

**A PARTIAL SURVEY OF THE NEMATODE PARASITES OF CANADIAN
MARINE AND FRESH-WATER FISHES.**

By

Enid Mary Smedley, B.Sc., Man., 1931.

**Being a thesis submitted to the University of Manitoba
in partial fulfilment of the requirements for the de-
gree of Master of Science, 1932.**

ABSTRACT

A number of nematodes from Canadian marine and fresh-water fishes have been collected and described. The following are new species:--Ichthyofilaria fragilis, gen. et sp. nov., Raphidascaris canadensis, Oncullanus elongatus, and Bulbodaenitis occidentalis. Cystidicola stigmatura (Leidy) is also described. A summary is made of the general methods of nematode technique, with a new method of preparing material for sectioning.

INTRODUCTION

No attempt has hitherto been made to describe or even to identify most of the nematodes found parasitic in Canadian fishes. Indeed, with the exception of the work of Leidy, Baylis, Linton, Skinker, and Ward and Magath, very little work has been done on fish nemas on the North American continent. The fauna of such an important source of food must be known in its entirety, and furthermore must be completed before an American monograph on parasitic nematodes can be compiled.

This survey was at first intended to cover only those species occurring in fresh-water fishes, but it very soon became apparent that, for some reason not at present known, these are very scarce. It was therefore decided to extend the scope of the survey to include marine forms of the Pacific slope.

Material has been received from the following, to whom grateful acknowledgments are hereby made:--R. E. Foerster (Ichthyofilaria fragilis), D. Rawson (Bulbodactylus occidentalis, Raphidascaris canadensis, Cystidicola stigmatura), R. A. Wardle and E. Kuitunen (Cuonellanus elongatus), E. May Lyons (Cystidicola stigmatura), and M. V. B. Newton (Raphidascaris canadensis). Special thanks are due to Professor Robert A. Wardle for first interesting me in this line of work, and for making it possible for me to carry it out.

METHODS

The technique of nematode preparation is attended with certain difficulties which make the group an unpopular field of study. A special technique is required which is, however, quite simple when once mastered. The author's methods, which have been tried and proved many times, are given here for convenience of other workers, and because the author has nowhere found a brief summary of general nematode technique.

FIXATION:

The most satisfactory general fixative is hot 70% alcohol. For material intended for sectioning, Hetherington's Carnoy-phenol is better. Specimens are collected by slitting the gut of the fish and washing it in a large quantity of water. The nematodes sink to the bottom of the dish, and the water with most of the debris can be decanted off by successive washings. The specimens should be fixed as soon as possible, since they die very rapidly even in saline, and will probably die curled up into a tight knot. The specimens should not be handled before fixing as they are very easily injured. Handling is avoided by retaining the worms in a very small amount of water and pouring them into the fixative, which should be just hot enough to steam. They will then die in a regular curve instead of the cork-screw coils which so often result from improper fixation.

Once a nema is fixed it is quite impossible to change its shape. Formalin, corrosive sublimate, and the other common fixatives should in general be avoided, as they shrink the inner structures of the worm and leave the cuticula wrinkled and distorted. From the fixative--either alcohol or Carnoy-phenol, the worms should be transferred to 70% glycerine alcohol for storage. For further uses of Carnoy-phenol reference may be made to Hetherington, 1922. The formula is given here for convenience:--

Absolute alcohol.....	20 cc.
Chloroform.....	15 cc.
Glacial acetic acid.....	5 cc.
Phenol crystals to raise the volume by.....	10 cc.
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Total.....	50 cc.

"As this mixture is water-free and very corrosive it must be kept in glass-stoppered bottles until used and also should not be kept more than two weeks as an ester formation destroys its efficiency. In working with it, it is most easily handled in Syracuse dishes, the edges of which have been dipped in hot paraffin to prevent the liquid from creeping over the rims." If the dish be warmed before dipping in paraffin, the paraffin will stick much better, and last longer. If any of the fluid chances to get on the fingers, a quick rinse in water will prevent serious damage.

DEHYDRATION AND CLEARING:

These processes can be carried through simultaneously by the Loess method. The medium, 70% alcohol containing 5-10% glycerine, is simply allowed to evaporate. More fluid is added from time to time if there is not sufficient to cover the worms. The advantage of glycerine alcohol as a storing fluid is immediately seen--if the material is accidentally allowed to dry out, the glycerine prevents damage to the specimens. Evaporation should not be hurried if the best results are needed, but usually it is permissible to have the material in the constant temperature even at about 55° C. When the odor of alcohol has disappeared, the specimens will be found to be sufficiently cleared and dehydrated for mounting. It is better to study the specimens at this stage in a Syracuse dish, where they can be readily manipulated, and later to make permanent mounts of representative specimens. Material fixed in formalin offers some difficulty. Taking such materials through a series of alcohols up to 70% is unsatisfactory since it increases the distortion of the cuticula, and takes up a great deal of time. A simple and effective means of dehydrating such specimens is to transfer them directly from formalin or other fixative to Carnoy-phenol, and there to leave them uncovered for a few hours or until cleared. This treatment actually improves the specimens. From Carnoy-

phenol the worms are transferred to glycerine alcohol as before.

MOUNTING:

The specimens are taken from glycerine and mounted on a slide in a drop of glycerine jelly, and a cover slip added. The glycerine jelly should be first heated till very fluid, as this prevents making a preparation which is so thick that the high power objective cannot be used. The cover slip is ringed first with gold size, then with brown cement, allowing an hour in between each step.

Staining is largely unsuccessful in toto mounts, and in this case was abandoned as unnecessary--worms which are not stained show more structure than stained mounts.

