location: stomach and intestine.

Azygia lucii commonly occurs in our pike (*Esox lucius* L.). LEVANDER (1909) found this parasite in 32 per cent (total 41 pike) and JÄRNEFELT (1921) in 39 per cent (total 42 pike). Further JÄÄSKELÄINEN (1913 b) found *Azygia lucii* in one out of 9 pike from Kemiälv, BROFELDT (1917) in one out of 13 pike from Lake Längelmävesi and JÄÄSKELÄINEN (1917) in 5 out of 15 pike from Lake Ladoga. JÄÄSKELÄINEN (1921) also reports finds from Lake Höytiäinen. I have frequently seen this trematode in pikes caught in Tvärminne, Lake Vanajavesi and several other localities.

The Museum collections include 25 finds of *Azygia lucii* from *Esox, Perca* and *Silurus glanis.*

The larval stages of *Azygia lucii* are described on p. 68.

Bunodera luciopercae (Müller 1776)

Hosts: *Perca fluviatilis* L., *Acerina cernua* (L.), *Esox lucius* L., Salmonidae, a.o.

Location: intestine.

The intestinal parasite *Bunodera luciopercae* has been found by LEVANDER (1906) in 4 out of 5 perch caught in Lake Valkea-Mustajärvi, and by JÄRNEFELT (1921) in about 0.5 per cent of a large material of perch and in one pike-perch (*Lucioperca sandra* Cuv.) from Lake Tuusulanjärvi.

The Museum collections contain one find.

The life-history of *Bunodera luciopercae* has been studied by the Russian scientists LAYMAN (1940) and KOMAROVA (1941). The cercaria is an Ophthalmoxiphidiocercaria.

Bucephalus polymorphus Baer 1827

Hosts: *Esox lucius* L., *Perca fluviatilis* L., *Lota vulgaris* Jenyns, etc.

Location: intestine.

This parasite has been reported by JÄRNEFELT (1921) to occur in 0.4 per cent of perch from Lake Tuusulanjärvi.

The parthenitae develop in *Anodonta* and *Unio* species. The cercariae are very characteristic, belonging to the Furcocercariae (*'Bucephalus'* Group). They are real planktonic organisms provided with broad, wingshaped furcae. Many plankton-eating fishes serve as transport hosts.

Crepidostomum farionis (Müller 1784)

Hosts: Salmonidae, Coregonidae.
Location: intestine.

JÄÄSKELÄINEN (1911, 1913) has reported two findings of *Crepidostomum farionis*, one from *Thymallus vulgaris* Nilss. (from Puntarikoski), the other from *Salmo trutta lacustris* L. (from Kemijoki).

The Museum collections include 4 finds.

The life history of *Crepidostomum farionis* has been discovered by BROWN (1926) and CRAWFORD (1943). The parthenitae develop in *Pisidium* and *Sphaerium*. The cercariae are large (about 1 mm. long) Ophthalmoxiphidiocercariae. They use *Ephemera* species as the second intermediate host.

Distomum perlatum v. Nordmann (?)

LEVANDER (1909, p. 23) has reported one find of a sexually mature *Distomum perlatum* from *Leuciscus rutilus* (L.).

Trematoda sp.

Distomum sp.: JÄRNEFELT (1921) from a perch.

Cercaria sp.: JÄRNEFELT (1921) from a pike.

Trematoda sp.: LEVANDER (1909) from a perch; BROFELDT (1917) in one out of 38 perch (p. 190), in 3 out of 29 bream (p. 203), and in 4 out of 13 pike (p. 212) from Lake Längelmävesi.

PARASITES OF AMPHIBIANS

The Museum collections include the following finds of trematodes from frogs:

Gorgodera cygnoides (Zeder 1800)
Haplometra cylindracea (Zeder 1800) Looss 1899
Pleurogenes claviger (Rudolphi 1819)

PARASITES OF BIRDS

Diplostomum spathaceum (Rudolphi 1819) Olsson 1876

Hosts: gulls and many other sea birds.
Location: intestine.

BROFELDT (1925) has found the encysted stage of this parasite in burbots (*Lota vulgaris* Jenyns) caught in the following lakes: Lake Latvajärvi, Lake Savijärvi, Lake Valkea-Mustajärvi, Lake Ylempi Rautjärvi and Lake Alempi Rautjärvi. In Lake Latvajärvi most burbots were infected, in the other only a few fish. In Lake Hokajärvi 8 out of 422 dace (*Leuciscus rutilus* (L.)) were infected with *Diplostomum*. In the dace only few trematodes were found in the eyes, in the burbot the eyes were often heavily infected, some fish being blind.

The Museum collections include 4 finds of *Diplostomum spathaceum* together with *Tylodelphys clavata* from fish.

I have found *Diplostomum spathaceum* on two occasions. The first time I found it on July 4, 1947, in the intestine of an eider (*Somateria mollissima* (L.)). Later, on August 4, 1948, I found this species again, this time in the intestine of a dead juvenile black-backed gull (*Larus fuscus* L.). The ileum of the gull was in some sections very heavily inflammed, obviously as a result of the attacks of the trematode.

The cercaria stage of *Diplostomum spathaceum* is very common (p. 57).

Posthodiplostomum cuticola (v. Nordmann 1832) Dubois 1936.

Hosts: *Ardea cinerea* L., *Ardea purpurea* L., *Ardeaola ralloides* (Scop.) *Egretta garzetta* (L.), *Nycticorax nycticorax* (L.).
Location: intestine.

In one *Alburnus lucidus* Heck. LEVANDER (1909) found 3 encysted trematodes, which he supposed to be *Posthodiplostomum cuticola* (notes as *Diplostomum cuticola?*). The identification of this species is thus very vague.

Lypersomum corrigia Braun 1901

Hosts: *Tetrao urogallus* L., *Tetrastes bonasia* (L.), a.o.
Location: intestine.

According to MUROMA (1951), *Lypersomum corrigia* has been found in one out of 44 partridge (*Tetrastes bonasia* (L.)).

Bilharziella polonica (Kowalewsky 1895)

Hosts: Anatidae.
Location: abdominal veins.

The cercaria of *Bilhaziella polonica* has been found from Vesvuo (Lohja) by PIRILÄ and WIKGREN (1955).

Strigea sp.

MUROMA (1951) reports findings of *Strigea* sp. in 6 out of 22 eiders (*Somateria mollissima* (L.)). In 5 more birds, trematodes of undetermined species were found. Thus 50 per cent of the eiders investigated were infected with trematodes. I suppose that some of the trematodes found are *Diplostomum spathaceum.*

Tetracotyle percae fluviatilis Moulinié 1856

JÄÄSKELÄINEN (1910) reports find of *Tetracotyle percae fluviatilis* v. Linst. (should be: Moulinié) from one perch caught in Lake Ladoga. Further history unknown.

In the Museum collections are samples of the following bird trematodes:

Posthogonimus ovatus (Rudolphi 1803) Lühe 1899
Plagiorchis cirratus (Rudolphi 1802)
Philophthalmus lucipetus (Rudolphi 1819) Looss 1899
Notocotylus attenuatus (Rudolphi 1809) Kossack 1911
(*Catatropis verrucosa* (Frölich 1789) Odhner 1905)
Leucochloridium macrostomum (Rudolphi 1803) Poche 1907
Echinostoma revolutum (Frölich 1802) Looss 1899
Stephanoprora denticulata (Rudolphi 1802)
Apatemon gracilis (Rudolphi 1819) Szidat 1928
Cardiocephalus longicollis (Rudolphi 1819) Szidat 1928
Tylodelphys clavata (v. Nordmann 1832) Diesing 1850
Distoma mesostomum
(*Distoma macrouroides* Tengström)
(*Monostoma perpusillum* Tengström)
(*Holostomum insigne* Tengström)

PARASITES OF MAMMALS

Only two species of trematodes parasitizing mammals seem to be known from Finland. These are the cosmopolitan *Fasciola hepatica* Linnaeus 1758 and *Dicrocoelium dendriticum* (Rudolphi 1819) Looss 1899. To these may be added one find of *Opisthorchis* sp. from *Vulpes vulpes* (MUROMA 1951) and some undetermined samples.

Fasciola hepatica Linnaeus 1758

Hosts: *Homo, Ovis, Bos, Equus, Sus, Felis, Lepus,* etc.
Location: bile ducts.

The Museum collections include 4 finds of *F. hepatica;* the oldest dates from 1869. In 1889 Oker-Blom reported a find of *F. hepatica* from a hare shot at Viborg. Levander (1927) reports a find in a hare from Hausjärvi and mentions an earlier find (1899) from Fredrikshamn (W. Segercrantz). According to Muroma (1951) *F. hepatica* has been found in 14 out of 410 *Lepus timidus* and in one out of 69 *Lepus europaeus.*

Both *F. hepatica* and *Dicrocoelium dendriticum* are common in our domestic animals, especially in cows and sheep. From the Veterinary Department of the Ministry of Agriculture I have obtained some information regarding the numbers of parts or organs of animals which have been rejected at meat

Table 8. The number of parts or organs of animals which have been rejected at meat inspection owing to the presence of trematodes (Diagnosis: *Distomatosis*) during the years 1930—53. The total livestock of adult cows, sheep, pigs and horses for the years 1929—30, 1941 and 1950 are included. (The figures referring to the infected organs have been obtained by verbal communication from the Veterinary Dept. of the Ministry of Agriculture; the figures referring to the total livestock are taken from the 1950 Census of Agriculture (The Official Statistics of Finland, 1954).

		Cows	Sheep	Pigs	Horses
Total livestock	1929	1 149 398	596 946	189 375	322 564
Infected	1930	36 583	17 147	149	—
»	1931	37 043	18 467	—	—
»	1932	41 775	15 705	4	—
»	1933	47 410	20 013	—	—
»	1934	42 264	17 958	—	—
»	1935	42 829	19 248	—	—
»	1936	47 507	21 123	—	—
»	1937	54 920	21 324	—	—
»	1938	50 433	21 169	—	—
»	1939	47 435	17 429	—	—
»	1940	51 470	8 214	73	—
»	1941	20 682	1 924	—	—
Total livestock	1941	1 058 999	333 177	86 589	277 633
Infected	1942	11 679	725	—	—
»	1943	10 710	1 658	—	—
»	1944	17 160	2 497	3	—
»	1945	18 920	2 320	—	—
»	1946	19 529	3 405	—	—
»	1947	23 994	9 305	22	—
»	1948	17 424	10 684	26	—
»	1949	16 137	16 994	27	—
»	1950	22 837	15 231	28	—
Total livestock	1950	1 110 454	670 879	90 850	347 187
Infected	1951	29 728	10 465	205	91
»	1952	30 408	11 916	35	35
»	1953	25 662	11 924	56	67

inspection due to the presence of trematodes (table 8). I assume that these numbers are nearly equal to the number of animals infected. In these statistics the two trematode species are not kept separate and I have obtained very vague information regarding the relative frequencies of the two species. In answer to a phone inquiry to the Veterinary Laboratory, I gather that about $^1/_3$ of the cases may be due to *D. dendriticum*. Often both species occur together in the same animal.

From table 8 some interesting information could be gained. The livestock of cows in 1929 and 1950 are of approximately the same magnitude, but the cases of infection are much fewer in 1950—1951. A similar decrease is also apparent for sheep. The decrease in the degree of infection during the war is not real, but is accounted for by the fact that meat inspection was then apparently insufficient. I do not know how the very surprising figures relating to the infection of pigs and horses should be explained.

Dicrocoelium dendriticum (Rudolphi 1819) Looss 1899

Hosts: *Ovis, Bos, Sus, Canis, Felis, Lepus,* etc.
Location: bile ducts and gall bladder.

D. dendriticum is sparsely mentioned in the literature. According to MUROMA (op.c.) it has been found in 15 out of 410 *Lepus timidus,* in one out of 69 *Lepus europaeus* and in one out of 284 *Vulpes vulpes*. See further above.

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SUMMARY

1. This paper includes descriptions of the parthenitae (cercariae) of 23 digenetic trematode species that emerged from snails (*Lymnaea stagnalis*, *L. peregra*, *L. palustris*, *Anisus vortex*, and *Bithynia tentaculata*) collected chiefly in the archipelago near the Zoological Station, Tvärminne, S. Finland. Futhermore 5 species are described according to observations made by Mrs. SELINHEIMO in 1933. For 5 species, corresponding descriptions have not been found in the literature and these are described as new species. The material includes 2 Monostomous, 2 Cystocercous, 9 Furcocercous, 5 Gymnocephalous and 2 Echinostomous cercariae, 6 Xiphidiocercariae, one Microcercous cercaria and one tail less cercaria.

2. One of the Xiphidiocercariae found is a Microcotylous cercaria with only one pair of penetration gland cells. A new group '*Monoadena*' is proposed for these extremely simple forms.

3. The penetration of Xiphidiocercariae has been studied and, in conformity with the observations of other authors, it is verified that chemotactic responses are poorly developed in cercariae. The piercing activity seems to be released chiefly by mechanical stimuli.

4. Some problems concerning the degree of infection of snails with trematode parthenitae are discussed. Among the conclusions reached, it is shown that 1) the snail populations of shores are less infected than those of pools, 2) the degree of infection on shores is probably dependent on the density of host animals carrying adult trematodes *and* the waves and currents of the water, 3) the degree of infection in pools is solely dependent on the immediate surroundings of the pools (attractiveness to birds and slope of the rock walls), and 4) no significant differences could be observed in the infection of the Lymnaeids studied.

5. The host specificity of the trematodes as regards the first intermediate mollusc host has been discussed. The Lymnaeids may substitute each other as hosts, but the trematode faunas of the Lymnaeids and *Bithynia tentaculata* are quite different.

6. Several species have been found to occur both in pools and on shores and both in fresh and brackish water. It is assumed that differences in the salt content of the water between the limits 0—6 ‰ do not affect the viability of cercariae.

7. The effects of trematodes on the invertebrate fauna of pools is discussed. Trematodes play an important rôle in the distribution and population dynamics of snails.

8. The problem of trematodes as pathogens of vertebrates, especially fish, is briefly discussed.

9. A list of digenetic trematodes found in Finland with references is given. This list includes 28 species. This paper adds to the list 3 species of which the life history is known.

Authors' Address: Dr. Bo-J. Wikgren, Bureau for Fishery Investigations, Nätholmen, Helsingfors, Finland.

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Abbreviations to SELINHEIMO's figures.

ao: anterior organ
cgl: cystogenous glands
ff: fin-fold
ga: gonad anlage
int: intestine
o: eye-spot
os: oral sucker
pgl: penetration gland cells
ph: pharynx
rc: rod cells
s: stylet
ub: urinary bladder
ud: urinary ducts
ur: urethra
vs: ventral sucker

Fig. 1

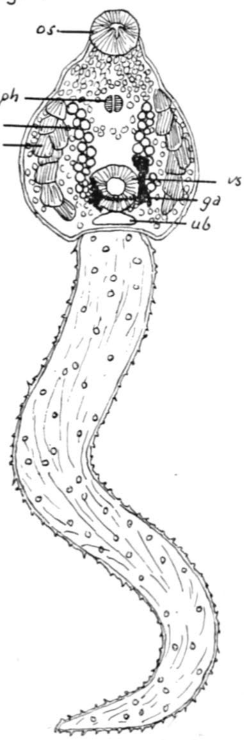

Fig. 2

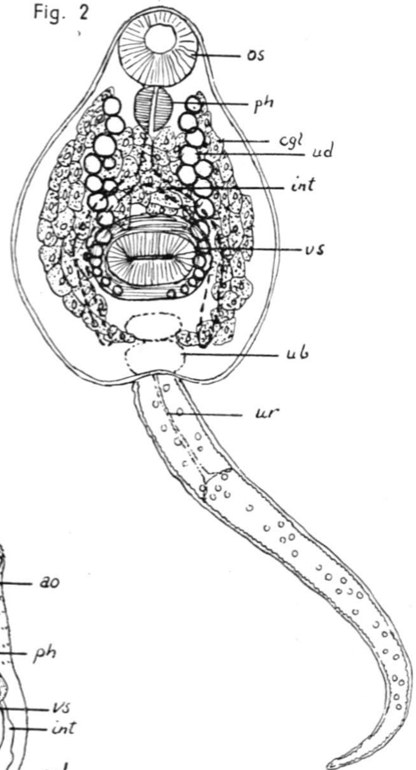

Fig. 3

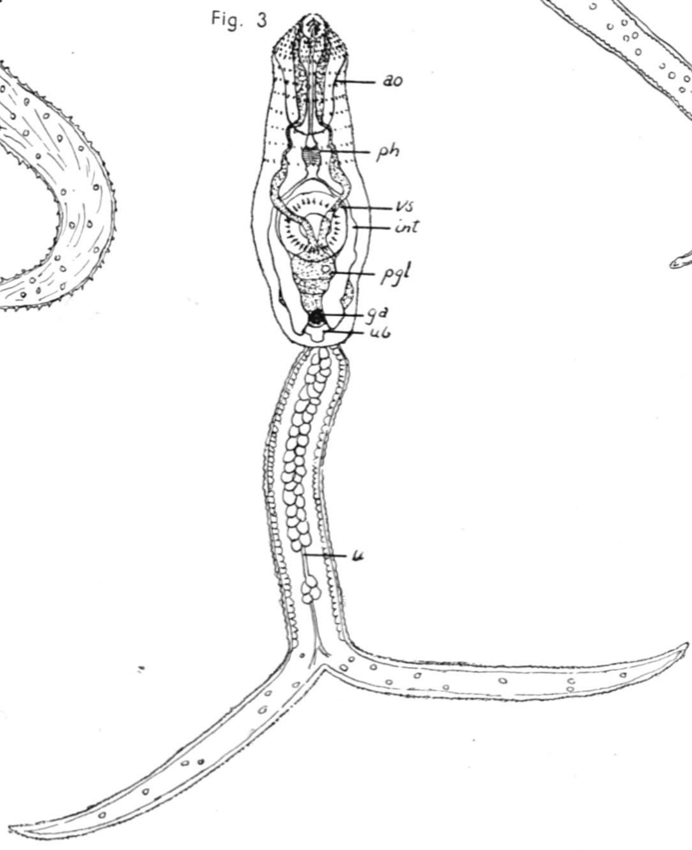

Fig. 1. *Cercaria helvetica XVII* (SELINHEIMO)
Fig. 2. *Gymnocephalous cercaria C* (SELINHEIMO)
Fig. 3. Cercaria of *Diplostomum spathaceum* (SELINHEIMO)