SECTIONS:

Where it is desirable to cut sections, a different procedure may be adopted. The worms are transferred from whatever fluid they have been stored in, cut into pieces of the desired length, and placed in Carnoy-phenol. They are left uncovered in this fluid until clear, when they are completely dehydrated. All that is now necessary is to get the material into paraffin. The specimens are first freed of Carnoy-phenol by placing in absolute alcohol. The fluid chosen for intermediary between alcohol and paraffin must be freely miscible in alcohol, since it can only be introduced very gradually, or the specimens shrink or become

filled with air bubbles. The oils commonly used as clearing agents, such as cedar oil, wintergreen, xylol or creosote, all make nemas very brittle, and should be generally avoided. These considerations limit the choice to such fluids as ether, chloroform, benzol, etc. Ether is unsuitable because of its rapid vaporization and inflammability--benzol, like xylol, shrinks nemas readily. A series of four mixtures of alcohol and chloroform should be prepared:--

1. 20 cc. alcohol with 5 cc. chloroform.
2. 15 cc. alcohol with 10 cc. chloroform.
3. 10 cc. alcohol with 15 cc. chloroform.
4. 5 cc. alcohol with 20 cc. chloroform.

These must be kept in tightly stoppered bottles to prevent evaporation of the chloroform. The worms are kept in each of these fluids for at least one hour, though a better procedure is to leave them until they sink to the bottom of the fluid. In the later stages, this may take two hours. Any whitish spots appearing during this process mean air bubbles in the specimens, and they must then be moved back one or two steps and again brought through more slowly. Finally they should be left overnight if possible in pure chloroform. Now remove the tight cover from the jar, and add a few chips of pure paraffin. Cover loosely and put in the oven. At long intervals, say half an hour, add a few more chips of paraffin.

The intervals can be successively shortened, and the chips made larger. When the mixture is one half paraffin the cover may be removed, and the chloroform allowed to evaporate. When the odor of chloroform has completely disappeared, transfer the specimens to pure wax, preferably a "hard" wax--melting point 58° to 60° C. Change the wax several times before finally embedding. Sections should be chopped at about 10 μ for most purposes. From this point the treatment is exactly similar to that for any other type of material. Most stains work well after Carnoy-phenol, Delafield's hematoxylin being quite satisfactory. The best results have been obtained by using Kuitunen's triple-stain process, employing Delafield, saffranin, and picric acid, as follows:--

Delafield.....2 to 3 hours.
Wash in running water.....15 mins.
30% alcohol.....5 mins.
Saffranin in 50% alcohol.....5 to 10 mins.
Run up to absolute.
Absolute with picric acid (5 drops of picric acid to each 5 cc. absolute alcohol)..10 mins.
Absolute--xylol--xylol balsam.

Ichthyofilaria fragilis, gen. et sp. nov.

Material collected by R. E. Foerster--from the body cavities of Sockeye Salmon come up to spawn in Cultus Lake, B. C. None of the worms are actually lying free in the body cavity but are entangled in the fatty connective tissues of the pyloric caecae, liver, etc. There are three types present:-

1 Long, plump, extremely fragile, semi-transparent mature females.

2 Irregularly coiled, small, delicate males with a slender posterior end embedded in tissue and a tightly coiled tail.

3 "Watch Springs", immature females lying beneath the mesenteries--small, firm, tightly coiled. It is doubtful whether these belong to the same genus, or are ascaroids of the type known as "Ascaris capsularia". Since there are no transition types between these and the mature females, they are at least a separate generation.

These worms are very obviously filarioids of the family: Dracunculidae, which contains two genera--Dracunculus and Philometra. The latter is a heterogeneous group containing all the filarioid fish parasites whose males are much smaller than the females. The species here described does not fit even the loose description given of Philometra. It may be distinguished by the absence of

cervical papillae, by the tapering posterior extremities of both male and female, and by the absence of the gubernaculum in the male.

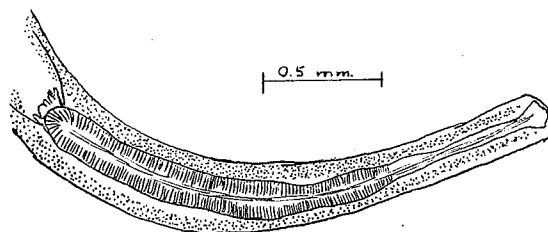


Figure 1.--Ichthyofilaria fragilis, anterior end of male.

Family: DRACUNCULIDAE Leiper, 1912.

Genus: Ichthyofilaria, gen. nov.

Generic Diagnosis: Dracunculidae. Female enormously larger than male; body filiform; anterior extremity rounded; mouth without lips or papillae; oesophagus very short and slender, extending completely to anterior extremity; posterior extremity tapering to a long, slender, very fragile point. Male: posterior extremity tapering, anus sub-terminal; spicules equal and needle-like; gubernaculum absent. Female: anus and vulva atrophied in adult; body occupied almost entirely by uterus filled with embryos; small ovary at each end of body. Parasitic in coelom and tissues of

fishes. Type species: I. fragilis, n. sp., in Oncorhynchus nerka.

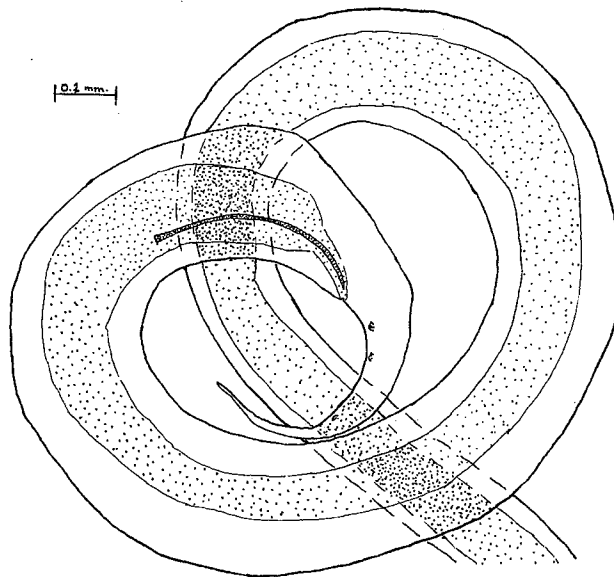


Figure 2.--Ichthyofilaria fragilis, posterior end of male.

Ichthyofilaria fragilis, n. sp. With the general characters of the genus.

Male: Up to 50 mm. long. 0.4 mm. wide throughout anterior two-thirds of its length. Posterior one-third narrower, more coiled, although whole length is much distorted (this may be due to formalin fixation). Posterior extremity coiled in tight spiral. Oesophagus divided into two parts, anterior 1.21 mm. long, posterior 1.365 mm. -- total length, 2.57 mm. Nerve ring 0.4 mm. from tip. Intestine functional, although the walls are so thin as to be almost indistinguishable. Small valve between oesophagus

and intestine. Body narrows rapidly behind anus, ending in a long, slender, fragile point. Anus about 0.47 mm. from tip of tail. Several small postanal papillae. Spicules very slender, anterior end blunt, posterior end very pointed. Spicule is 0.4 mm. long, by 0.006 mm. wide, sharply curved. Female: Up to 230 mm. long. Oesophageal

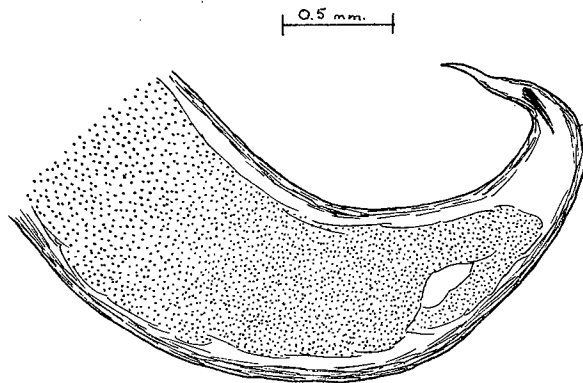


Figure 3.--Ichthyofilaria fragilis, posterior end of female.

measurements as in male--oesophagus slender and fragile, two portions indistinctly separated--2.57 mm. long. Nerve ring 0.4 mm. from anterior end. Intestine a broad, flat, collapsed tube, empty, and ending blindly near posterior end. No trace of anus. Body of uniform thickness throughout, tapering at posterior extremity, behind former position of anus, as in the male. Body thickness up to 1.2 mm. Body held turgid only

by large uterus crammed with embryos. Uterus a simple, straight tube with a small ovary beside the oesophagus, and a second at the posterior end. No trace of vulva. Uterus free from body wall throughout entire length. This is readily demonstrated by a very simple dissection. A cross-section of a mature female shows the thin body-wall with its two muscle bands, the flat, empty intestine, and the large, round uterus filled with embryos. There must be thousands of embryos in an individual worm. The embryos are usually coiled up, 0.026 mm. wide, by 0.55 mm. long. About

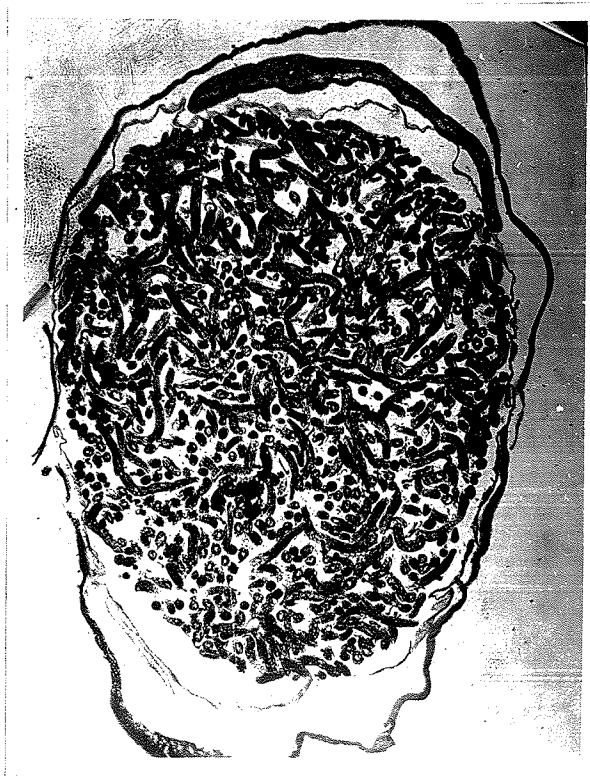


Figure 4.--Ichthyofilaria fragilis, cross-section of mature female.

half this length is the slender, whip-like tail.

Type Host. Oncorhynchus nerka.

Type Location. Body cavity and viscera.

Type Locality. Cultus Lake, B. C.

Raphidascaris canadensis, sp. n.

This is the most widely distributed species found during the present work. Never very abundant, it yet seems to be present wherever Esox lucius is found. I have received a few specimens from many lakes throughout Manitoba and Saskatchewan, ranging into the northern areas of the two provinces.

Family: HETEROCHEILIDAE Raillet & Henry, 1915.

Genus: Raphidascaris Raillet & Henry, 1915.

Synonyms: Hysterothylacium Ward and Magath, 1916; Hysterothylacium of Wigdor, 1918; Ascaris Bloch, 1779.

Generic Diagnosis. Anisakinae: Fairly large, stout worms; thick, coarsely striate cuticula; lips three in number, with cuticular expansions, particularly well-developed on the sub-ventral lips; interlabia absent; dentigerous ridges absent; lateral alae present; oesophagus with an anterior muscular portion and a small posterior ventriculus, from which springs a posterior appendix; intestinal caecum absent. Male: tail curved ventrally, tapering to a point; spicules equal and winged; preanal papillae present; gubernaculum absent. Female: vulva in front of the middle of the body; oviparous. Parasites of fishes. Type species: R. acus (Bloch, 1779).