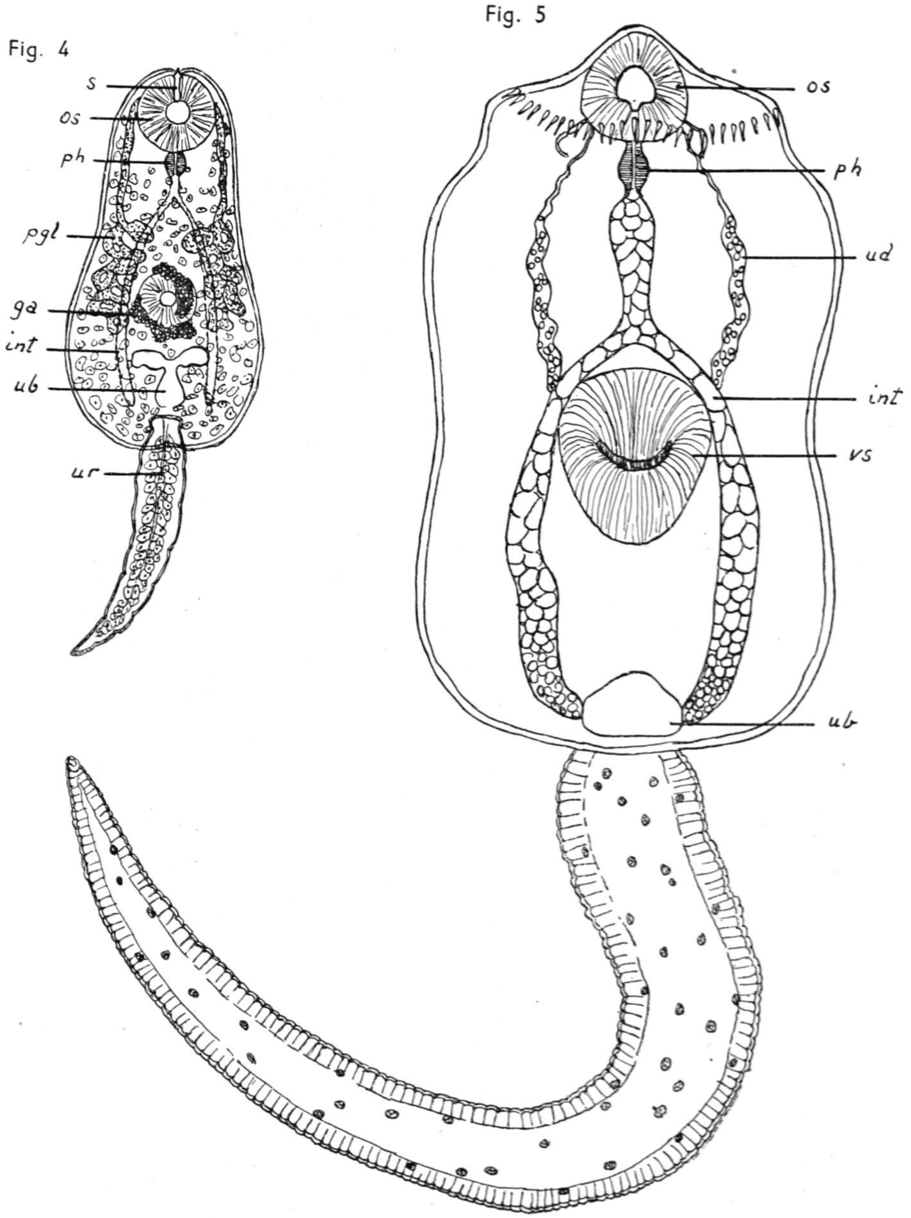

Fig. 4. Polyadenous cercaria sp. (SELINHEIMO)
Fig. 5. Cercaria of *Echinostomn revolutum* (SELINHEIMO)

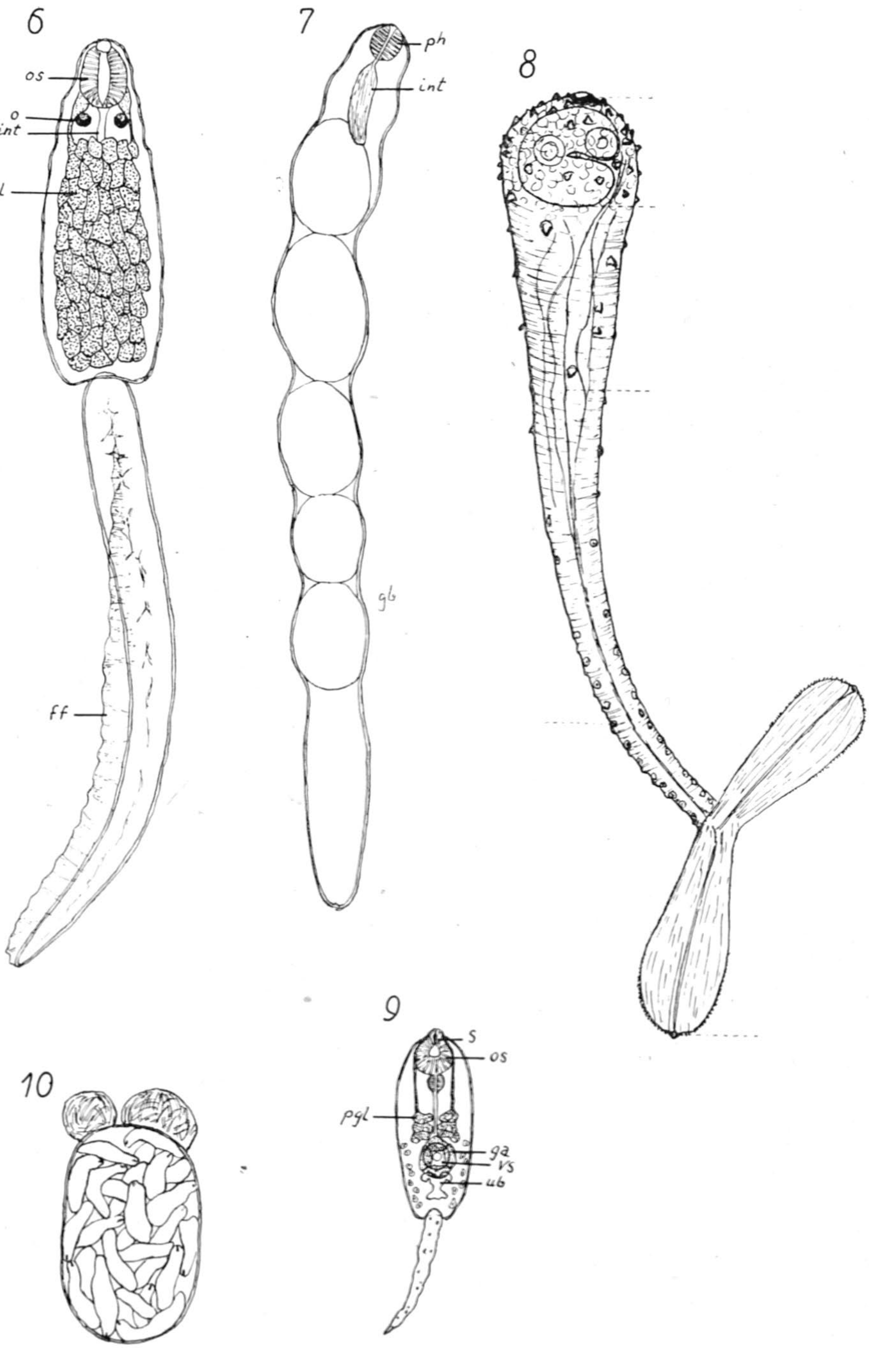

Fig. 6. Cercaria of *Metorchis* sp. (SELINHEIMO)
Fig. 7. Redia of *Metorchis* sp. (SELINHEIMO)
Fig. 8. Cercaria of *Azygia lucii* (JÄRVINEN)
Fig. 9. *Cercaria cordiformis* (SELINHEIMO)
Fig. 10. Sporocyst belonging to *Cercaria cordiformis* (SELINHEIMO)

Fig. 11. KROGARVIKEN (loc. no. 8). This shallow bay with a rich *Phragmites* vegetation lies in the outer archipelago, but is of almost the same character as the shores in the inner archipelago. In the vegetation lives a rich snail fauna, including *Bithynia tentaculata, Lymnaea stagnalis, L. palustris, L. peregra, Anisus vortex* and occasionally some *Physa fontinalis*. Degree of exposure: 1. Photo: Prof. H. Suomalainen.

Fig. 12. BRÄNNSKÄR (loc. no. 12). This shallow shore with gravel and small stones may exemplify the typical shores in the outer archipelago zone. Along the shore lies a submerged *Fucus* vegetation. On the shore-line occur *Lymnaea stagnalis* and *L. palustris*, together with *L. peregra*, but in the *Fucus* vegetation and on more exposed shores *L. peregra* and *Theodoxus fluviatilis* dominate. Degree of exposure: 2. Photo: Author.

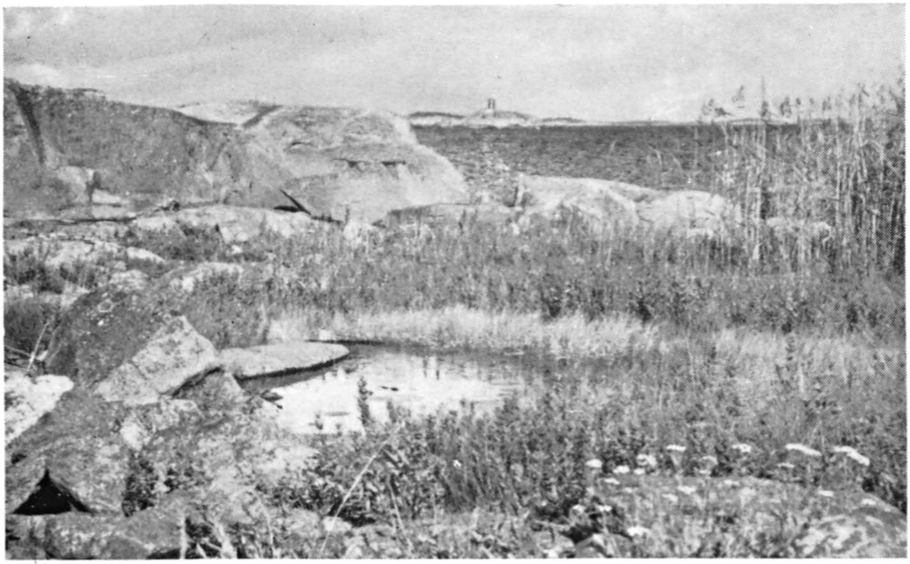

Fig. 13. A sumpy, supralittoral pool on NÄTTELHARUN (loc. no. 47). Note the rich vegetation including *Lythrum* and *Phragmites*. The pool is almost filled by a rich algal vegetation. Large specimens of *Lymnaea stagnalis* and *L. palustris* were found in this pool. Photo: Author.

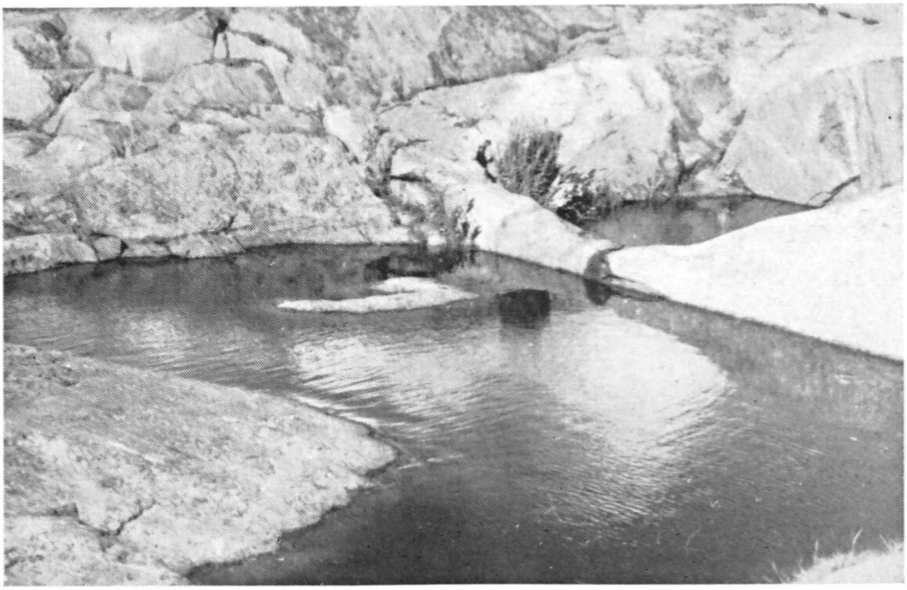

Fig. 14. This shallow pool on KLOVASKÄR (loc. no. 49) examplifies a very common pool type. It lies 3 m. above sea level and at a distance of 10 m. from the shore line. It may be classified as a supralittoral pool. According to LEVANDER's classification it belongs to pool type 6 B, *i.e.* »Permanente Regenwassertümpel mit Moos, Torfmoos und Gras in den Ecken und Ritzen der Wände.» *Lymnaea peregra* has been found here. Photo: Author.

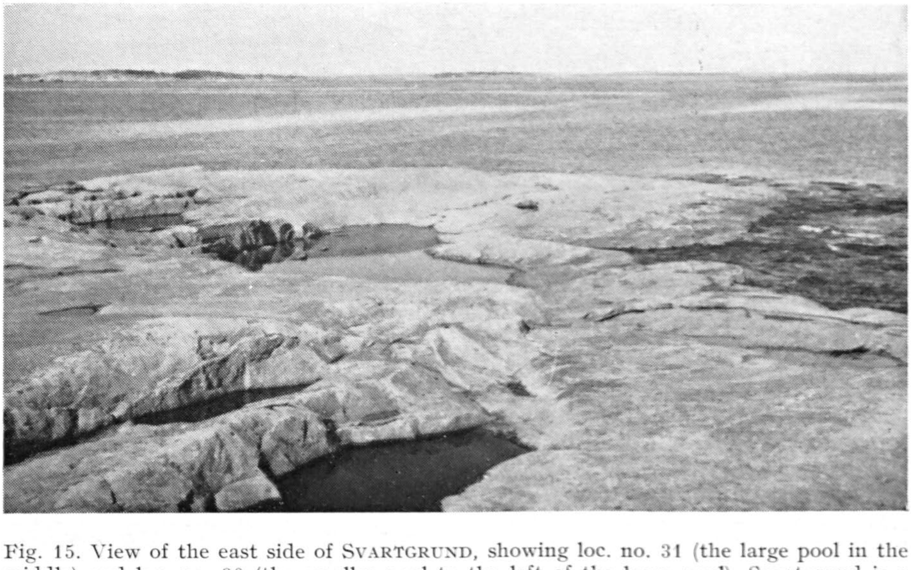

Fig. 15. View of the east side of SVARTGRUND, showing loc. no. 31 (the large pool in the middle) and loc. no. 30 (the smaller pool to the left of the large pool). Svartgrund is a good representative of the flat treeless islets in the sea zone. The shores consist of smoothed rocks. The snail fauna on the rock walls and in the *Fucus* vegetation consists chiefly of *Lymnaea peregra* and *Theodoxus fluviatilis*. Degree of exposure: 3. The vegetation in the pools consists chiefly of *Enteromorpha*, which shows that they are true littoral pools. *Lymnaea stagnalis* and *L. peregra* were found in the pools. Photo: Prof. H. Suomalainen.

ACTA ZOOLOGICA FENNICA 92
EDIDIT
SOCIETAS PRO FAUNA ET FLORA FENNICA

HISTOLOGY OF FIVE CERCARIAE
(TREMATODA: MALACOCOTYLEA)

BY

AILI SELINHEIMO

REWRITTEN AND EDITED
BY
BO-JUNGAR WIKGREN
(ZOOLOGICAL STATION, TVÄRMINNE)

WITH 9 PLATES INCLUDING 80 FIGURES

HELSINGFORSIAE 1956

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INTRODUCTION

The laboratory work, the preparation of the slides and the drawings were done by Mrs. AILI SELINHEIMO (née VALTONEN). The investigation was carried out at Tvärminne Zoological Station in 1933. The manuscript was submitted as a thesis for the degree of Cand. phil., but was not prepared for publication. WIKGREN was given the original manuscript to prepare for publication. His task has merely been that of an editor in rewriting the text, adding some details and notes on the literature, translating the manuscript into English and rearranging the figures.

Since microanatomical investigations on cercariae are very few and restricted to a few species only, it is hoped that this work will be of some value. Without doubt the microanatomical treatment of trematode larvae reveals certain features not observable in the living state.

We wish to express our sincerest thanks to Professor ALEXANDER LUTHER, Ph. D., under whose guidance both the experimental work and the final preparation have been made, for his great interest, critical advice and kindness in making available the resources of the Tvärminne Zoological Station.

We also thank Mrs. JEAN M. PERTTUNEN, B.Sc., for checking the English of the manuscript. The Figures have kindly been redrawn by Mr. V. NYSTRÖM.

February 1956.

Bo-Jungar Wikgren.

MATERIAL

The cercariae here studied have emerged from snails collected from two localities, *viz.* Krogarviken, a bay at the Tvärminne Zoological Station, and Baggby (Gloet?), a shore near the town of Ekenäs/Tammisaari. Five cercaria species have been investigated microanatomically. These species will be described in a paper by WIKGREN. Here only short descriptions and drawings of the cercariae are given.

1) *Cercaria helvetica XVII* Dubois 1929 (synonym: *Cercaria obscura* Wesenberg-Lund 1934), a Gymnocephalous cercaria with a remarkably large tail and exhibiting in extreme degree the capacity to alter the body form. Host: *Bithynia tentaculata* (L.). Fig. I, 1.

2) *Gymnocephalous cercaria C* sp. indet., a cercaria closely related to the cercaria of *Fasciola hepatica* Linnaeus 1758. The host is *Bithynia tentaculata* (L.). Fig. I, 2.

3) The cercaria of *Echinostoma revolutum* (Frölich 1802) Looss 1899 (synonym: *Cercaria echinata* Siebold 1837, etc.), a large Echinostomous cercaria emerging from *Lymnaea stagnalis* (L.). Fig. II, 5.

4) A Polyadenous *Xiphidiocercaria* sp. indet. with 7 penetration gland cells on each side. Hosts: *Lymnaea* species. Fig. II, 4.