Raphidascaris canadensis, n. sp. Stout worms, the head usually bent ventrad; tail in male also curved ventrad. Body tapering at both ends, maximum width just behind center of body. Lateral alae extending entire length of body. Cuticula very thick, striations deep, 15μ apart. Lips large, prominent, cuticular expansions at base of sub-ventral lips; oesophagus long, $1/8$ of body length; oesophageal bulb not well differentiated. Male: up to

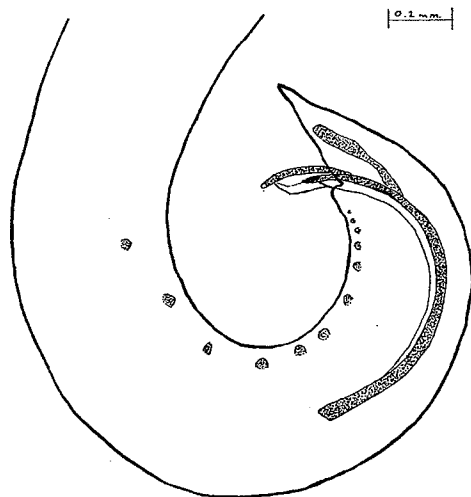
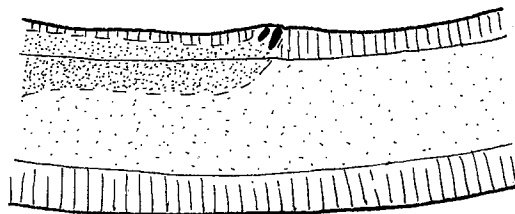


Figure 5.--Raphidascaris canadensis, posterior end of male.

23 mm. long. Testis a long slender tube running the length of the body several times, and twisted into a tight spiral like a rope. Spicules equal--long, slender needles sharply

curved, and with broad alae which are characterized by a longitudinal sulcus; spicule 0.65 mm. long, by 0.0125 mm. wide; alae 0.03 mm. wide. There are from nine to twenty-one pairs of preanal papillae, depending on the size and development of the worm. Nine seems to be the original equipment of the young worm, with additional ones built up from the cuticula--very small ones next to the anus, and large, flat ones higher up on the body beyond the original nine, as the worm grows larger. Anus only 0.1 mm. from the tip of the tail. Tail very short, narrowing very abruptly, and ending in a small delicate



0.1mm

Figure 6.--Rhabdiascaris canadensis, female, showing vulva.

point of tissue. Female: Length up to 50 mm. Vulva small, a mere slit in the cuticula, one-fifth of body length from anterior end, supported by two small rods on either side. Uteri directed posteriad. Ovarian tubes slender, very long,

much convoluted, extending to within 1 mm. of the posterior end. They do not extend beyond the vulva anteriorly. Ova small, very numerous, approximately 0.06 mm. long, by 0.04 mm. wide. Anus 0.55 mm. from tip of tail. Tail conical, narrowing rapidly from a point 0.55 mm. in front of anus to the tip. Tip surmounted by a small, fragile point of tissue as in the male.

Type Host. Esox lucius L.

Type Location. Intestine.

Type Localities. Waskesiu Lake and Sandy Lake, Saskatchewan; lakes Winnipeg and Winnipegosis, and the district around the Pas, Manitoba; with many single specimens whose locality is doubtful, but all from Western Canada.

Cucullanus elongatus, sp. n.

Specimens are from the Ling Cod, or Blue Cod, of the Pacific coast of North America, Ophiodon elongatus. The first lot, 8 females, were collected by Professor Wardle on August 25th, 1929. These were cleared in creosote after formalin fixation, and were not satisfactory. A second lot was collected and fixed in 70% alcohol, on June 15, 1932. There were 2 males and ten females.

Family: CUCULLANIDAE, Cobbold, 1864.

Genus: Cucullanus, O. F. Mueller, 1777.

Synonyms: Pleurorinchus Nau, 1787; Pleurorhynchus Rud., 1801; Ophiostoma Rud., 1801, in part; Daeritis Euj., 1845; Stelmus Duj., 1845; Dichelyne, Jägerskiöld, 1902.

0.5 mm.



Figure 7.--Cucullianus elongatus, anterior end of female.

Generic Diagnosis. Cucullianidae: Modified from Barreto (1922), and York and Maplestone (1926). Cephalic extremity generally bent dorsally. Mouth ellipsoid with large dorsoventral axis, limited by two lips with saw-like chitinous apparatus, each with three papillae. No chitinous buccal capsule, but a pseudo-capsule formed by the dilation of the anterior end of the oesophagus; the oesophagus also enlarged posteriorly, no oesophageal bulb; intestine simple. No lateral alae. Male: Preanal sucker without a chitinous rim; caudal alae rudimentary, sometimes absent; spicules equal; gubernaculum present. Caudal papillae arranged in two longitudinal rows, never more than eleven pairs. Female: Vulva near equator, in posterior half of body; vagina directed anteriorly; two

ovaries. Oviparous, eggs with a thin shell. Parasites of intestines of fishes. Type species: C. cirratus Mueller, 1777.

Whether the present species has already been described, I cannot at present determine. It fits most closely the description of C. dodsworthi, Barreto, 1922, but is a much larger worm, and the proportional length of the oesophagus is very different-----C. dodsworthi-- oesophagus to body 1:7. Present species, oesophagus to body 1:18. Furthermore, Cucullianus has not been reported from the north Pacific coast, nor any species in the least resembling this in any fish closely related to Ophiodon from any water. I am therefore describing this as a new species.