5) The cercaria of *Diplostomum spathaceum* (Rudolphi 1815) Olsson 1876, emend. (synonym: *Cercaria C* Szidat 1924), a very common Furcocercous cercaria emerging from *Lymnaea* species. A confusion between two species has obviously occurred, since the cercaria is noted as having emerged from *Bithynia tentaculata* also. Fig. I, 3.

METHODS

The cercariae were fixed with LANG's corrosive sublimat-acetic acid. Whole mounts were stained with Borax-Carmine and sections with HEIDENHAIN's Iron Haematoxylin or HANSEN's Alum Haematoxylin. HEIDENHAIN's stain was superior in staining muscle, HANSEN's stain in staining gland cells, etc. The paraffin sections were 3—5 μ thick.

RESULTS

Epidermis

(Figs. III, 6—15)

The outermost layer is a usually thin cuticle (*c*), followed by the subcuticle (*sc*) and the basement membrane (*bm*). The epidermal cells (*ec*) lie below the basement membrane, being connected by thin protoplasmic processes with the other epidermal layers (fig. III, 6). In *Gymnocephalous cercaria C* the cuticle appears cellular, being formed of small, cuboidal cells (*ec*). The cell membranes of these have been seen only in sagittal sections, not in sections perpendicular to the surface (figs. III, 7—9). According to WALTER (1893) the ends of the dorsoventral muscles pass into the subcuticle, but BETTENDORF (1897) does not confirm this. In *Gymnocephalous cercaria C* and in the cercaria of *Echinostoma revolutum* the muscle fibres (*dvm*) do pass to the surface (figs. III, 9, 12). These fibres are not identical with the processes of the epithelial cells.

In the epidermis of *Cercaria helvetica XVII* are seen small, round structures, osmewhat resembling the rhabdites of turbellarians (figs. III, 10, 11).

Typical epidermal spines occur in the cercaria of *E. revolutum.* They stain deeply with HEIDENHAIN's, but not at all with HANSEN's Haematoxylin. The spines (*sp*) are short and pyriform and situated on the basement membrane and do not reach to the surface. They are arranged in transverse rows. Each spine has a rounded base, staining red with HANSEN's Haematoxylin. Four muscles adhere to this base. They run obliquely toward the underlying tissues (figs. III, 12, 13). The muscles are not seen to pass from spine to spine as BETTENDORF (op.c.) has reported.

In the body wall of the Xiphidiocercaria are structures which resemble spines in that they stain intensely with HEIDENHAIN's Haematoxylin. They lie very close together (figs. III, 14, 15). These spines (*sp*) do not possess either a rounded base or muscles of their own.

Gymnocephalous cercaria C possesses a circular epidermal fold (*cf*) around the ventral sucker. Many muscle fibres adhere to the inner side of this fold (fig. V, 39).

Parenchyma

(Figs. III, 16; V, 37—VI, 47; VII, 49—53; VII, 55—VIII, 57; VIII, 65; VIII, 68—IX, 71; IX, 77)

The network of the parenchymal syncytium fills all the free spaces of the body. Usually the nuclei are large and surrounded by a thin protoplasmic layer with processes to the adjacent protoplasm territories. The parenchyma occurs in all parts of the body, the suckers, the tail, etc. Protoplasmic threads are also seen between the muscle fibres, beneath the epidermis and on the surface of the nerve centres. No differences in the parenchyma of the different species are observable. *Xiphidiocercaria* sp. is richly supplied with long threads, possibly parenchymal fibrils (figs. VI, 42, 46; *pf*). The cercaria of *Echinostoma revolutum* has a unique structure between the ventral sucker and the pharynx, *viz.* a reticle with scattered nuclei (mucin glands?) (figs. VII, 55, 56; *x*).

Muscles

(Seen in most figures)

The body muscles may be divided into two main groups, *viz.* body wall muscles and dorsoventral muscles.

The muscle layers forming the muscular body wall are from the outside: longitudinal muscles (*lm*), circular muscles (*cm*) and two oblique muscle layers (*dm*) (figs. III, 16—IV, 22; IV, 29).

In *Gymnocephalous cercaria C* all the different muscles appear to be of equal thickness, in the cercaria of *Echinostoma revolutum* the longitudinal muscles are stronger than the others. In spite of the fact that *Cercaria helvetica XVII* continuously alters its form, the muscles in this species are poorly developed.

The muscle fibres are mostly unbranched, but do sometimes branch (figs. III, 17; IV, 23; V, 38, 39; VI, 41). The myoblasts (*mb*) lie scattered between the muscle fibres. Their shape is very diverse (figs. III, 7, 8, 16, 18; IV, 24—30; V, 38; VI, 41; VII, 51). In *Gymnocephalous cercaria C* two main types occur (figs. IV, 24, 25). The long processes of the muscle cells are not seen to unite with the muscle fibres. The cells assumed to be myoblasts are much smaller in the cercaria of *Echinostoma revolutum* (figs. IV, 26, 27) than in the other species. It may be noted that similar cells lie around the ventral sucker below the epidermal fold of *Gymnocephalous cercaria C* (figs. IV, 30; VII, 51).

The dorsoventral muscles run obliquely in many directions between the dorsal and ventral surfaces of the body (figs. IV, 31—V, 35; VIII, 67). The cell body is in intimate connection with the muscle fibres (fig. V, 36). On reaching the surface the fibres split up into many radiating fibrils (figs. IV, 31; V, 33).

Both smooth and striated muscles occur in the tail (p. 11).

Suckers

(Figs. IV, 28, 31; V, 33, 34, 37—VI, 42; VI, 45; VII, 51, 52, 55; VIII, 67)

The structure of the ventral and oral suckers is quite similar. The outer lining seems to be a direct continuation of the body cuticle, while the innermost layer consists of a powerful basement membrane. The suckers are made up of parenchyma cells, muscle cells and muscle fibres. The muscle layers are the same as those that FUHRMANN (1928) mentions in adult trematodes, *viz.* equatorial (*em*), meridional (*mm*) and radial muscles (*rm*). The ends of the radial muscles are seen to split up into numerous fibrils.

Anterior organ

(Fig. VI, 43)

The anterior part of the anterior organ of the cercaria of *Diplostomum spathaceum* is an invagination of the epidermis, the posterior part being very muscular. There are circular, radial and oblique muscles.

Stylet

(Figs. VI, 42; VIII, 61)

Two muscle systems operate the stylet (*s*) of *Xiphidiocercaria* sp., the one adhering to the proximal end (piercing muscles) the other to the thickenings near the distal end (shoulders) (withdrawal muscles). The muscle fibres are branched. No sheath has been seen around the stylet (compare REES, 1932, p. 21).

Penetration glands

(Figs. VI, 45, 47)

Penetration glands (*pgl*) have been seen in the Xiphidiocercaria (fig. II, 4) and the Furcocercaria (fig. I, 3). In *Xiphidiocercaria* sp. they are finely granulated, deeply staining cells with conspicuous nuclei. They lie around the ventral sucker (fig. VI, 45). The ducts (*dpgl*) stain in the same manner as the gland cells (fig. VI, 47).

Cystogenous glands

(Figs. IV, 30, 31; V, 32, 33; VI, 44—46, 48; VII, 49—56; VIII, 67)

The cystogenous cells are extremely well developed in all these cercariae except the cercaria of *Diplostomum spathaceum*. There are two main types of apparently cystogenous cells, *viz.* rod cells (*rc*) and granulated cells (*cgl*). Rod cells alone occur in *Cercaria helvetica XVII* (fig. VII, 49), both types are found in *Gymnocephalous cercaria C* (fig. VII, 53) and only granulated cells in the cercaria of *Echinostoma revolutum* (figs. VII, 55, 56) and *Xiphidiocercaria* sp. (fig. VI, 44).

The rod cells (*rc*) in *Cercaria helvetica XVII* are quadrangular with long rods, sharply pointed at the ends (fig. VII, 50), while the rod cells in the other Gymnocephalous cercaria are often drop-shaped and filled with a large number of smaller rods, arranged in rows (fig. VII, 54). The locus of the rod cells in the body seems to suggest that they secrete cystogenous material. According to Leuckart (see Rees, 1932, p. 11) these cells should be myoblasts. Braun (1893) states that the rod cells in the cercaria of *Fasciola hepatica* do not disappear at encystment, but form the inner membrane of the cyst.

The granulated cystogenous gland cells (*cgl*) in *Gymnocephalous cercaria C* are located in a compact mass on the ventral side of the body anterior to the ventral sucker (fig. VII, 53). In the cercaria of *Echinostoma revolutum* the cells are smaller, filling all the body spaces (fig. VII, 56). In the Xiphidiocercaria the cystogenous glands are large and the connection with the cuticle is clearly seen (figs. VI, 44, 45, 48). They stain red with Hansen's Haematoxylin. Scattered among these larger cells are other smaller, blue-staining cells. From fig. VIII, 63 it is seen that the processes of these cells run to the body surface. These cells are probably nerve cells.

In the Xiphidiocercaria are large chromatophobe cells (*vgl*), containing scattered staining particles, situated anteriorly of the penetration gland cells (*i.e.* in front of the ventral sucker) (figs. VI, 45, 46). In the nuclei the nucleolus is clearly seen. Dubois (1929) called these cells »cellules giantes» and Rees (1952) »ventral gland cells», arranging them among the cystogenous glands. Obviously they are mucin glands (Kruidenier, 1947). In transverse sections of the body in front of these cells rounded structures (*x*) staining in the same manner as the large cells are seen. These structures may be ducts. They lie beneath the ducts of the true penetration glands (*dpgl*), as is seen from fig. VI, 47 (cf. fig. VI, 42).

Intestine

(Figs. V, 35; VI, 41—43; VII, 52, 53, 55, 56—VIII, 61)

The cuticle which lines the cavity of the oral sucker is seen to be a continuation of the lining of the praepharynx (*pph*) and pharynx (*ph*) and at least partially of that of the oesophagus (*oe*) (figs. VI, 41—43; VII, 52). The praepharynx has thin layers of longitudinal and circular muscles (fig. VI, 41). According to FUHRMANN (op.c.) similar muscle layers occur in the oesophagus, too. The pharynx has the same structure as the suckers, *viz.* equatorial, meridional and radial muscles together with parenchyma cells and muscle cells (figs. VI, 41, 42). The oesophagus in all except the cercaria of *Echinostoma revolutum* is tubular; in the cercaria of *E. revolutum* it is cellular without a lumen (fig. VII, 56). The intestinal diverticula (*int*) are cellular in *Gymnocephalous cercaria C* (fig. VIII, 58), the cercaria of *E. revolutum* (fig. VIII, 59) and *Xiphidiocercaria* sp. (fig. VIII, 60), and most probably also in *Cercaria helvetica XVII* (fig. VII, 49). The diverticula of the cercaria of *Diplostomum spathaceum* are filled with a homogeneous mass. The walls are thin (fig. V, 35).

Nervous system

(Figs. VI, 47; VII, 51, 55; VIII, 57, 62—64)

The central nerves have been most clearly seen in the Xiphidiocercaria. The composition of the central nerves and the centres is clearly shown in fig. VIII, 62. All the nerves and ganglia are covered with deeply staining cells (*nc*). Some of those of *Xiphidiocercaria* sp. were provided with only two processes, some with more (figs. VIII, 63, 64). The cells are presumably nerve cells (compare p. 8). The similar cells in the cercaria of *Echinostoma revolutum* were much smaller, which is in correlation with the relatively small size of all cells in this species (fig. VII, 55).

Excretory system

(Figs. V, 32; VI, 45; VII, 49, 53, 56; VIII, 65, 68; IX, 70, 73—75, 78, 79)

The urinary bladder (*ub*) of *Cercaria helvetica XVII* is bilobed, being composed of a thin-walled bladder in the posterior end of the body and a thick-walled, muscular bladder in the proximal end of the tail (fig. VIII, 65). Apparently the posterior lobe functions as an action and suction pump and the anterior lobe serves merely as a reservoir.

In *Gymnocephalous cercaria C* the urinary bladder consists of two thin-walled lobes. In the anterior lobe are parenchyma cells (?) (figs. VIII, 66, 67).

The Y-shaped vesicle of the Xiphidiocercaria has a lining of cuboidal cells (fig. VI, 45).

Of other parts belonging to the excretory system the horns (tubes) of the vesicles (*ud*) in the two Gymnocephalous cercariae have been seen (figs. VII, 49, 53). The wall of the urethra (*ur*) in *Gymnocephalous cercaria C* seems to be composed of endothelial cells (fig. VIII, 68). See further the urethra in figs. VIII, 65; IX, 70, 72—74, 78.

Gonad anlage

(Figs. VI, 44, 45; VII, 51, 55)

Aggregates of small, deeply staining cells (*ga*) have been seen around the ventral sucker in most species. These cells most probably form the gonad anlage, but no definite arrangement into reproductive organs has been recognized.

Tail

(Figs. VIII, 65, 68; IX, 69—80)

The tail of the cercariae is an ingenious organ. The swimming behaviour and movements of the cercariae seem to be directly related to the structure of the tail. This is also shown by the occurrence of a great diversity of tail structures. These problems have been dealt with by WUNDER (1924). According to him the main layers are: the cuticle, the muscle layers, of which the outer is circular and the inner longitudinal, and the innermost parenchyma.

The tail of *Cercaria helvetica XVII* has an enormous capacity to alter its form. According to WESENBERG-LUND (1934) the tail is often flattened. The cercaria swims in a very characteristical, lazy manner. In the tail, below the cuticle, lies a thin circular muscle layer (*cm*), but the longitudinal muscles (*lm*) have been transformed to an oblique muscle system running from the urethra to the cuticle (figs. VIII, 65; IX, 69, 70). This organisation may be characteristical of flat tails. Within the tail is a granulated mass with smaller and larger nuclei. Cell membranes have not been observed.

The tails of Gymnocephalous cercariae are usually very muscular, the cercariae swimming with vigorous lashings of the tail. *Gymnocephalous cercaria C* is provided with circular and longitudinal muscles. The longitudinal muscles are grouped on opposite sides and on each side there are two muscle bunches (figs. IX, 72, 73). The myoblasts (*mb*) are large, granulated cells with large nuclei and conspicuous nucleoli. They lie beneath the muscle fibres or are connected with these by a short nec (fig. IX, 71 *a* and *b*). This is in good agreement with BETTENDORF's (op.c.) observations. In the tail there is furthermore a parenchymal syncytium.

The tail of the cercaria of *Echinostoma revolutum* is very similar to that of *Gymnocephalous cercaria C*. The muscles seem to be stronger and the longitudinal muscles are striated (*slm*). The arrangement of the longitudinal muscles is the same, but the two lateral bunches are better isolated from each other (fig. IX, 77). The muscle cells are large and chromatophobe. The nuclei are large (figs. VIII, 68; IX, 76, 77). The parenchymal network is typical. The cercaria of *E. revolutum* is a good swimmer.

In *Xiphidiocercaria* sp. the longitudinal muscles are arranged in one group on either side of the tail (fig. IX, 75); they are poorly developed in comparison with the two lastmentioned species. Myoblasts are not seen. According to Cort (1915) the longitudinal muscles in the tail of *Cercaria urbanensis* Cort 1915 and *Cercaria inhabilis* Cort 1915 form a continuous layer. In the tail of *Xiphidiocercaria* sp. are large chromatophobe cells (turgescent cells or perhaps myoblasts) (figs. IX, 74, 75). These Xiphidiocercariae are poor swimmers, swimming periods (ascents) being followed by resting periods (sinking).

The tail-stem of the Furcocercous cercaria of *Diplostomum spathaceum* is nearly rectangular in transverse section, the longitudinal striated muscle-bunches (*slm*) being concentrated in the corners (figs. IX, 78—80). Between the bunches of striated muscles non-striated longitudinal muscles (*lm*) are seen. A similar organisation in Furcocercous cercariae has been reported by Miller (1926). The circular muscles are poorly developed. Beneath the muscle bunches are small cells, perhaps myoblasts. Around the urethra are large, faintly granulated cells with rounded nuclei and conspicuous nucleoli. There is a close relation between the structure of the Furcocercous tail and the fact that during swimming the tail only swings in one plane.

SUMMARY

The histology of five cercaria species has been studied. Of these two are Gymnocephalous, one Echinostomous, one a Xiphidiocercaria and one a Furcocercaria. The results are in good agreement with the findings of previous authors.

The epidermis in one Gymnocephalous cercaria appears to be cellular, in the other species it is of usual type, consisting of a cuticle and inverted epidermal cells. The parenchymal syncytium fills all the free spaces of the body. The muscles are of three types: body wall muscles, dorsoventral muscles and striated muscles. The cells of the body wall muscles are large with branched projections. The cells of the dorsoventral muscles are directly connected with the muscle fibres. Striated muscles occur in the tail of the Echinostomous

and the Furcocercous cercaria; the muscle cells are large and chromatophobe. The muscles of the suckers and the pharynx consist of equatorial, meridional and radial layers. There are penetration glands and cystogenous glands of various structure. The rod-cells of the Gymnocephalous cercariae appear to be cystogenous, but they may have other functions, too. A typical feature of the Xiphidiocercaria is the presence of large, chromatophobe cells in front of the ventral sucker (mucin glands). The oesophagus is in most species tubular; the diverticula in all except the Furcocercous cercaria are cellular. The nervous system has been most clearly seen in the Xiphidiocercaria. The excretory system is rather different in the different species. The tail structure in relation to the swimming behaviour is briefly discussed.

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INDEX TO FIGURES OF EACH CERCARIA SPECIES

Cercaria helvetica XVII Dubois
Figs. I, 1; III, 10, 11; V, 37; VII, 49, 50; VIII, 65; IX, 69, 70.

Gymnocephalous cercaria C sp.
Figs. I, 2; III, 7—9, 16; IV, 24, 25, 30, 31; V, 32, 33, 36, 38, 39; VI, 41; VII, 51—54; VIII, 58, 66, 67; IX, 71, 72.

Cercaria of *Echinostoma revolutum*
Figs. II, 5; III, 6, 12, 13, 17—21; IV, 26—28; V, 34, 40; VII, 55, 56; VIII, 59, 68; IX, 76, 77.

Xiphidiocercaria sp.
Figs. II, 4; III, 14, 15; IV, 22, 23, 29; VI, 42, 44—48; VIII, 60—64; IX, 73—75.

Cercaria of *Diplostomum spathaceum*
Figs. I, 3; V, 35; VI, 43; VIII, 57; IX, 78—80.

ABBREVIATIONS

ao anterior organ
bm basement membrane
c cuticle
cf circular fold
cg cerebral ganglion
cgl cystogenous glands
cm circular muscles
cp caudal pocket
dc dorsal commissure
dm diagonal muscles
dpgl ducts of penetration glands
dvm dorsoventral muscles
ec epidermal cells
em equatorial muscles
ep epidermis
ff fin-fold
ga gonad anlage
gl glands
int intestine (gut)
lm longitudinal muscles
mb myoblasts
mm meridional muscles
nc nerve cells
ndp nervus dorsalis posterior
nla nervus lateralis anterior
nlp nervus lateralis posterior
nva nervus ventralis anterior
nvp nervus ventralis posterior
oe oesophagus
os oral sucker
pc parenchyma cells
pf parenchymal fibrils
pgl penetration glands
ph pharynx
pph praepharynx
rc rod cells
rm radial muscles
s stylet
sc subcuticle
slm striated longitudinal muscles
sm stylet muscles
sp spines
ub urinary bladder
ud urinary ducts
ur urethra
vgl ventral gland cells
vs ventral sucker

Fig. 2

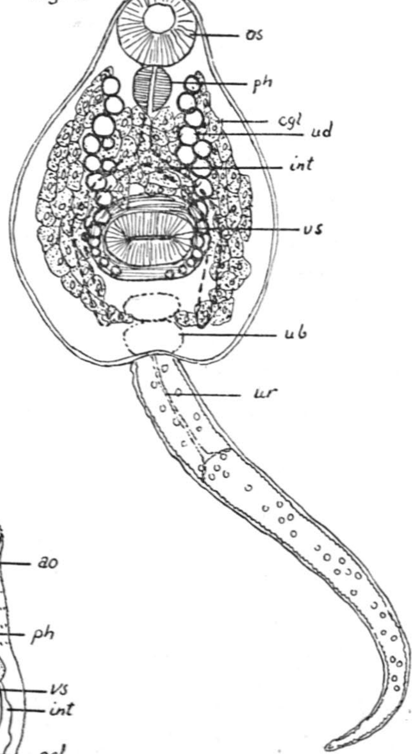


Fig. 1

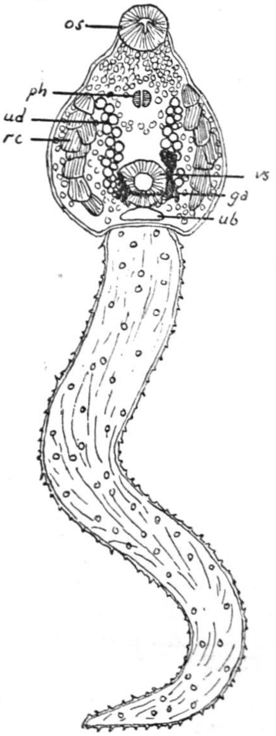


Fig. 3

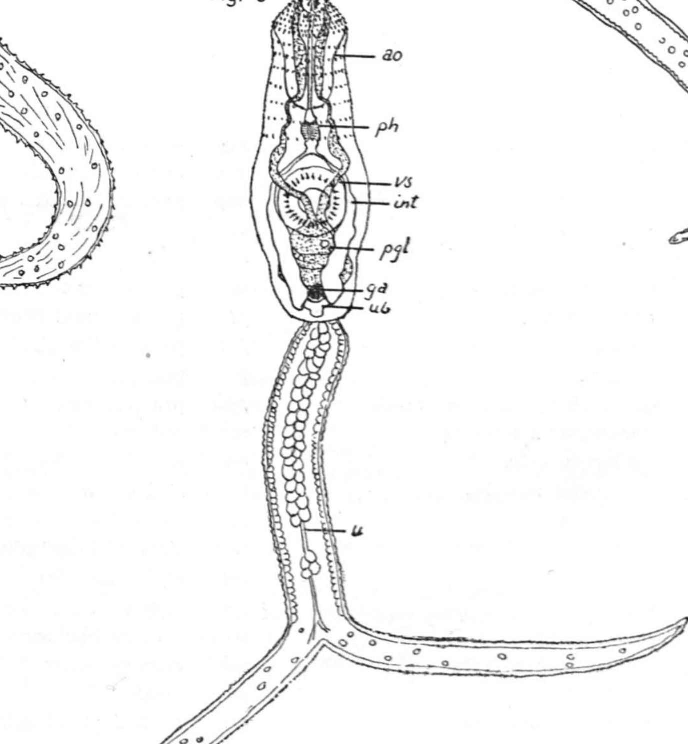


PLATE I

Fig. 1. *Cercaria helvetica XVII* Dubois 1929.
Fig. 2. *Gymnocephalous cercaria C* sp.
Fig. 3. Cercaria of *Diplostomum spathaceum* (Rudolphi 1815) Olsson 1876.

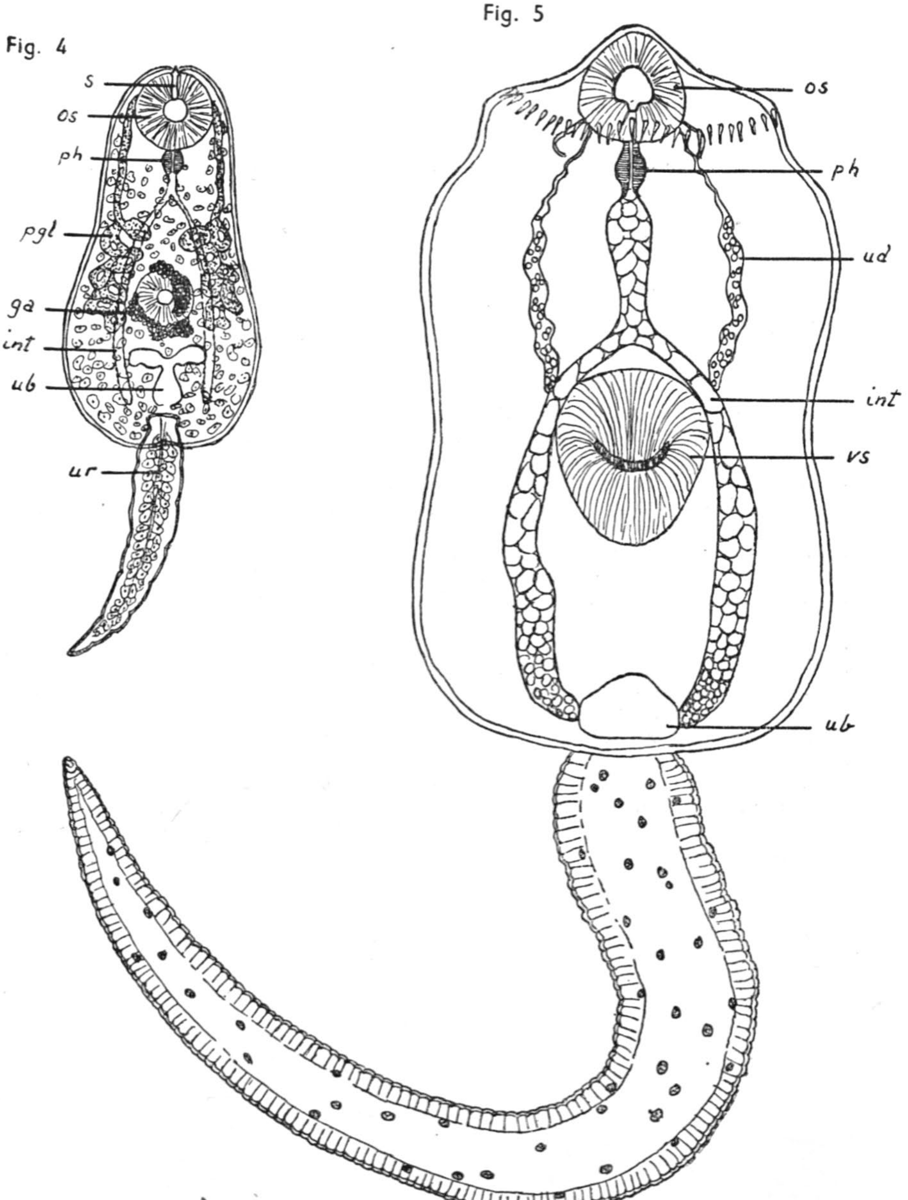


PLATE II

Fig. 4. *Xiphidiocercaria* sp.

Fig. 5. Cercaria of *Echinostoma revolutum* (Frölich 1802) Looss 1899.

PLATE III

Fig. 6. Cercaria of *Echinostoma revolutum*. Section of the epidermis. Inverted epidermis cells (*ec*) with branched protoplasmic processes.

Figs. 7 and 8. *Gymnocephalous cercaria C* sp. Sagittal section of the body wall, showing muscle fibres (*lm, cm*) beneath the epidermis, muscle cells (*mb*) and small, cuboidal epidermal cells (*ec*).

Fig. 9. *Gymnocephalous cercaria C* sp. Transverse section of the body wall.

Figs. 10 and 11. *Cercaria helvetica XVII*. Epidermis with small granules. In fig. 11 the small granules are seen at greater magnification.

Fig. 12. Cercaria of *Echinostoma revolutum*. Transverse section of the body wall, showing the minute epidermal spines (*sp*) on the basement membrane (*bm*) and the ends of the dorsoventral muscles (*dvm*).

Fig. 13. Cercaria of *Echinostoma revolutum*. Horizontal view of the body wall, showing epidermal muscles (*lm, cm*) and spines (*sp*).

Fig. 14. *Xiphidiocercaria* sp. Horizontal view of the body wall, showing epidermal spines (?).

Fig. 15. *Xiphidiocercaria* sp. Section of the body wall (compare with fig. 14).

Fig. 16. *Gymnocephalous cercaria C* sp. Sagittal section of the body wall.

Fig. 17. Cercaria of *Echinostoma revolutum*. Sagittal section of the body wall. Some of the muscle fibres are seen to branch.

Fig. 18. Cercaria of *Echinostoma revolutum*. Sagittal section of the body wall.

Fig. 19. Cercaria of *Echinostoma revolutum*. Body wall muscles.

Fig. 20. Cercaria of *Echinostoma revolutum*. Body wall muscles. The longitudinal muscles (*lm*) are contracted. Observe that the extended muscles (*cm*) are waved.

Fig. 21. Cercaria of *Echinostoma revolutum*. Body wall muscles. The circular muscles (*cm*) are contracted.

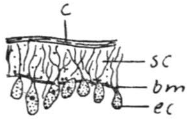


Fig. 6

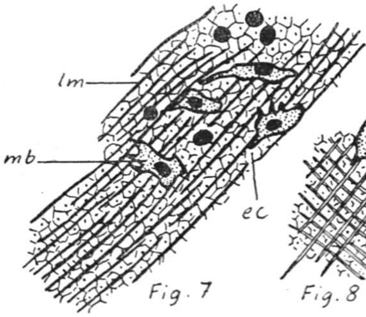


Fig. 7

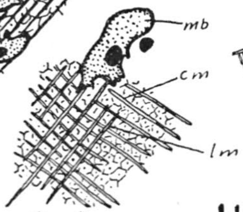


Fig. 8

Fig. 9

Fig. 10

Fig. 11

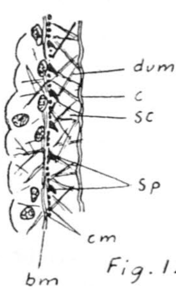


Fig. 12

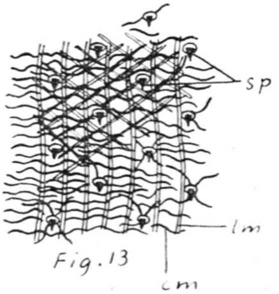


Fig. 13

Fig. 14

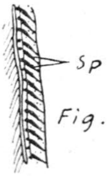


Fig. 15

Fig. 16

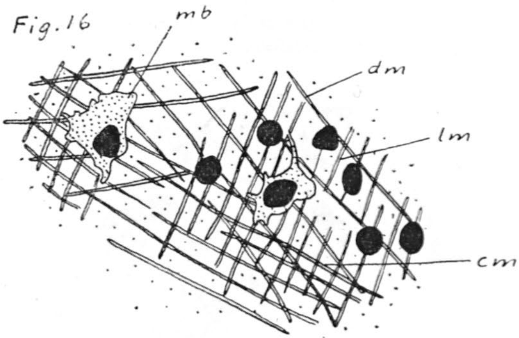
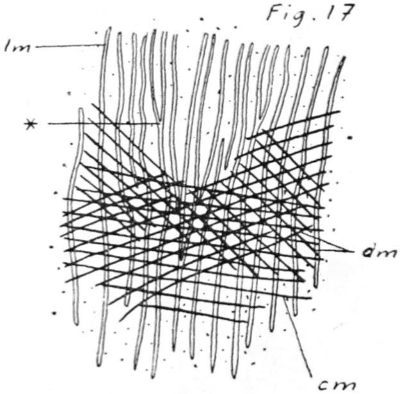


Fig. 17



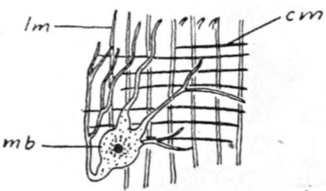


Fig. 18

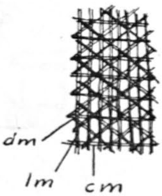


Fig. 19

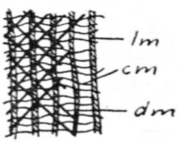


Fig. 20

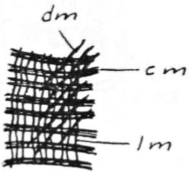


Fig. 21

PLATE IV

Fig. 22. *Xiphidiocercaria* sp. Body wall muscles.

Fig. 23. *Xiphidiocercaria* sp. Branching stylet muscles.

Figs. 24 and 25. *Gymnocephalous cercaria C* sp. Sections of the body wall, showing muscle cells (*mb*).

Fig. 26. Cercaria of *Echinostoma revolutum.* Transverse section of the body wall, showing muscle cells (*mb*) beneath the subcuticle.

Fig. 27. Cercaria of *Echinostoma revolutum.* Sagittal section of the body wall.

Fig. 28. Cercaria of *Echinostoma revolutum.* Sagittal section of the ventral sucker. Myoblasts (*mb*) lie between muscles and parenchyma cells.

Fig. 29. *Xiphidiocercaria* sp. Body wall muscles, and myoblasts.

Fig. 30. *Gymnocephalous cercaria C* sp. Sagittal section of the posterior half of the body, showing large myoblasts (*mb*) beneath the ventral sucker (*vs*), etc.

Fig. 31. *Gymnocephalous cercaria C* sp. Median section of the body showing the dorso-ventral muscles (*dvm*). The figure is combined from three sections.

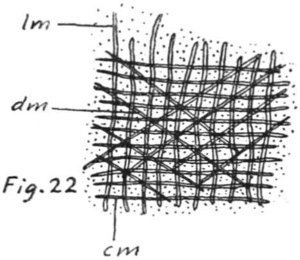
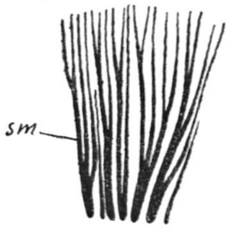


Fig. 22

Fig. 23


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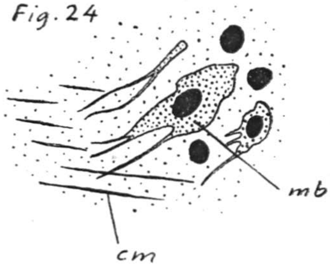

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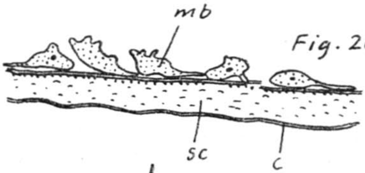

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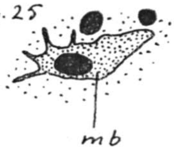


Fig. 28

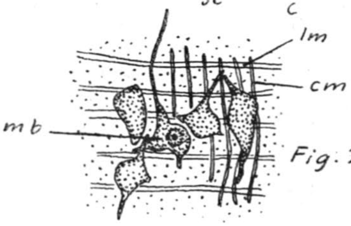


Fig. 27

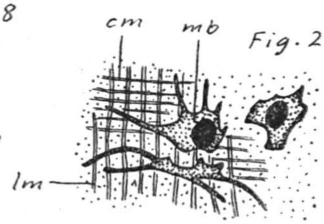
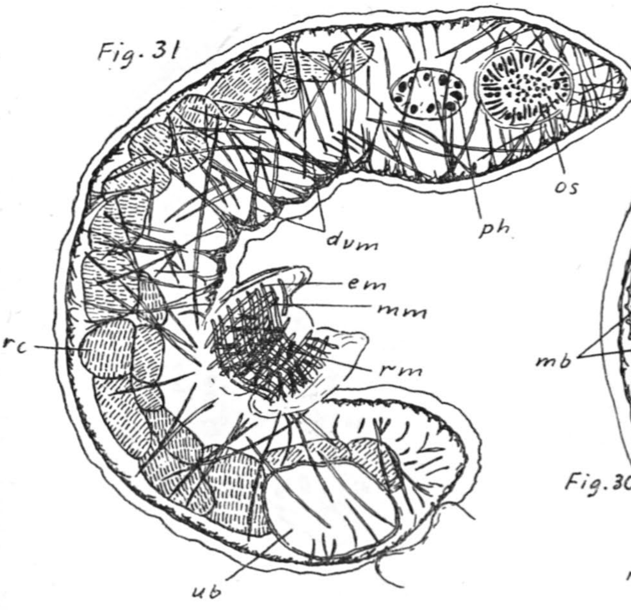
Fig. 29


Fig. 31


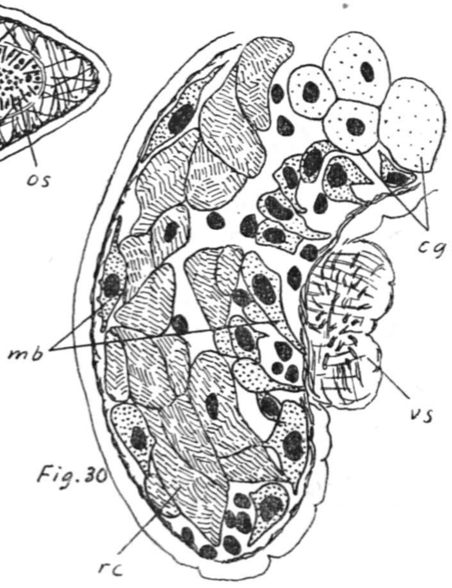


Fig. 30

PLATE V

Fig. 32. *Gymnocephalous cercaria C* sp. Transverse section of the body behind the pharynx, showing dorsoventral muscles (*dvm*). The figure is combined from three sections.