Cucullianus elongatus, n. sp. Body characteristically very long and narrow, of practically uniform width throughout, tapering at the anal extremity rather abruptly, and slightly narrower also about the middle of the oesophagus. Posterior extremity curved like a hook, in males only. Cuticular striations very fine, about 0.0042 mm. apart. Cuticula of two layers, the outer very hyaline, 0.0082 mm. thick at its thickest point, the other translucent, slightly granular, and of irregular thickness, generally thinner than the outer layer. Greatest thickness of cuticula about 0.0187

mm. Lateral alae wanting. Nerve collar at junction of anterior $2/7$ and posterior $5/7$ of oesophagus--i.e., in a specimen with the oesophagus 2.2 mm. long, the nerve collar is 0.64 mm. from the anterior end. Mouth formed of two equal lobes, each with three papillae on the outside, and a chitinous sheet, with deep striations produced into denticles at their outer edges, on the inside. Oesophagus shaped like a short, stubby, baseball bat, the sub-oral dilation forming a rather exaggerated handle. Walls of oesophagus very muscular. Proportion of oesophagus to body 1:16. In specimens with the intestine empty may be seen what appears to be a two-lobed valve at the junction of oesophagus and intestine. Commencement of intestine dilated, almost filling the body cavity. Intestine passing into a short rectum, wider than the intestine at its commencement, but tapering rapidly posteriorly. The tissue forming the rectum is very hyaline. It is much more readily seen in females than in males.

Male: Length up to 30 mm. Accessory piece small, indistinct, pointed at both ends, 0.125 mm. long, about 0.012 mm. wide. Two spicules equal, long, slender, blunt, curved ventrally, with two small secondary curves dorsad in the anterior half. They are 1.4 mm. long. Tail narrows abruptly at anus, and again very near tip, which is 0.24 mm. from the anus. Preanal sucker large and muscular;

the spicules in both specimens are completely withdrawn, and extend just a little beyond the anterior edge of the sucker. Papillae--ten pairs. Testis extends up to within

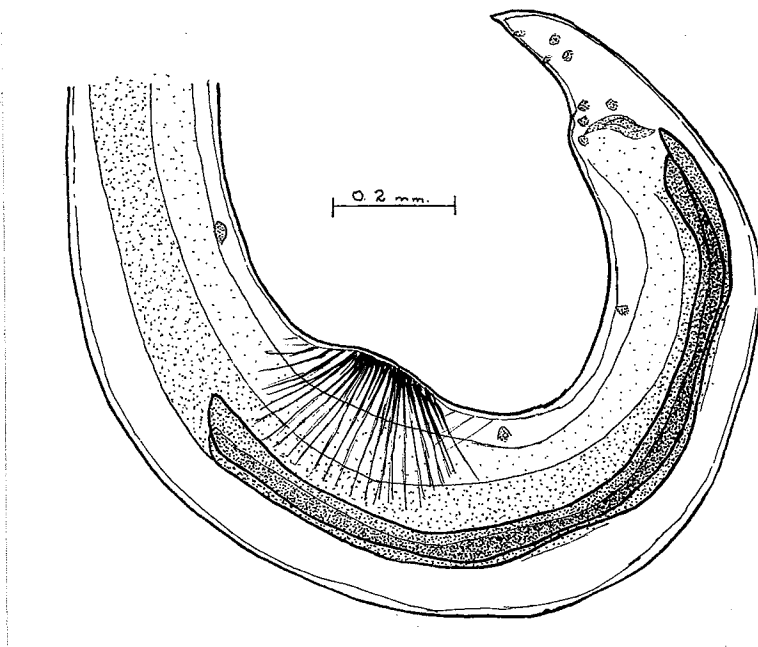


Figure 8.--Cucullianus elongatus, posterior end of male.

4 mm. of the oesophagus, is folded back on itself for most of this length, and much convoluted,

Female: Up to 40 mm. long. Tail forming a broad, round spike, tapering suddenly at tip to a sharp, firm point. Vulva apparently not present in many of the worms (this is taken as meaning that these specimens are not fully mature). When present, is fairly prominent, about

25 mm. from anterior end. Vagina directed anteriorly, swing-around in a horseshoe curve to run posteriorly. 0.4mm. posterior of the vulva the vagina bifurcates to form the two uteri, one continuing posteriorly, the other doubling back

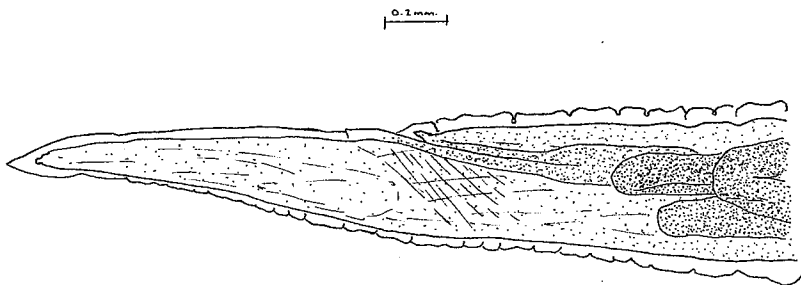


Figure 9.--Cnecillanus elongatus, posterior end of female.

on itself to run anteriorly. Ovary extending to within 3.6 mm. of the oesophagus, its tip doubled back on itself. Posterior ovary extending to within 0.16 mm. of the rectum, and is also doubled back on itself. Eggs ellipsoid, with thin shell. Protoplast segregated from shell. Eggs 0.0875 mm. long, by 0.05 mm. wide. Anus 0.54 mm. from tip of tail.

Type Host. Ophiodon elongatus, Girard.

Type Location. Intestine.

Type Locality. North Pacific coast in vicinity of Vancouver Island.

Bulbodaenitis occidentalis, sp. n.

Material collected from Paul Lake, B. C., June 30, 1931.