Fig. 33. *Gymnocephalous cercaria C* sp. Transverse section of the body at the ventral sucker (*vs*). The figure is combined from three sections.

Fig. 34. Cercaria of *Echinostoma revolutum*. Sagittal section of the body, showing the dorsoventral muscles (*dvm*).

Fig. 35. Cercaria of *Diplostomum spathaceum*. Transverse section of the body behind the ventral sucker.

Fig. 36. *Gymnocephalous cercaria C* sp. Cell bodies of dorsoventral muscles.

Fig. 37. *Cercaria helvetica XVII*. Horizontal section of the ventral sucker. The sucker is provided with a row of small spines.

Fig. 38. *Gymnocephalous cercaria C* sp. Horizontal section of the ventral sucker. *c* erroneous, should be *pc*.

Fig. 39. *Gymnocephalous cercaria C* sp. Transverse section of the ventral sucker. Observe the epidermal fold around the sucker.

Fig. 40. Cercaria of *Echinostoma revolutum*. Transverse section of the ventral sucker.

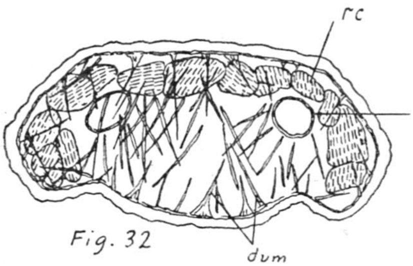
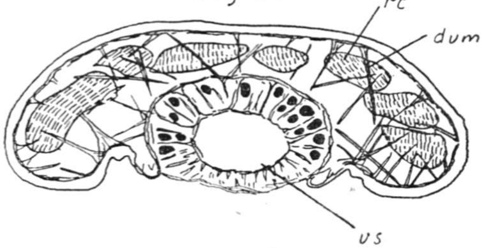
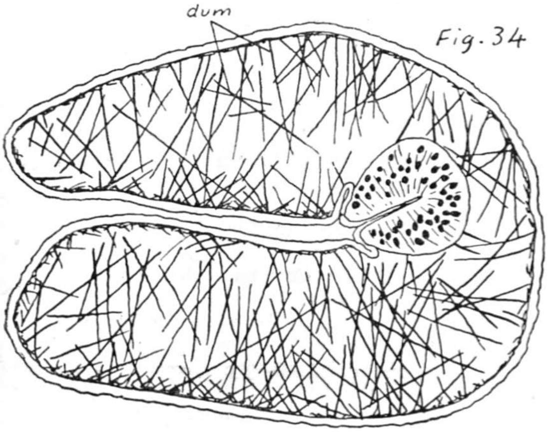


Fig. 32

Fig. 33





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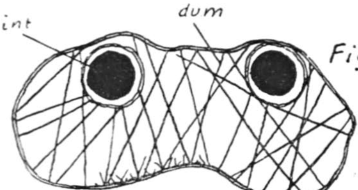
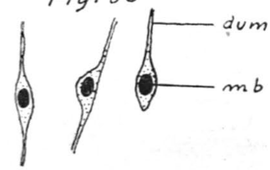


Fig. 35

Fig. 36



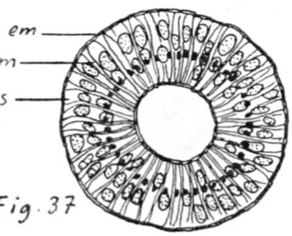


Fig. 37

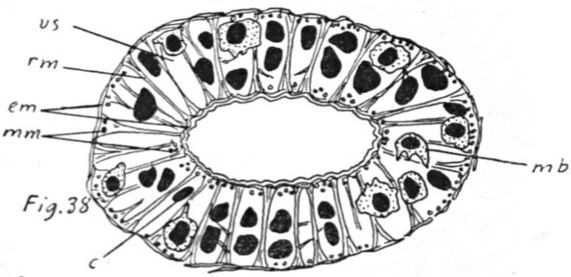


Fig. 38

Fig. 39

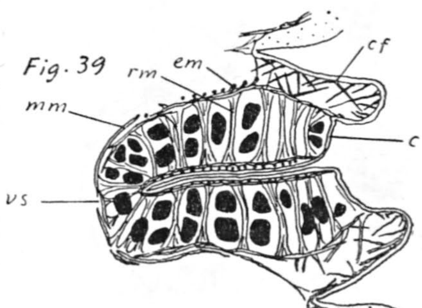


Fig. 40

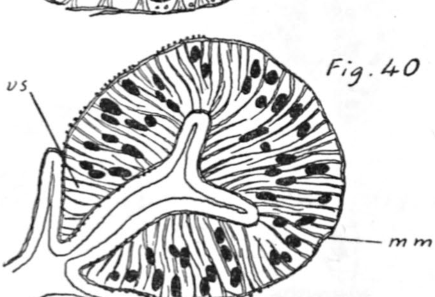


PLATE VI

Fig. 41. *Gymnocephalous cercaria C* sp. Horizontal view of the oral sucker (*os*) and the pharynx (*ph*). Combined from several sections.

Fig. 42. *Xiphidiocercaria* sp. Horizontal view of the oral sucker (*os*) and the pharynx (*ph*). Combined from several sections. Observe the long fibrils (?) marked *x*. These may be part of the ducts of the penetration glands or perhaps of the large chromatophobe cells. (Compare with fig. 47).

Fig. 43. Cercaria of *Diplostomum spathaceum.* Horizontal section of the anterior organ (*ao*).

Fig. 44. *Xiphidiocercaria* sp. Horizontal section of the body near the dorsal surface.

Fig. 45. *Xiphidiocercaria* sp. Horizontal section of the body.

Fig. 46. *Xiphidiocercaria* sp. Transverse section of the body between the pharynx and the ventral sucker. Observe the parenchymatous threads (*pf*) which fill all the body spaces.

Fig. 47. *Xiphidiocercaria* sp. Transverse section of the body at the pharynx (*ph*). Observe the ducts of the penetration gland cells (*dpgl*) and the chromatophobe structures (ducts?) beneath them (*x*).

Fig. 48. *Xiphidiocercaria* sp. Granulated cystogenous gland cells.

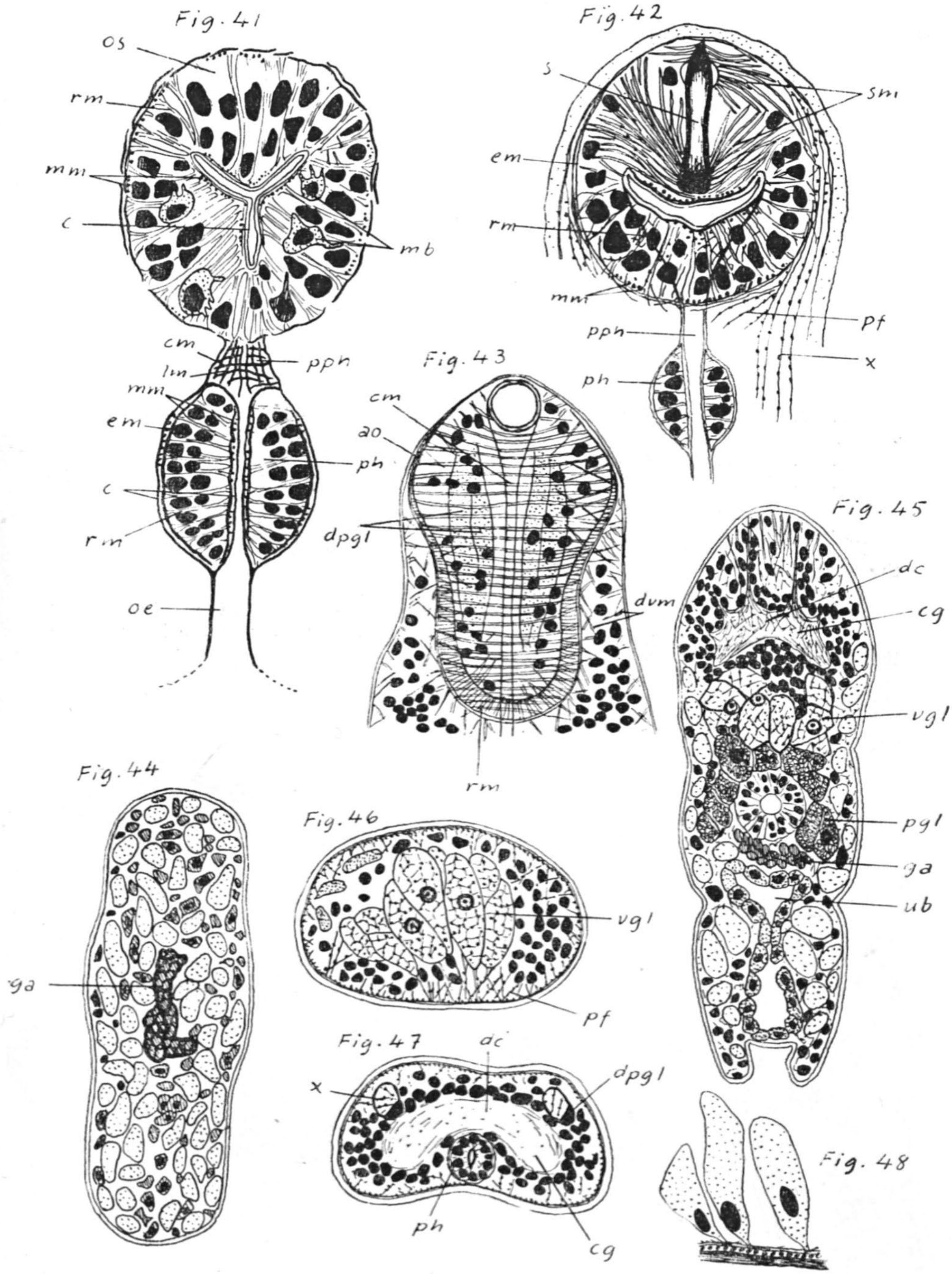


Fig. 41
os
rm
mm
c
mb
cm
lm
pph
mm
em
ph
c
rm
oe
Fig. 42
s
sm
em
rm
mm
pf
pph
x
ph
Fig. 43
cm
ao
dpgl
dvm
rm
Fig. 45
dc
cg
vgl
pgl
ga
ub
Fig. 44
ga
Fig. 46
vgl
pf
Fig. 47
dc
x
dpgl
ph
cg
Fig. 48

PLATE VII

Fig. 49. *Cercaria helvetica XVII.* Transverse section of the body in front of the ventral sucker.

Fig. 50. *Cercaria helvetica XVII.* A rod cell (*rc*).

Fig. 51. *Gymnocephalous cercaria C* sp. Horizontal section of the body. Observe the ring of large cells (myoblasts, *mb*) around the ventral sucker.

Fig. 52. *Gymnocephalous cercaria C* sp. Median view of the body.

Fig. 53. *Gymnocephalous cercaria C* sp. Transverse section of the body in front of the ventral sucker.

Fig. 54. *Gymnocephalous cercaria C* sp. Rod cells.

Fig. 55. Cercaria of *Echinostoma revolutum.* Horizontal section of the body.

Fig. 56. Cercaria of *Echinostoma revolutum.* Transverse section of the body behind the pharynx.

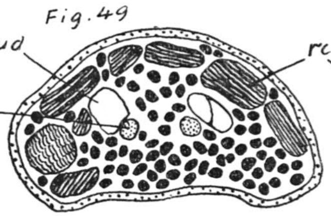


Fig. 49
ud
int
rc

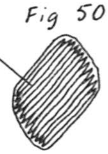


Fig 50

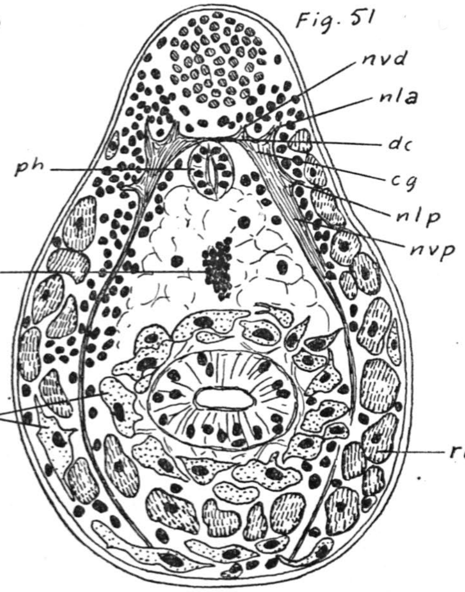


Fig. 51
nvd
nla
dc
cg
nlp
nvp
ph
ga
mb
rc

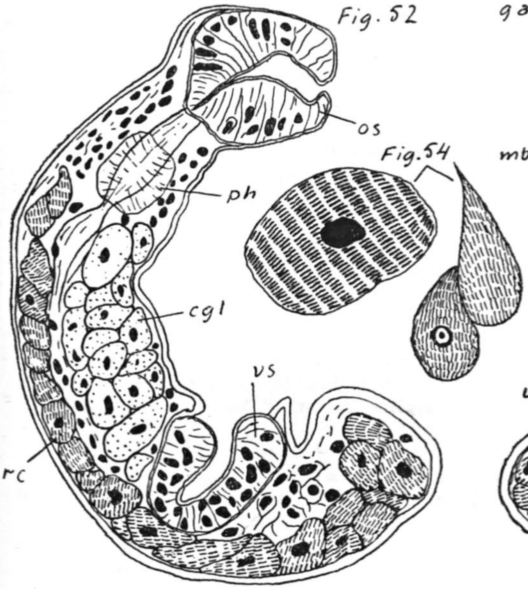


Fig. 52
os
ph
cgl
vs
rc
Fig. 54

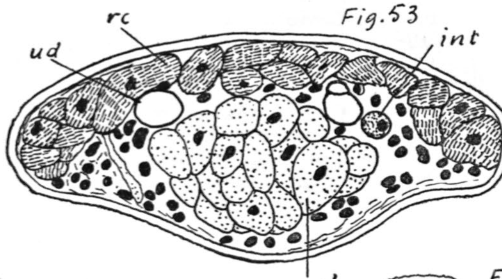


Fig. 53
rc
ud
int
cgl

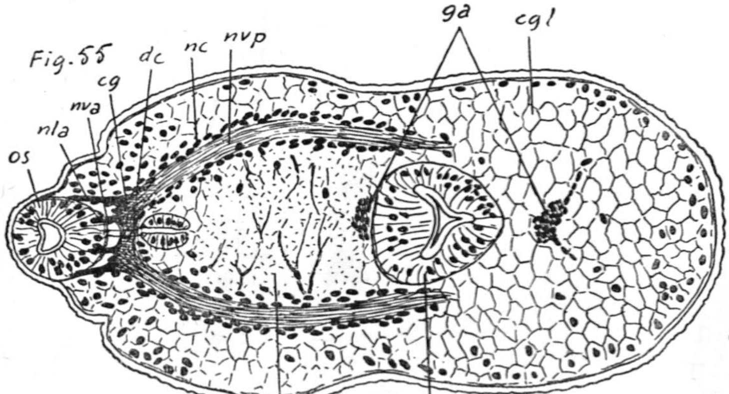


Fig. 55
dc
nc
nvp
cg
nva
nla
os
ga
cgl
x
vs

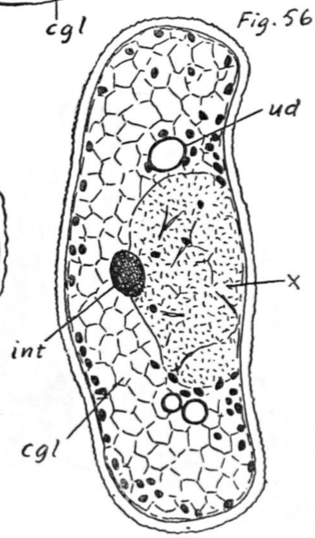


Fig. 56
ud
x
int
cgl

PLATE VIII

Fig. 57. Cercaria of *Diplostomum spathaceum*. Horizontal section of the body, showing the region between the anterior organ (*ao*) and the ventral sucker (*vs*).

Fig. 58. *Gymnocephalous cercaria C* sp. Part of the cellular intestine (*int*).

Fig. 59. Cercaria of *Echinostoma revolutum*. Part of the cellular intestine (*int*).

Fig. 60. *Xiphidiocercaria* sp. Part of the cellular intestine (*int*).

Fig. 61. *Xiphidiocercaria* sp. Schematic drawing of the oral sucker (*os*) and the mouth opening seen from the side.

Fig. 62. *Xiphidiocercaria* sp. The ganglia and the central nerves.

Fig. 63. *Xiphidiocercaria* sp. Oblique section of the anterior end of the body, showing cerebral ganglia (*cg*) and nerve cells (*nc*).

Fig. 64. *Xiphidiocercaria* sp. Deeply staining (blue) cells assumed to be nerve cells (*nc*).

Fig. 65. *Cercaria helvetica XVII*. Horizontal section of the posterior end of the body and the proximal part of the tail, showing the bilobed urinary bladder (*ub* and *ub'*).

Fig. 66. *Gymnocephalous cercaria C* sp. Oblique sagittal section of the bilobed urinary bladder (*ub*).

Fig. 67. *Gymnocephalous cercaria C* sp. Horizontal section of the posterior half of the body. Only the posterior lobe of the urinary bladder (*ub*) is visible.

Fig. 68. Cercaria of *Echinostoma revolutum*. Longitudinal section of the tail, showing the bifurcation of the urethra (*ur*).

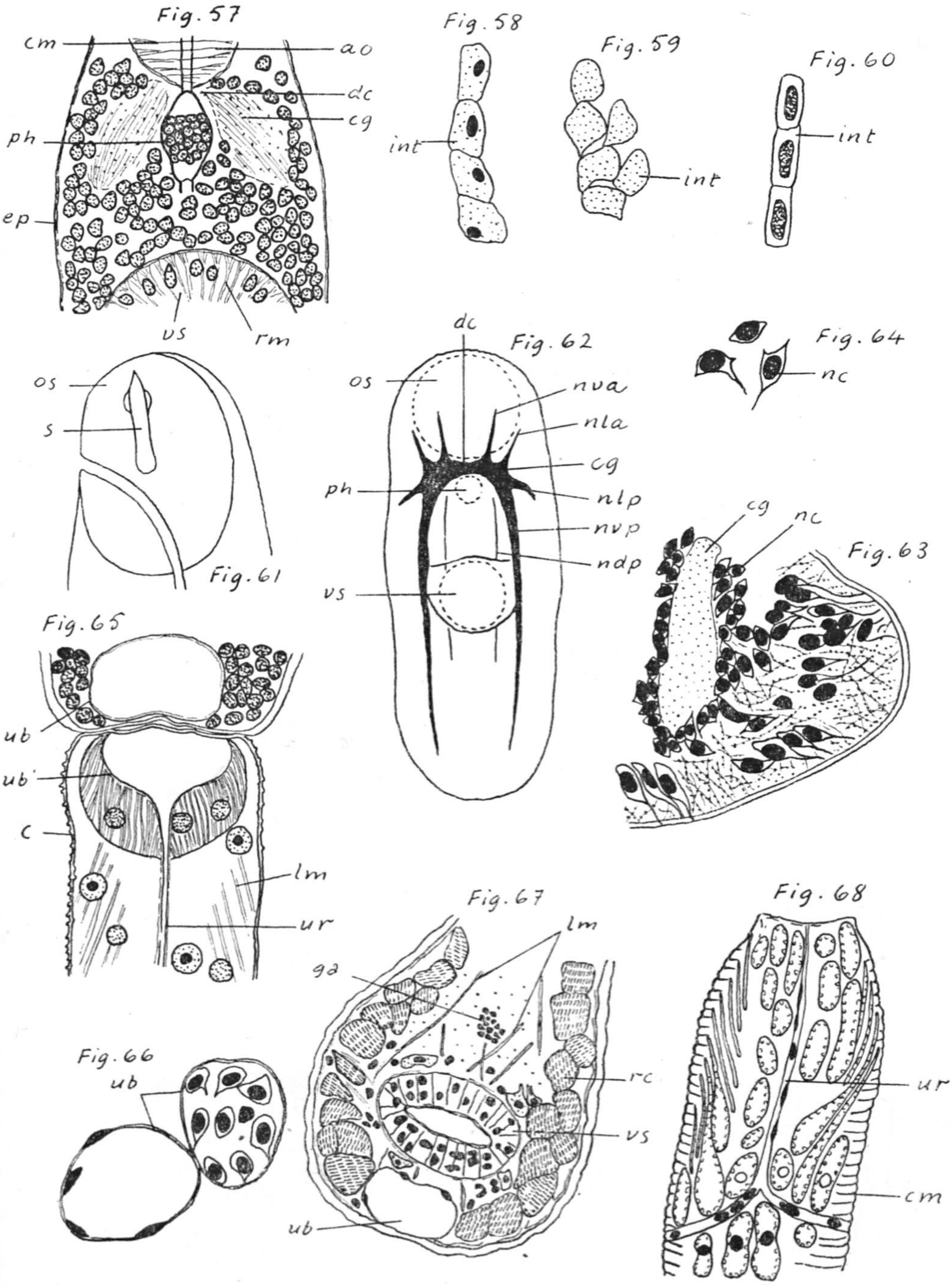


Fig. 57
cm
ao
dc
cg
ph
ep
vs
rm
Fig. 58
int
Fig. 59
int
Fig. 60
int
os
s
Fig. 61
dc
Fig. 62
os
nva
nla
cg
ph
nlp
nvp
ndp
vs
Fig. 64
nc
cg
nc
Fig. 63
Fig. 65
ub
ub'
c
lm
ur
Fig. 67
lm
ga
rc
vs
ub
Fig. 68
ur
cm
Fig. 66
ub

PLATE IX

Fig. 69. *Cercaria helvetica XVII.* Horizontal section of the proximal part of the tail.

Fig. 70. *Cercaria helvetica XVII.* Section of the distal end of the tail.

Fig. 71. *Gymnocephalous cercaria C* sp. Sagittal section of the middle part of the tail. Observe the two types of connections between the muscle cells and the muscle fibres (*a* and *b*).

Fig. 72. *Gymnocephalous cercaria C* sp. Transverse section of the tail.

Fig. 73. *Xiphidiocercaria* sp. Horizontal section of the proximal end of the tail, also showing the caudal pocket (*cp*).

Fig. 74. *Xiphidiocercaria* sp. Longitudinal section of the tail, showing the large chromatophobe cells (myoblasts?).

Fig. 75. *Xiphidiocercaria* sp. Transverse section of the tail.

Fig. 76. Cercaria of *Echinostoma revolutum.* Sagittal section of the middle part of the tail.

Fig. 77. Cercaria of *Echinostoma revolutum.* Transverse section of the tail.

Fig. 78. Cercaria of *Diplostomum spathaceum.* Longitudinal section of the middle of the tail-stem.

Fig. 79. Cercaria of *Diplostomum spathaceum.* Transverse section of the tail-stem.

Fig. 80. Cercaria of *Diplostomum spathaceum.* Longitudinal muscles in the tail-stem. Striated muscles (*slm*) occur only in the corners.

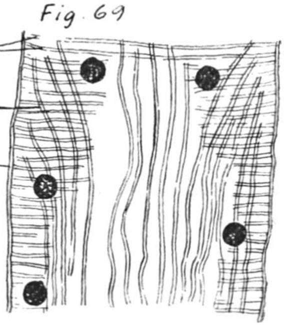


Fig. 69
cm
lm
c

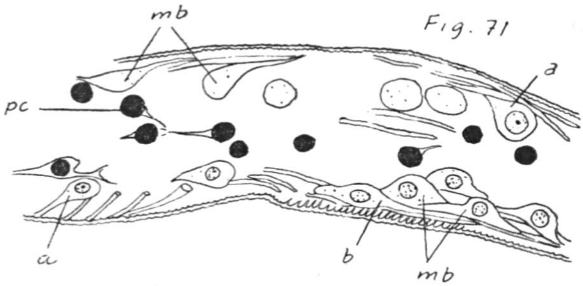


Fig. 71
mb
a
pc
a
b
mb

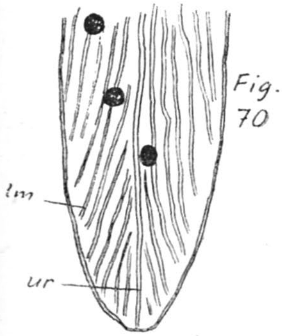


Fig. 70
lm
ur

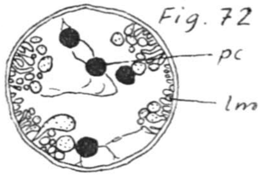


Fig. 72
pc
lm

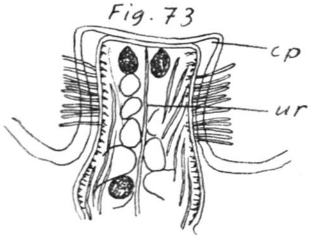


Fig. 73
cp
ur

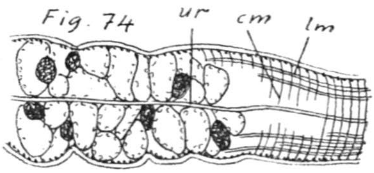


Fig. 74
ur
cm
lm

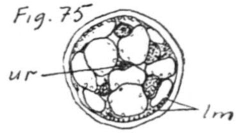


Fig. 75
ur
lm

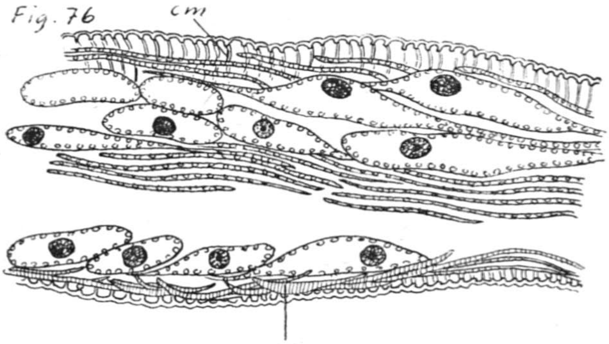


Fig. 76
cm
slm

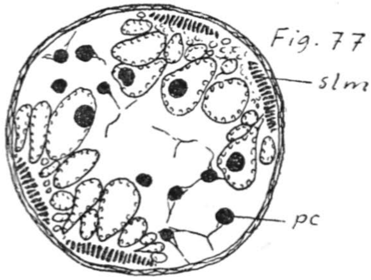


Fig. 77
slm
pc

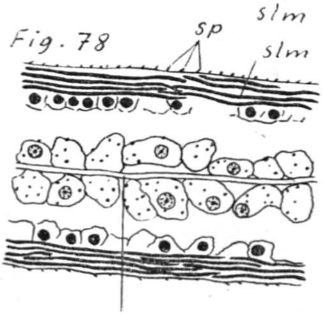


Fig. 78
sp
slm
ur


Fig. 79
c
ur
slm

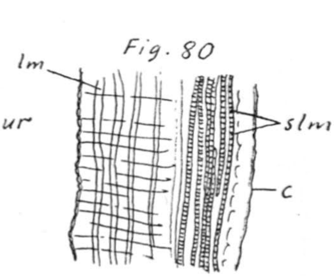


Fig. 80
lm
slm
c

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SOCIETAS PRO FAUNA ET FLORA FENNICA

STUDIES ON THE GENUS DIPHYLLOBOTHRIUM

A REVISION OF THE FINNISH FINDS OF DIPHYLLOBOTHRID PLEROCERCOIDS

BY

BO-JUNGAR WIKGREN AND EERO MUROMA

FROM THE BUREAU FOR FISHERY INVESTIGATIONS
AND THE ZOOLOGICAL LABORATORY, HELSINKI/HELSINGFORS

WITH 10 FIGURES IN THE TEXT

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TILGMANNS TRYCKERI

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INTRODUCTION

Our present interest in Diphyllobothrid plerocercoids was aroused when one of us was confronted with several types of Diphyllobothrid larva which could not be distinguished from larvae of *Diphyllobothrium latum* according to the special literature available (Finnish authors, SCHÄPERCLAUS, FIEBIGER, HOFER, etc.). Both the morphological differences and the differences in cyst formation and location of the plerocercoids were too great to make it probable that all these larvae belonged to the same species. Some Finnish research workers familiar with tapeworm larvae were questioned, but no assistance could be obtained. The situation changed at once when the excellent works of KUHLOW (1953 a, b, c, and 1955) were seen. KUHLOW is the first to give a differential diagnosis of four *Diphyllobothrium* species which makes it possible to identify these at the plerocercoid stage. Thus it was confirmed that the different plerocercoid types do in fact belong to different species.

It was immediately obvious that the Finnish literature on Diphyllobothrid plerocercoids contained many errors due to the tendency of the authors to identify every plerocercoid as belonging to *D. latum*.

As is well known, the human population in Finland is heavily infested with the fish tapeworm (cf. p. 7). It is therefore of outstanding importance to know which fish species are the second intermediary or transport hosts of the fish tapeworm and to what degree the fish populations of at least some lakes are infected with plerocercoids. The authors hope to be able to perform investigations on this problem. The first work to be done seems, however, to be a revision of the earlier finds of *Diphyllobothrium* plerocercoids. In 1950

HUHTALA has reviewed the present state of tapeworm research in Finland, but his data on plerocercoids are very incomplete and they are not, of course, reviewed in the critical sense here applied.

IDENTIFICATION OF DIPHYLLOBOTHRID PLEROCERCOIDS

There exist a large number of species of the genus *Diphyllobothrium.* It is difficult to distinguish between many of them even in the adult stage. Hence it must be assumed that the difficulties in making correct species determinations at the larval stages are very great.

Working with material derived from fish from Soviet Karelia, PETRUSCHEWSKY and TARASSOW (1933) showed experimentally that not all those plerocercoids which had been suspected of belonging to *D. latum* developed to the adult worm in man. As mentioned above, KUHLOW (op.c.) gives for the first time a reliable specific diagnosis of four species of *Diphyllobothrium* which allows a distinction between these even at the plerocercoid stage. It is obvious that much further research remains to be done in this field, but KUHLOW's works afford a reliable basis for further investigations. In the present state of knowledge of Diphyllobothrid plerocercoids it seems, however, indispensable to make infection experiments before any conclusive deductions regarding the species specificity of the plerocercoids can be made. (It may, for instance, be mentioned that according to WARDLE (1935) eleven per cent of the burbot (*Lota lota maculosa*) in Lake Winnipeg harbour a plerocercoid very similar to that of *D. latum,* but that infection experiments were negative.)

The four species with which KUHLOW's works deal are: *Diphyllobothrium dendriticum* Nitzsch 1824, *D. osmeri* (v. Linstow 1878), *D. vogeli* Kuhlow 1955, and *D. latum* Linnaeus. As adults the three first-mentioned species are parasites of birds, especially of Laridae. The differential diagnosis cannot be cited here in full. Only those characters are given which have to do with external and easily recognisable characters, such as those usually mentioned in the literature.

D. dendriticum (fig. 1a) was found free in the coelom of *Gasterosteus.* Its maximal length (relaxed) was 4.8 cm. The plerocercoids are contracted and the cuticle is folded into numerous regular deep folds. The scolex is mostly extruded and laterally compressed. The colour is white. The body of the plerocercoids is covered with cuticular bristles 4—10 μ long.

D. osmeri (fig. 1b). The plerocercoids occur in the smelt in cysts which usually lie around the ventricle. The body is somewhat transparent, bluish-white in colour, and always without folds. The length varied within 8—16 mm. The scolex is extruded and rounded. Both the body and the scolex are provided with cuticular bristles 14—18 μ long.

D. vogeli (fig. 1c). This species was found in the liver of *Gasterosteus.* It resembles *D. osmeri,* but is smaller (10 mm.). The caudal end is pointed and cannot be contracted

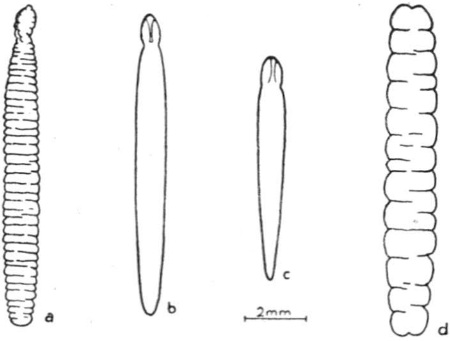

Fig. 1. Reproduction of the figures given by KUHLOW (1953a) of the plerocercoids of *Diphyllobothrium dendriticum* (a), *D. osmeri* (b), *D. vogeli* (c), and *D. latum* (d).

into the body. The scolex and the bothrids are short. The body surface is covered with long bristles (18—35 μ).

D. latum (fig. 1d). KUHLOW found the plerocercoids of this species in burbot (*Lota vulgaris*) and perch (*Perca fluviatilis*). In burbot the larvae were found subperitoneally on the ventricle and the appendices pylores. In perch they lived in the body muscles. The plerocercoids were not encysted. They are deeply folded and strongly contracted. Both the scolex and the caudal end of the body are withdrawn into the body. The larvae are nontransparent, and white. The largest observed specimen measured 4.5 cm. (relaxed). Usually the plerocercoids are much smaller. The cuticle lacks bristles.

The figure given by KUHLOW of the plerocercoid of *D. latum* does not in our experience fully correspond with the majority of cases found by us (cfr. figs. 3 and 4).

One character very important in the following discussion may be especially pointed out. According to the literature it seems to be convincingly proved that the plerocercoids of *D. latum* are not encysted, i.e. surrounded by a wall of connective tissue formed by the host. WARDLE writes: »It may be taken as certain, however, that any plerocercoid that is enclosed in a cyst is not *Diphyllobothrium latum*.» Our own observations are in full accordance with this statement.

Furthermore, some interesting observations by KUHLOW (1955) on the life history of *D. latum* may be summarized here.

In infection experiments with procercoids positive results were obtained on feeding procercoids to ruff (*Acerina cernua*), ten-spined stickleback (*Gasterosteus pungitius*), pike (*Esox lucius*) and perch. The plerocercoids were found chiefly in the musculature. Negative results were obtained with eel (*Anguilla vulgaris*), three-spined stickleback (*Gasterosteus aculeatus*) and tench (*Tinca vulgaris*). The numbers of fish used in the experiments were, however, relatively small.

In infection experiments with plerocercoids a penetration of these through the gut of the hosts was shown in all the fish species used, *viz.* ruff, pike, perch, rainbow-trout (*Trutta shasta*), and roach (*Leuciscus rutilus*). The plerocercoids were located partly in the coelom and partly in the muscles. Thus ruff, perch and pike can serve as both second intermediary and transport hosts. Plankton-feeding fishes can also serve as transport hosts in spite of the fact that they are obviously immune to infection with procercoids.

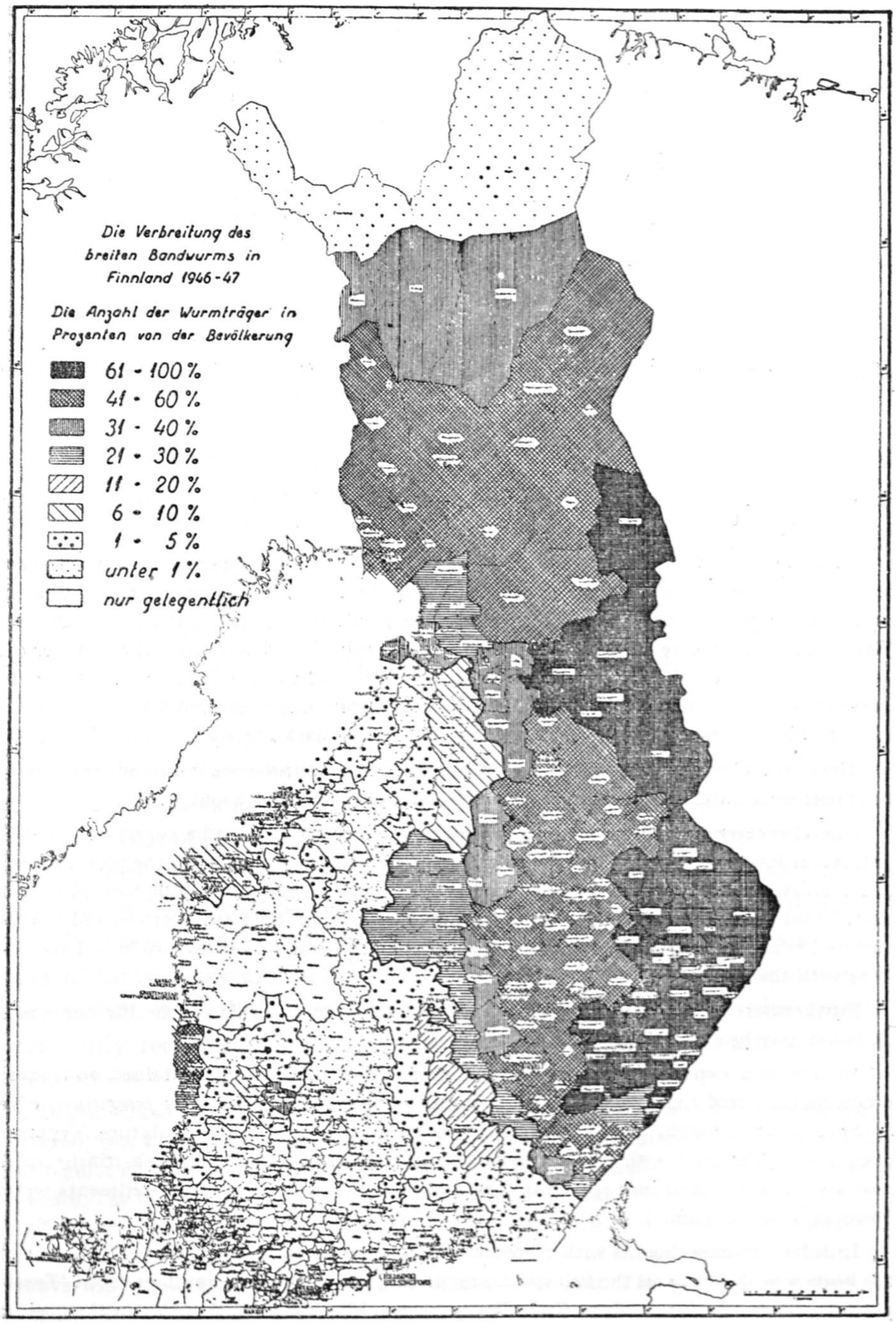

Fig. 2. **The distribution of the adult fish tapeworm in Finland according to HUHTALA (1950).**

THE DISTRIBUTION OF THE FISH TAPEWORM

The distribution of the fish tapeworm in Finland has been studied by SIEVERS (1905), EHRSTRÖM (1926), SEPPÄ (1927), OLLILAINEN (1943), TÖTTERMAN (1944), GYLLING (1949), and HUHTALA (1950).