The host is Salmo kamloops, the worms being found in the pylorus and rectum. The validity of the genus Bulbodaenitis has been frequently questioned. There being only one species fully described--B. bulbosa Lane 1916, many authors have contended that the characteristic dorsal bulb on the head is merely a specific character, and have called the species Cucullianus bulbosa. Careful examination of the present material shows that while possessing a distinct cephalic bulb, it does not in any other way resemble the species B. bulbosa. This is therefore a new species and the position of the genus Bulbodaenitis may be accepted as fully established.

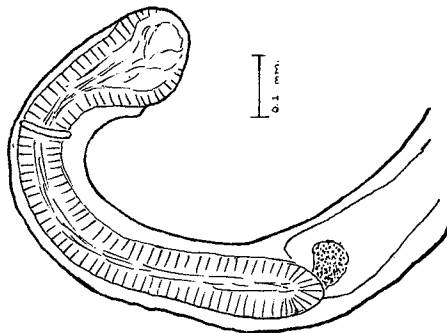


Figure 10.--Bulbodaenitis occidentalis, anterior end of female.

There is, of course, the possibility that this may be the original Daenitis globosa named by Dujardin, in 1845, from

Salmo fario in Europe. There being no accurate description of this species, the only means of determining this point is by comparison of actual specimens. The author would be pleased to receive specimens of Bulbodaenitis globosa from any interested worker in Europe, or to send slides of the present specimens.

Family: CUCULLANIDAE Cobbold, 1864.

Genus: Bulbodaenitis Lane, 1916.

Synonyms: Daenitis, Lujardin, 1845; Cucullanus Barreto, 1922.

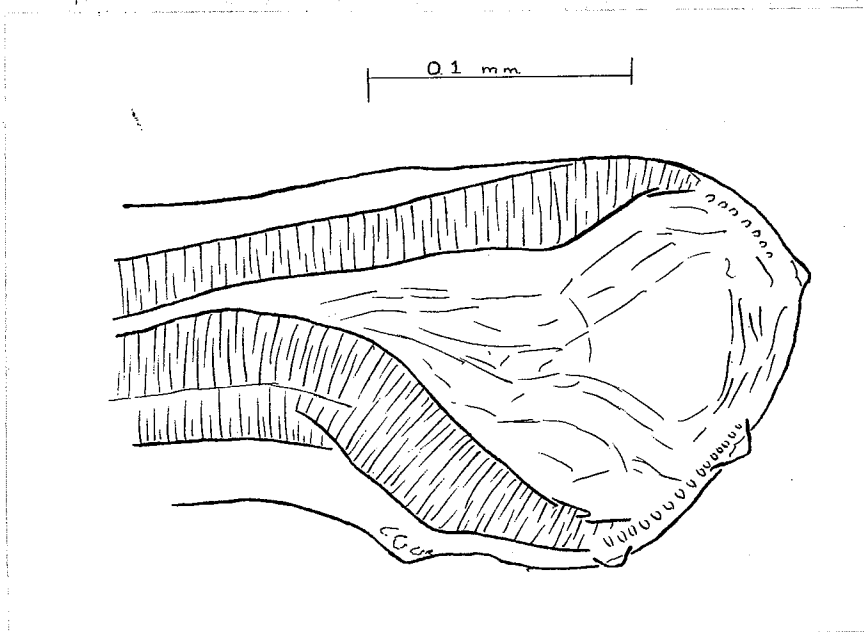


Figure 11.--Bulbodaenitis occidentalis, head of female, detail.

Generic Diagnosis. Cucullanidae: Cephalic extremity bent

dorsad. Mouth ellipsoid with large dorso-ventral axis, limited by two lips with internal saw-like chitinous apparatus, and externally six papillae. No chitinous buccal capsule, but a pseudo-capsule formed by the dilation of the anterior end of the oesophagus; the oesophagus also enlarged posteriorly; no oesophageal bulb; intestine simple. No lateral alae. Male: Preanal sucker without a chitinous rim; caudal alae rudimentary or absent; apicules equal; gubernaculum present. Caudal papillae arranged in two longitudinal rows; never more than eleven pairs. Female: Vulva in posterior half of body; vagina runs anteriorly; two ovaries. Oviparous, eggs with a thin shell. Differentiated from Cusullanus by the possession on the dorsal aspect of the head of a hemispherical bulbous prominence. Parasites of intestines of fishes. Type species: E. bulbosa Lane, 1916.

Bulbodaenitis occidentalis, n. sp. Small worms, the females always in the form of a long hook, the male a double S-shaped hook, in fixed material. Body of uniform width from head to anus, with the exception of a distinct dilation at the commencement of the intestine. Anterior extremity bent back on itself in all but three specimens, where it merely turns at right angles to the body. In a few specimens the head end is coiled into almost two complete turns. Posterior end of males curved

in the opposite (ventral) direction. Cuticular striations extremely fine, 0.0016 mm. apart. Cuticula of two layers, approximately equal thickness, total thickness about 0.015 mm. Lateral alae wanting. Nerve collar at junction of anterior one-third, and posterior two-thirds of the oesophagus. Mouth formed of two equal lobes, each with three papillae on the outside, and a chitinous sheet, which appears jointed and punctate. The edges of the mouth are produced into very small denticles. Line of mouth not at right angles to axis of body, but sloping from ventral to dorsal at an angle of about 40° to the axis. Oesophagus only slightly enlarged at the posterior end, but the sub-oral dilation is large. Oesophagus to body length 1:6. A small, irregular valve at the commencement of the intestine. The oesophagus joins the intestine on the ventral side. The commencement of the intestine is dilated, particularly dorsally, where it may even extend up beside the oesophagus. Rectum can be seen in female.

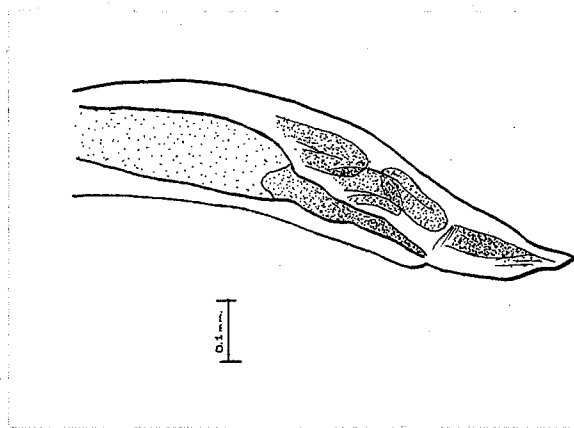


Figure 12.--Bulbodaenitis occidentalis, posterior end of female.

Male: Length up to 10 mm. Accessory piece large, granular, slightly curved, bluntly rounded at each end, 0.1375 mm. long, by 0.0187 mm. wide. The spicules are long and broad, blunt at caudad end, with a flat knob at the anterior end. They are approximately 0.65 mm. long, and 0.04 mm. wide. Anus set on decided prominence. Tail tapering rapidly beyond the anus, 0.09 mm. long. There is a peculiar little hyaline valve hinged on at the posterior margin of the anus, which closes the anal opening when the spicules are not protruded. Preanal sucker cup-shaped, practically absent in some young specimens; posterior margin 0.385 mm. from anus, measured along ventral surface. Testis extends to within 1 mm. of the oesophagus; is bent back on itself for at least half that distance; not convoluted.

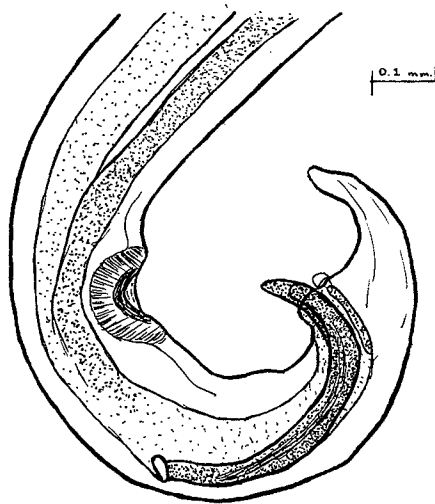


Figure 13.-- Bulbodaenitis occidentalis, posterior end of male.

Female: Length up to 14 mm. Tail tapers gradually to a round point, 0.31 mm. from anus. Vulva prominent; vagina runs almost straight in, though slightly posteriorly--swings around in a horseshoe curve to run anteriorly. Bifurcates into two slender uteri, filled with large eggs, one running anteriorly, the other posteriorly. Anterior ovary runs to within 1 mm. of oesophagus, posterior to beyond the anus; much convoluted. Eggs angular, in the 2-cell stage in the terminal part of the uteri--0.071 mm. long, by 0.0625 mm. wide.

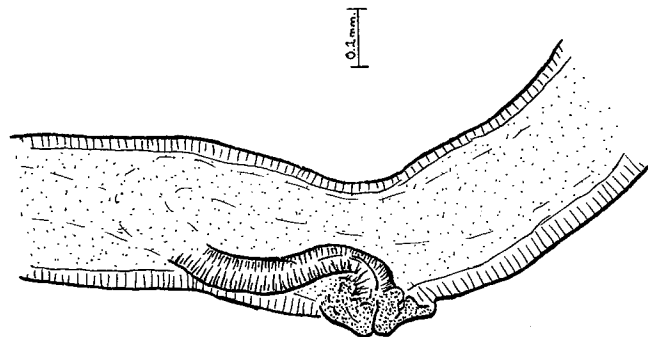


Figure 14.--Bulbodactylus occidentalis, female, showing vulva.

Type Host. Salmo kamloops.

Type Location. Pylorus and rectum.

Type Locality. Paul Lake, B. C. Canada.

Cystidicola stigmatura (Leidy)

The first specimen of this genus found during the present survey was a single male in the gut of a whitefish, Coregonus clupeaformis, September, 1931. To date, this is the only specimen found in a fish from lake Winnipeg. On November 4, 1931, numerous specimens of this nematode were found in the swim-bladders of whitefish from Jackfish and Murray lakes, in northern Manitoba, again with a single specimen found in the gut of one of the fish. Owing to the method of placing the whole gut contents in water and then decanting, it is impossible to state from what part of the gut these worms came, but it is probable that they were in the oesophagus. The next material to come to hand (in the spring of 1932), was from Primrose lake, Alberta, date of collection unknown. I have also a few specimens from the Lake of the Woods, Ontario, and a few fragments from lake Waskesiu, Saskatchewan. All these specimens are from Coregonus clupeaformis.

The description of Mary Scott Skinker (1931) is followed with slight modifications.

Family: THELAZIIDAE Railliet, 1916.

Genus: Cystidicola Fischer, 1798.

Synonyms: Fissula, Lamarck, 1801; Ophiostoma, Rudolphi, 1801; Ancyraecanthus, Schneider, 1866, in part, not Diesing, 1838; Pseudancyraecanthus, Skrjabin, 1923.

Generic Diagnosis. Thelaziidae: Mouth simple, or with small lips; followed by a cylindrical vestibule with a chitinous wall; oesophagus very long. Male: Posterior extremity usually coiled spirally, but may be perfectly straight; tail rounded at the tip; caudal alae fairly narrow; a long row of double pre-anal papillae, and five post-anal papillae of which four pairs are simple, and the fifth pair may or may not be doubled; spicules unequal and dissimilar. Female: Tail straight and blunt; vulva in or near the equatorial region; uteri opposed. Oviparous, eggs very numerous, thick shelled, provided (at least in C. farionis, and C. stigmatura) with polar filaments. Parasites of the swim-bladder, air-vessels, and rarely, the oesophagus and intestine of fresh-water fishes. Type species: C. farionis, Fischer, 1798.