The material of SIEVERS, EHRSTRÖM and HUHTALA consists of information given by physicians in different parts of the country regarding findings of worm ova in faeces of patients. SEPPÄ, OLLILAINEN and TÖTTERMAN have studied the occurrence of the broad tapeworm in hospital patients. GYLLING's work is based on data taken from case reports. HUHTALA's paper also includes a summary of the previous investigations in this field.

The material collected by SIEVERS was quite small. The chief conclusion was that the broad tapeworm is distributed all over the country. The eastern and central parts of Finland were shown to be most strongly infested, and especially heavily infested areas were those around the water-systems of Pielisjärvi—Saimaa and Keitele—Päijänne. The southwest parts of the country and southern Ostrobothnia were not so heavily infested.

Twenty years later EHRSTRÖM made a new and larger inquiry among about 500 physicians and showed that the most strongly infested areas lay in the eastern districts, along the coasts of Lake Ladoga and in the water-system of the Vuoksi. Strong infection was also recognised in the large inland lake district except for its westernmost parts (Tavastlandia). EHRSTRÖM suggests that the weak infection in Tavastlandia depends upon the fact that the people in this district do not usually eat raw or insufficiently salted fish. This same fact had already been mentioned by SIEVERS.

SEPPÄ's material is based on patients examined in the military hospital at Viipuri. The patients came from nearly all parts of the country, but the majority were from the eastern districts of Savonia and Karelia. Infection with the broad tapeworm was discovered in 11.8 per cent of 3937 persons examined. According to SEPPÄ the strongest infection occurred in the wilds of Kainuu and Kuusamo, on the coasts of Lake Ladoga and around the towns of Pieksämäki, Uusikaupunki and Pori. The lake districts of Tavastlandia and Southern Ostrobothnia were almost free from tapeworm infection. OLLILAINEN chiefly investigated soldiers from North Finland and again the Kainuu area proved to be exceptionally strongly infested. TÖTTERMAN's investigation was performed on patients of a military hospital situated on the north coast of Lake Ladoga. Both soldiers and civilians were examined. The civilians were found to harbour the broad tapeworm to a much higher degree than the soldiers.

GYLLING worked through 14 631 case reports which included mentions of tapeworm infection. Areas with a high degree of infection were the easternmost districts and the neighbourhood of the lake Oulunjärvi. A similar infection occurred in some districts in North Finland.

HUHTALA re-examined the above-mentioned investigations and obtained supplementary information. He was able to show clearly the pronounced easterly distribution of the broad tapeworm. The real *Diphyllobothrium* district lies east of the line Oulu—Kotka (fig. 2.).

Most of the above-mentioned authors have calculated the total degree of infection of the nation. The figures given are: SEPPÄ about 14 per cent, GYLLING about 18 per cent, TÖTTERMAN about 14.5 per cent and HUHTALA about 20 per cent. In an official verdict MUSTAKALLIO (1940) also reckons a total degree of infection of 20 per cent.

FINNISH FINDS OF DIPHYLLOBOTHRID PLEROCERCOIDS

The previous finds of plerocercoids have been listed and discussed below. For the sake of completeness it seems desirable to give fairly extensive citations of the definitions given by different authors. It seems desirable to treat the finds from the fish species pike, burbot, perch and ruff separately from those from Coregonids and other fish species.

FINDS FROM PIKE, BURBOT, PERCH AND RUFF

Since the works of BRAUN (1882), it has been known that larvae of the broad tapeworm occur in pike and burbot. SCHRÖDER (1895, 1896) found them in perch. KUHLOW (1955) has shown that the ruff is among the species which can serve as both intermediary and transport host. Investigating fish from Soviet Karelia PETRUSCHEWSKY (1931) found a heavy infection with plerocercoids obviously belonging to *D. latum* in all these fish species (*Acerina cernua* 98 %, *Lota vulgaris* 91.6 %, *Esox lucius* 88.8 %, *Perca fluviatilis* 53.3 %). Even if, perhaps, other *Diphyllobothrium* plerocercoids than those belonging to *D. latum* can occur in these fish (cf. p. 4), it seems likely that plerocercoids which lie free in the coelom or in the peritoneal membranes or in the musculature of pike, burbot, perch and ruff do in fact belong to *D. latum*.

The first finds of *D. latum* plerocercoids from pike seem to be those made by SCHNEIDER (1901). In two out of nine pike caught in brackish waters at Esbo—Kyrkslätt he found *D. latum* larvae in the coelom. One of these pike contained two plerocercoids, the other only one. LEVANDER (1902) dissected five pike from the same waters and found a larva »on the surface of the ventricle» of one fish. In this same year LUTHER found numerous larvae of *D. latum* in the mesenteries and gut of pike from Lake Keitele. SCHNEIDER (1902), in studying 12 pike from coastal waters (Tvärminne), found plerocercoids of *D. latum* in two pike but only one specimen in each fish (in the coelom and the ovary). In 1903 SCHNEIDER further reported that one out of four pike investigated showed a fairly severe infection with plerocercoids of *D. latum*. E. W. SUOMALAINEN (1909) wrote that he knew of the occurrence of *D. latum* plerocercoids in pike, ruff, whitefish and trout in the lake Kallavesi without, however, giving any evidence in support of his statement. In 1909 LEVANDER reported plerocercoids in eight out of 41 pike (coastal waters). JÄÄSKELÄINEN (1911) reported finds of 32 plerocercoids in the coelom and ovaries of a pike caught in Lake Ladoga. In pike from the lake Kuolimonjärvi KAJAVA (1913) observed plerocercoids in five out of six specimens. He also studied six pike from Lake Saimaa and three of these were infected with plerocercoids. JÄÄSKELÄINEN (1915) observed plerocercoids in 18 out of 21 pike investigated (Lake Ladoga). The larvae were found on the surface of the ventricle, in the pancreas and the spleen, in the liver and the gonads of both sexes, free in the coelom, in the walls of the gut and in one specimen within the gut (distal part), and further in the musculature. BROFELDT (1917) reported unconfirmed finds of *D. latum* plerocercoids in two out of 13 pike from the lake Längelmävesi. JÄRNEFELT (1921), studying a large number of pike from the lake Tuusulanjärvi, found *D. latum* larvae in 39.4 per cent. (cf. also BROFELDT 1915). Further, BROFELDT (1925) shortly reported finds in pike from the lakes Ylimmäinen and Alimmainen Rautjärvi (Evo). The plerocercoids were situated in the musculature, and the liver, on the surface of the viscera, in the mucosa of the mouth, and in the gonads.

In 1913 JÄÄSKELÄINEN reported having found four plerocercoids of *D. latum* in one pike out of nine from Kemi River.

Plerocercoids from burbot have been observed as follows:

LEVANDER (1906) found four small plerocercoids in the liver of a burbot caught in Rautunselkä (the lake Vanajavesi). KAJAVA (1913) dissected about 20—30 burbot from the lakes Kuolimonjärvi and Saimaa and discovered numerous plerocercoids in all specimens. The larvae were located in the musculature, below the peritoneal membranes and in the gonads. JÄÄSKELÄINEN (1915) observed plerocercoids in eight out of 30 burbot investigated (Lake Ladoga). The plerocercoids were located in the liver, the peritoneal membranes and the outer wall of the ventricle. The musculature was investigated in only a few cases. BROFELDT (1915) reported finds from two burbot caught in the lake Tuusulanjärvi (musculature and surface of viscera) and in a burbot purchased at Tampere (very numerous larvae in the liver and musculature) JÄRNEFELT (1921) mentioned plerocercoids in some burbot from the lake Tuusulanjärvi. BROFELDT (1925) reported finds from the lakes Alimmainen, Keskimmäinen and Ylimmäinen Rautjärvi, and Savijärvi. The plerocercoids were situated in the musculature, in the liver and on the viscera. In some cases there were hundreds of them in one fish. WIKGREN (1955) reported finds in burbot from the lakes Immolanjärvi and Päijänne (larvae in nearly all parts of the body).

The finds of Diphyllobothrid plerocercoids from perch are fewer. LEVANDER (1902) reported larvae in the dorsal musculature in four out of 32 perch caught in coastal waters. He wrote: »I cannot doubt that this larva is the young stage (plerocercoid) of the broad tapeworm of man (*Bothriocephalus latus*) since in its shape it fully resembles as far as I can see the figures and descriptions which are to be found in the literature». Later LEVANDER (1909) was unable to find plerocercoids in perch again. SCHNEIDER (1903) searched for plerocercoids in perch and found one larva in one perch. This specimen closely resembled those derived from pike; it was one centimetre long and situated in the mesentery close to the spleen. Investigating the parasites of the fish of Lake Ladoga JÄÄSKELÄINEN (1915) found plerocercoids in two out of 21 perch dissected. The plerocercoids were situated in the liver and in the peritoneal membranes. BROFELDT (1925) found plerocercoids in perch from the lake Ylimmäinen Rautjärvi. He mentions that they were located in the mucosa of the mouth. According to JÄÄSKELÄINEN (1921), finds of Diphyllobothrid plerocercoids from perch caught in the lake Pyhäjärvi (S.W. Finland) have been made by JÄRNEFELT.

There seem to exist only four records of plerocercoids belonging to *D. latum* from the ruff. In 1902 LEVANDER was the first to observe two Diphyllobothrid plerocercoids in one ruff out of 11 dissected (coastal waters). One of the larvae was found in the coelom, the other in the dorsal musculature. LEVANDER was convinced that at least the larva in the musculature belonged to *D. latum*. In 1909 LEVANDER again reported a find of one *D. latum* plerocercoid (2 cm. long) in the dorsal musculature of a ruff caught near Helsinki. JÄÄSKELÄINEN (1915) reported finds of plerocercoids in 4 out of 31 ruff investigated. The plerocercoids were situated on the outer wall of the gut, in the peritoneal membranes, free in the coelom, and in the musculature. Further finds have been reported by E.W. SUOMALAINEN (1900).

Summarizing the finds of Diphyllobothrid plerocercoids from the fish species mentioned above, it becomes apparent that the pike and the burbot are especially heavily infested. The data available on the numbers of plerocercoids per fish show that usually fewer larvae are present in fish caught in coastal waters compared with fish from inland waters. In spite of the incompleteness of the reports there is ample reason to assume that plerocercoids do not occur to the same extent in perch. Thus, for instance, JÄÄSKELÄINEN (1915) found plerocercoids in 18 out of 21 pike, but in only two out of as many perch investigated. It may also be remembered that the investigations of SCHNEIDER

(1902), LUTHER (1902), KAJAVA (1913), BROFELDT (1915, 1917), and JÄRNEFELT (1921) included material of a large number of fish species, but that plerocercoids were not found in perch. From the data given by PETRUSCHEWSKY (1931) it also appears that the degree of infection of perch is lower than that of the other species. The ruff has been so little studied that no conclusions can be based on the informations available. A heavy infection of ruff must be expected.

SOME OBSERVATIONS ON THE PLEROCERCOIDS OF *D. latum* L.

The morphology of the Diphyllobothrid plerocercoids will be dealt with in a later paper. Here only some data are given.

In connection with fishery biological investigations one of us (B. W.) has found plerocercoids obviously belonging to *D. latum* in pike and burbot caught in the lake Vanajavesi and in the lakes Rautavesi and Liekovesi and in the river Kokemäenjoki. Plerocercoids have also been observed in burbot from the lake Pyhäjärvi (S.W. Finland). Only a part of the material is worked through, but it seems as if both these fish species are strongly infected. Plerocercoids have been found both on and in the inner organs and in the musculature. They often lie close below the peritoneal membrane without being enclosed in any recognisable cyst. Plerocercoids have also been found in the gonads of both sexes.

Fig. 3. Drawing of a plerocercoid of *D. latum* from a burbot caught in the lake Pyhäjärvi (S. W. Finland). (orig.)

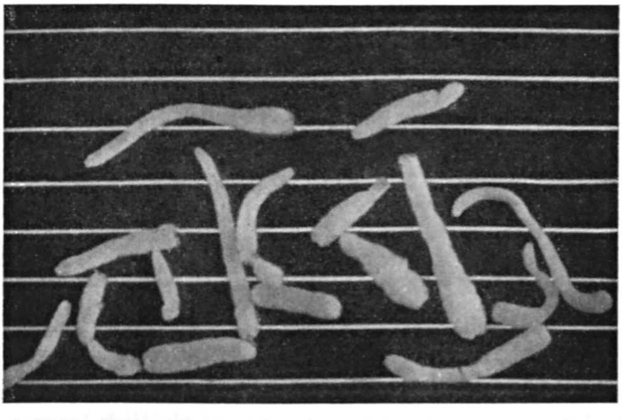

Fig. 4. Photo showing plerocercoids of *D. latum* taken from a pike from the lake Liekovesi. The plerocercoids had been fixed in formaldehyde. Distance between lines 2 mm. (orig.)

The shape of the plerocercoids (figs. 3 and 4) differs slightly from that pictured by KUHLOW. The anterior end is usually broader than the rest of the body, the larvae often being club-shaped in outline. They are of pure white colour. Both ends are tucked within the body. The cuticle lacks bristles. Some measurements on a few specimens (living): thickness of the cuticle: 3.2 – 6.5 μ, breadth of the lime corpuscle—free zone: about 10 μ, lime corpuscles: 15 μ $\times$ 19 μ. The average length of 56 specimens preserved in dilute formaldehyde is 5.2 mm and the limiting values are: 2–11 mm.

PLEROCERCOIDS FROM COREGONIDS

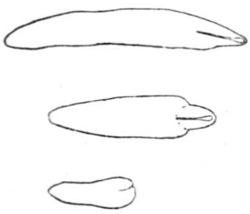

Fig. 5. Reproduction of JÄRVI's (1909) figures of the plerocercoids found in vendace from the lakes Kivijärvi and Keitele.

The question of the true nature of the plerocercoids found in Coregonids is a puzzling one. Physicians have for a long time suggested that the people in the lake districts are most probably infected with the fish tapeworm by eating insufficiently cured vendace (*Coregonus albula*). This belief was supported by the discovery by LÖNNBERG (1892) in Sweden of plerocercoids from vendace and whitefish (*Coregonus lavaretus*). LÖNNBERG described these plerocercoids as belonging to *D. latum*.

In 1908 JÄRVI published an article in which he declared that he had found plerocercoids of *D. latum* in vendace caught in the lakes Kivijärvi and Keitele. The degree of infection was fairly high, varying between 10 and 40 per cent. The number of plerocercoids per fish varied between one and fourteen, but the cases of one or two plerocercoids per fish were in the majority. The figures given by JÄRVI are reproduced in figs. 5 and 6. He gives the following description: »All the plerocercoids seen by me have been located on the outer wall of the ventricle of vendace, where they occur included in rounded, cyst-shaped growths; only twice have I seen them creeping on the walls of the ventricle. I have not found them in the ovaries or the peritoneal membranes in spite of having looked for them there . . . The walls of the cysts were slightly transparent or quite opaque. The walls were not especially hard; with a needle it was easy to make a hole and draw the larva out.» »The plerocercoids of the fish tapeworm found by me were relatively small. In some fish they can grow up to 30 mm., but only very few of those found by me in vendace were longer than 10 mm. The

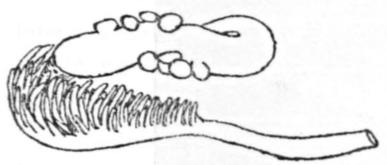

Fig. 6. The location of encysted plerocercoids around the ventricle of the vendace (JÄRVI 1909).

normal length was about 4—8 mm. Put into formaldehyde or spirit they contracted to about 2—5 mm.; the largest specimens being somewhat larger (up to 8 mm.)». In 1921, JÄRVI again mentioned these finds.

It is a remarkable fact that LUTHER (1902) investigating several fish species from Lake Keitele, did not report finds of plerocercoids from vendace. SUOMALAINEN (1909) also claimed to have found *D. latum* plerocercoids in vendace from Lake Kallavesi. Most of these larvae are said to have occurred in the gut, but some were also found on the walls of the coelom and on the swimbladder. KAJAVA (1913) reported having regularly found numerous *D. latum* plerocercoids in vendace from the lakes Kuolimonjärvi and Saimaa. JÄÄSKELÄINEN (1915) reported finds of plerocercoids from vendace from Lake Ladoga. Eight out of 38 fish were infected. The plerocercoids occurred on the ventricle and in the mesenteries. The figure given (cf. fig. 9.) shows plerocercoids which greatly resemble those found by JÄRVI. According to JÄÄSKELÄINEN (1921) Diphyllobothrid plerocercoids have further been found from vendace by HÄNNINEN (from Kuusamo) and by BROFELDT (from Evo). JÄÄSKELÄINEN has not given any references and the papers describing these finds cannot be traced. Perhaps they were not published (at least not referred to in Bibliotheca Zoologica Fennica).