Cystidicola stigmatura (Leidy, 1886) Ward and Magath, 1917.

Synonyms: Ancyracanthus cystidicola (Schneider) of Wright, 1879; Filaria stigmatura, Leidy, 1886; Cystidicola canadensis Skinker, 1930.

Specific diagnosis. Mouth with two large teeth and at least twelve smaller ones. Oesophagus approximately one-sixth of body length. The proportions of the different parts are as follows--vestibule; anterior oesophagus; posterior oesophagus; 1:3:15. These three divisions are very well marked. The anterior portion of the oesophagus is only

very slightly thicker than the vestibule, but is definitely marked off from it. The posterior portion of the oesophagus is again slightly thicker, but shows a decided change in histological nature. It continues to increase

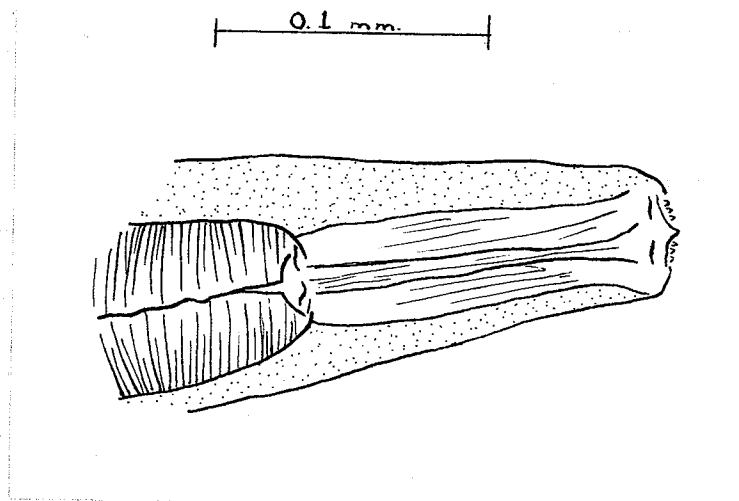


Figure 15.--Cystidiccia stigmatura, anterior end of female.

in thickness posteriorly, and is marked off very plainly from the rather thin intestine.

Male: Skinker states the males to vary from 12 to 40 mm. The longest specimens in the present material are not more than 25. mm. Tail usually coiled spirally, but several specimens from Primrose lake, Alberta, show the tail perfectly straight. Fairly wide caudal alae present, continuous posteriorly, supported by papillae. Five pairs are post-anal, the last pair doubled on at least one side, us-

usually the left. The pre-anal papillae vary from 6 to 8 on the left side, and from 7 to 9 on the right side, with sometimes vestiges of a tenth. Very occasionally, a worm is found in which the series of the left side is longer than that of the right. Numbering away from the anus, the papillae are typically doubled, though the last two on each side are usually single. The first is frequently single, and the 3rd 4th, or 5th of either side may be single. The two spicules are very dissimilar, one being long, thin, curved, with a needle-like point posteriorly, and a thick, blunt anterior end, the other very short and thick, irregularly curved. Testis large, somewhat convoluted, ending blindly about the middle of the body.

Female: Skinker gives 20 to 55 mm. as the length. The largest in the present survey are about 30 mm. Tail

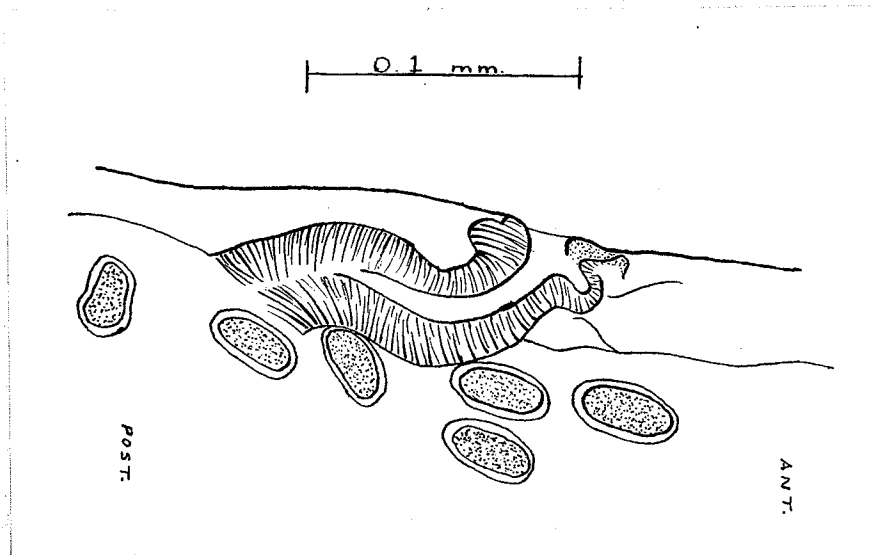


Figure 16.--Cystidicola stigmatura, vulva of female.

straight, short, conical, blunt. Vulva near middle of body, slightly posterior. Vagina about half as long as body is wide, in a characteristic S-shaped curve. Eggs 40 to 44 μ long, and 20 to 27 μ wide, a large number of polar filaments. It is probable that the polar filaments increase in length with the age of the egg; in embryonated eggs they may be two and one-half times the length of the egg. In no case were there fewer than 4 polar filaments and in most cases there appeared to be 8 to 20 or more.

Hosts. Salmo giscowet Ag., Salvelinus sp., S. namaycush, Lucioperca americana, Cristivomer namaycush, Coregonus clupeaformis, Leucichthys spp.

Location. Swim-bladder, and rarely, gut.

Locality. United States and Canada.

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