If we accept WARDLE's statement (cf. p. 5) that the plerocercoids of *D. latum* are never encysted and the conclusions of PETRUSCHEWSKY and TARASSOW (1933) that encysted plerocercoids in vendace are not infective to man, it is obvious that the plerocercoids found by JÄRVI do not belong to the broad tapeworm of man. In a personal communication (1955), Professor JÄRVI has also expressed some doubts on his determination in 1908. Further WIKGREN (1955) has shown that the cuticle of these plerocercoids is provided with bristles and that according to KUHLOW's differential diagnosis they pertain to *Diphyllobothrium osmeri* (v. Linstow 1878). On p. 14 a short description is given. The vendace is thus certainly heavily infested with *D. osmeri*. The possibility of infection with *D. latum* cannot, however, be fully excluded. JÄRVI's material obviously consisted of *D. osmeri* only, but the true nature of the finds of SUOMALAINEN, JÄÄSKELÄINEN and KAJAVA is questionable. This point needs further investigation.

The first finds of plerocercoids from whitefish (*Coregonus lavaretus*) which have been claimed to belong to *D. latum* seem to be those made by KAJAVA (1913) in two out of nine whitefish (the lakes Kuolimonjärvi and Saimaa). JÄÄSKELÄINEN (1921) mentions having made finds of *Bothriocephalus* sp. larvae in whitefish from Lake Höytiäinen. ODENWALL (1927) mentions the occurrence of cysts on the outer wall of the gut of whitefish. One such case was shown to Professor K. M. LEVANDER, who claimed these cysts to be caused by larvae of *Bothriocephalus latus*. In 1929 LEVANDER, in an article entitled »The whitefish as the intermediary host of the broad tapeworm», wrote that hitherto the only reports that whitefish could be infected with plerocercoids of *D. latum* were from Lake Höytiäinen (obviously referring to JÄÄSKELÄINEN). LEVANDER now reported that he had studied a sample consisting of the inner organs of a large whitefish caught in the lake Pyhäjärvi (S. W. Finland) and that he had found numerous plerocercoids which »on satisfactory evidence» could be determined as belonging to *D. latum.* The larvae occurred on the surface of the ventricle in round, protruding cysts 4 mm. in diameter. Some cysts were smaller. The larvae are said to have been 10—15 mm. long. Referring to this article ODENWALL (1930) wrote that it is the whitefish that seems to be the main source of infection to man and he mentions that nearly every whitefish caught in the lake Lappajärvi is infected with tapeworm larvae in cysts on the gut.

A prominent character in the descriptions mentioned above is that the larvae occurred in rounded, protruding cysts chiefly around the ventricle. This eliminates the possibility of a *D. latum* infection. As a curiosity it may be mentioned that in 1906 LEVANDER wrote that the larvae of *D. latum* are small, usually less than one centimetre in length, and do not form (!) cysts around themselves.

Investigating a large sample of whitefish from the lake Pyhäjärvi (S. W. Finland) one of us (B. W.) has found tapeworm plerocercoids in nearly every fish. These plerocercoids occur in cysts quite similar to those described by LEVANDER. They certainly do not belong to *D. latum* and it has been suggested (WIKGREN 1955) that they belong to the genus *Eubothrium.* Plerocercoids of *D. latum* certainly do not occur in whitefish from the lake Pyhäjärvi, but they are present in burbot.

It seems evident that certain finds of plerocercoids of *D. latum* in whitefish have not hitherto been reported in Finland.

PLEROCERCOIDS OF *D. osmeri* (V. LINSTOW 1878)

One of us (B. W.) has investigated Diphyllobothrid plerocercoids from vendace caught from the lakes Vanajavesi and Puulavesi. The plerocercoids lay in rounded cysts, chiefly on the outer wall of the ventricle. The larvae, when dissected out, measured 3—6 mm. in length and about 0.5—1.0 mm in

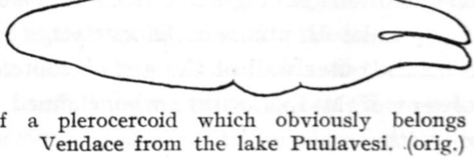

Fig. 7. Drawing of a plerocercoid which obviously belongs to *D. osmeri.* Host: Vendace from the lake Puulavesi. (orig.)

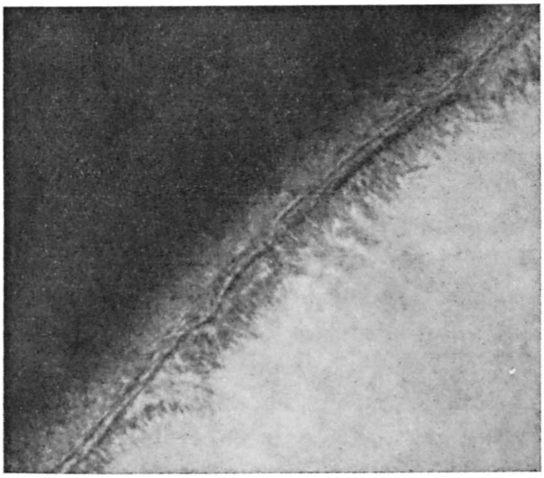

Fig. 8. Photo showing a part of the body cuticle of a plerocercoid of *D. osmeri*. Note the long cuticular bristles. (orig.)

breadth. The colour was whitish, but the larvae were not quite untransparent. Both the scolex and the caudal end were extruded (fig. 7). The cuticle was somewhat folded in the living state; in specimens preserved in formaldehyde the cuticle is unfolded. The body, except perhaps for its cranialmost end, was covered with cuticular bristles 16 μ long (fig. 8). The thickness of the cuticle measured about 13 μ. The bothrids were 0.5—0.7 mm. The lime corpuscle—free zone was about 14 μ broad (measured to the inner lining of the cuticle). The lime corpuscles measured about 10 × 13 μ.

These plerocercoids most closely resemble the plerocercoids of *D. osmeri* as these have been described by KUHLOW. Hence this name has been adopted until the final determination can be made with the aid of infection experiments.

PLEROCERCOIDS FROM OTHER FISH SPECIES

The data concerning finds of plerocercoids from fish species other than those dealt with above are very few, and most of them have been given by JÄÄSKELÄINEN (1915). This author investigated 27 fish species from Lake Ladoga and found Diphyllobothrid plerocercoids in 13 species. The findings from pike, burbot, perch, ruff and vendace have been cited above. Plerocercoids were further observed in the following species:

1) Three-spined stickleback (*Gasterosteus aculeatus*). Plerocercoids in the liver, the peritoneal membranes and on the walls of the ventricle together with specimens lying free in the coelom. 25 out of 100 fish were infected.

2) Ten-spined stickleback (*Gasterosteus pungitius*). Plerocercoids occurred in the liver. One out of nine fish was infected.

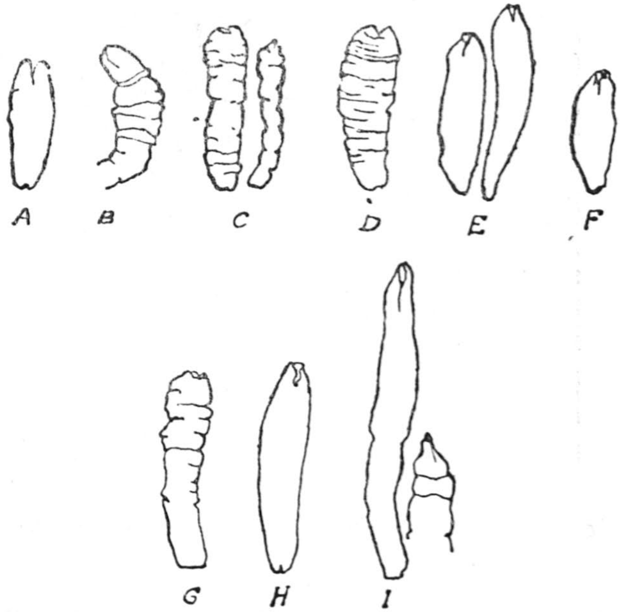

Fig. 9. Reproduction of the figures given by JÄÄSKELÄINEN (1915 and 1921) of the plerocercoids found by him in fish from Lake Ladoga. A. From *Salmo salvelinus*. B. From *Lota vulgaris*. C. From *Esox lucius*. D. From *Perca fluviatilis*. E. From *Gasterosteus aculeatus*. F. From *Petromyzon fluviatilis*. G. From *Thymallus vulgaris*. H. From *Osmerus eperlanus*. I. From *Coregonus albula*.

3) Four-horned Cottus (*Cottus quadricornis*). Larvae in the mesenteries. One out of 25 fish was infected.

4) Smelt (*Osmerus eperlanus*). Plerocercoids were found on the walls of the ventricle and in the liver. 39 per cent were infected.

5) Silver bream (*Abramis blicca*). Plerocercoids in the liver. One out of 21 fish was infected.

6) Char (*Salmo salvelinus*). Plerocercoids within the ventricle. In one out of 12 fish.

7) Grayling (*Thymallus vulgaris*). Plerocercoids occurred in the walls of the gut. Two out of 18 fish were infected.

8) River lamprey (*Petromyzon fluviatilis*). Plerocercoids in the walls of the gut and on the surface of the kidney. In two out of six lampreys.

The figures given by JÄÄSKELÄINEN are reproduced in fig. 9. JÄÄSKELÄINEN himself was convinced of the relation with *D. latum* only for the plerocercoids from char, burbot and pike. Some tentative conclusions can perhaps be drawn:

1) The shape of the plerocercoids from pike, perch and grayling closely correspond to the usual appearance of *D. latum* plerocercoids. The figure of plerocercoid from burbot shows a partially extruded scolex, but obviously

this larva also belongs to *D. latum*. In the char plerocercoids were found only from within the ventricle. Such larvae are probably not comparable with those which have penetrated the gut. It is possible that the larva from the char also belongs to *D. latum*.

2) The other plerocercoids figured, *i.e.* those from the ten-spined stickleback, the smelt, the vendace, and the lamprey, have an unfolded cuticle and do not seem to belong to *D. latum*. Those from the vendace are very similar to those from this same fish species found by WIKGREN.

LEVANDER (1907) writes that he had determined some plerocercoids from a lake trout (*Salmo trutta lacustris*) caught in Lake Saimaa as belonging to *D. latum*. The larger specimens were 7—9 mm. long and 1—2 mm. broad. The larvae were situated on the peritoneal membranes. KAJAVA (1913) mentioned having inspected one salmon (*Salmo salar*) in which some plerocercoids occurred in the peritoneum. According to JÄÄSKELÄINEN (1921) Diphyllobothrid plerocercoids had further been found by RANTANEN in trout (»*Salmo trutta*») from the river Kemijoki and by JÄÄSKELÄINEN in lake trout from Lake Höytiäinen.

It may be mentioned here that LEVANDER (1918) reported finds of tapeworm ova in plankton samples taken at the port of Helsinki. The ova were brownish and of 60 μ length and 50 μ breadth.

THE LOCALITIES OF DIPHYLLOBOTHRID PLEROCERCOID FINDS

The localities of Diphyllobothrid plerocercoid finds are listed below and also mapped in fig. 10. No relations between the occurrence of the adult worm and the plerocercoids can be deduced. This, of course, depends on the paucity of information regarding plerocercoids.

Plerocercoids from pike, burbot, perch and ruff.

Coastal waters:
- The coast line Helsinki—Hangö (pike, perch, ruff).

The lakes:
- Alimmainen Rautjärvi (Evo) (pike),
- Immolanjärvi (burbot),
- Kallavesi (pike, ruff),
- Keitele (pike),
- Keskimmäinen Rautjärvi (Evo) (burbot),
- Kuolimonjärvi (pike, burbot),
- Ladoga (pike, burbot, perch, ruff) (no longer belongs to Finland),
- Liekovesi (pike, burbot),
- Längelmävesi (pike),
- Pyhäjärvi (S.W. Finland) (burbot, ruff),
- Päijänne (burbot),
- Rautavesi (pike, burbot),
- Saimaa (pike, burbot),
- Savijärvi (Evo) (burbot),
- Tuusulanjärvi (pike, burbot),
- Vanajavesi (pike, burbot),
- Ylimmäinen Rautjärvi (Evo) (pike, perch),

and the rivers:
- Kokemäenjoki (pike, burbot),
- Kemijoki (pike).

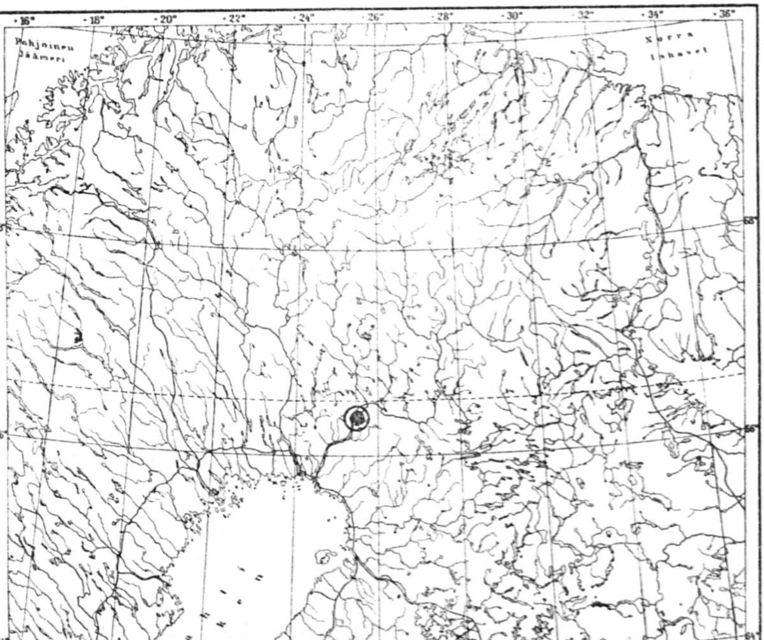

Fig. 10. The localities of Diphyllobothrid plerocercoid finds. Solid rings: finds from pike, burbot, perch and ruff. Open rings: finds from other fish species.

Plerocercoids from Coregonids

The lakes:

Höytiäinen,
Kallavesi,
Keitele,
Kivijärvi,
Kuolimonjärvi,
Ladoga,
Lappajärvi,
Puulavesi,
Pyhäjärvi (S. W. Finland),
Saimaa.

Plerocercoids from other fish species

The lakes:	and the river
Höytiäinen, Ladoga, Saimaa	Kemijoki

DISCUSSION

The facts mentioned above warrant only one certain conclusion, *viz* that the occurrence of fish tapeworm plerocercoids in Finland is quite unsatisfactorily known in relation to the importance of the problem. The first work to be done is to accumulate new facts regarding both the geographical distribution of *D. latum* plerocercoids and the occurrence of plerocercoids in different fish species. Simultaneously it will be possible to study the occurrence of plerocercoids of the other *Diphyllobothrium* species.

The problem of the occurrence of plerocercoids in different fish species is especially interesting from several points of view. As was shown, we can only be certain of the relationship with *D. latum* of the plerocercoids from pike, burbot, perch, and ruff, and perhaps also of those from Salmonids. All these species may be infected with procercoids in their early youth when still feeding on plankton. It must, however, be assumed that predatory fish also take over plerocercoids from their prey and that they thus »concentrate» plerocercoids. The most logical conclusion would be that plerocercoids occur in plankton-feeding fish, but on the other hand plankton-feeding fish do not seem to be susceptible to infection with procercoids (cf. p. 5).

If there were a plankton-feeding fish species which was the main source of infection of the predatory fish, this (or these) fish species should be very heavily infested with plerocercoids. According to preliminary investigations made by us and according to the Finnish literature no heavy infection of true plankton- feeding fish has been observed.

The list of host species given by Craig and Faust (1948) include the following species (for Europe): *Esox lucius, Perca fluviatilis, Lota vulgaris, Acerina cernua, Salmo trutta, Coregonus* sp., *Thymallus vulgaris*, and *Anguilla vulgaris*. It is interesting to compare with the corresponding list given by Wardle and McLeod (1952) which is: *Esox lucius, Perca fluviatilis, Lota vulgaris, Salmo salar, Salmo trutta, Salmo trutta lacustris*, and *Thymallus vulgaris*. It may be mentioned that exactly the same list was given by Wardle in 1935. The list of fish hosts given by Piekarsky (1954) is: »*Esox lucius, Perca fluviatilis, Lota vulgaris, Salmo umbla, Trutta vulgaris, Trutta lacustris, Thymallus vulgaris, Coregonus lavaretus, C. albula*, und *Anguilla vulgaris*».

The question of the primary fish host of *D. latum* is thus still unsolved. One hypothetical possibility may be mentioned, *viz.* that larger predatory fish take over plerocercoids only from the smaller predatory fish upon which they prey (cf. HOBMAIER, 1927). Thus, for example, both pike and burbot frequently feed on small perch and ruff which in turn feed on plankton for considerable periods of time.

As was mentioned above, physicians have long suspected the vendace as an important source of *D. latum* infection in man. Even if it now appears as if the dominant species parasitizing vendace is *D. osmeri*, the possibility of infection with *D. latum* must be taken into account. The investigation of ample material of vendace is accordingly one of the most important points of our research programme.

The exact knowledge of the occurrence of fish tapeworm plerocercoids is also of outstanding importance in the campaign against the worm. It cannot be tolerated that at least every fifth Finnish citizen harbours tapeworms.

SUMMARY

1) The state of knowledge of Diphyllobothrid plerocercoids is briefly discussed.

2) The distribution of the fish tapeworm in Finland is summarized according to the literature references available.

3) The Finnish finds of Diphyllobothrid plerocercoids are reviewed. It is assumed that the finds reported from pike, burbot, perch and ruff most probably belong to *D. latum*. Also the plerocercoids found in Salmonids may belong to this species. The true nature of the finds claimed as *D. latum* plerocercoids from Coregonids is questionable. A confusion with finds of other Diphyllobothrid species has certainly occurred. It seems not to be convincingly proved that Coregonids act as carriers of *D. latum* plerocercoids. Plerocercoids have been reported from some other fish species, too.

4) Short descriptions of new finds of plerocercoids of *D. latum* and *D. osmeri* are given.

5) The problem of the first fish host of *D. latum* is discussed. It is provisionally assumed that *D. latum* does not at all pass through true plankton-feeding fish species, but chiefly employs such fish species as ruff and perch as the first fish host.

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