STUDIES ON PARASITES AND DISEASES OF MARINE AND ANADROMOUS FISH FROM THE CANADIAN PACIFIC COAST.

A Thesis

By

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TABLE OF CONTENTS

INTRODUCTION

The parasites of marine and anadromous fish occurring in Canada's Pacific waters, their economic importance, pathological significance and host and geographical distribution have not been studied intensively. This becomes more apparent when one considers the number of species of fish inhabiting this area (245 listed in Clemens and Wilby's "Fishes of the Pacific Coast of Canada," 1949) and the relatively few species (thirty-one) and individuals of the species, and restricted areas which have been investigated for parasites. The only area in which fish have been subjected to parasitological studies is the Strait of Georgia. Again when the extensive investigations of parasites of fish found in European waters, in the North American Atlantic, in Japan and other localities are brought to one's attention, it is evident that we must know little concerning the parasitic fauna of Canadian Pacific fish and the distribution of these parasites. Parasitological investigations of fish in the neighbouring United States and Alaskan Pacific no doubt contribute to our knowledge of what we might expect in the way of parasites in fish from the coastal waters of British Columbia, as most of the species of fish occurring in Canadian waters have a distribution range from Alaska to California. Studies of this nature have been more frequent in the United States than in Canada, but the parasitic fauna can still be considered as largely unknown.

This thesis is intended to correlate our knowledge of the parasites of marine and anadromous fish of the west coast of Canada, and to add to this knowledge by studies made on a collection of parasites, mainly from the British Columbia coast. The material and information used in this study was collected mostly by myself during the summer of 1951. In the course of the text, "North American west coast" will imply the west coast of Alaska, Canada and the United States, Mexico not being included. I have chosen to exclude Mexico, as we are here dealing with a tropical fish fauna, largely different from that found in Canada.

SUMMARY OF FISH-PARASITE STUDIES ON THE WEST COAST OF NORTH AMERICA

TREMATODA (Monogenea)

The first reference to a parasite of fish on the west coast of North America appears to be that of De La Martiniere in 1787 when he described an ectoparasite of the ocean sun-fish. He did not recognize the nature of the parasite and referred to it as an "insect". He stated that it occurred on this fish between Nootka (presumably on the west coast of Vancouver Island) and Monterey Bay, California. This parasite was not named and was inadequately described according to modern standards. The host was not accurately identified but merely referred to the genus Diodon. Price (1939A) presented evidence to show that the fish could only be the ocean sun-fish, Mola mola (= Diodon mola). Bosc (1811) recognizing the true nature of this parasite, named the fluke Capsala martinieri n. sp. Price regarded Tristoma molae, a common ectoparasitic trematode of Mola mola, as a synonym of Capsala martinieri Bosc, 1811 and recognized the latter name as valid for this common parasite of the ocean sun-fish. There are no other records of ectoparasitic flukes from British Columbia coastal fish.

Causey (1926), Price (1937A, 1938B) and Linton (1940) described new species of monogenetic flukes from Alaska.

In Washington State studies on monogenetic flukes of marine fish have been confined to Puget Sound. Publications dealing with these parasites are those of Miller (1927), Folda (1928), Guberlet (1934, 1937), Bonham and Guberlet (1937, 1938) and Kay (1942A). Price (1942) also described a new species from Puget Sound. A paper entitled "Further studies on monogenetic trematodes from Puget Sound fish" was in preparation by Bonham and Guberlet at the time of Guberlet's death in 1940. This paper does not appear to have been published. Guberlet's paper of 1937 was a review of the ectoparasitic trematodes of Pacific coast fish.

In California Heath (1902), Guberlet (1936) and Menzies (1946) described new species of monogenetic trematodes.

TREMATODA (Digenea)

Digenetic trematode studies on the west coast of Canada were confined to the two papers of McFarlane (1934, 1936), who studied these parasites in fish from Departure Bay and near Nanaimo, Vancouver Island. He described fifteen species, of which eight were new.

Manter's (1926) report of Otodistomum veliporum Creplin (1834) and Ward and Fillingham's (1934) description of a new species from a toad fish are the only references to digenetic trematodes in marine fish of Alaskan waters.

Several papers dealing with digenetic trematodes of fishes from Puget Sound, Washington, have appeared in the literature. The first of these was published by Lloyd and Guberlet (1932). In 1936, these same authors reported Syncoelium filiferum (Sars, 1885) from Pacific salmon. Lloyd (1938) presented the most extensive report of digenetic trematode parasites of Puget Sound. fish. Fourteen species of which Lloyd considered four to be new, were described. Acena (1941) created a new genus of Opecoelidae and a new species of Lecithochirium from Sebastodes spp. In 1947 he erected a new genus of Hemiuridae and a new species of Lepidapedon for parasites from Puget Sound fish. Kay (1947) described Otodistomum plicatum n. sp. from Hexanchus griseus. Kohlruss (1933) studied the morphology of fish trematodes from Puget Sound. His results were not published but presented as a thesis to the University of Washington, Seattle.

From the coast of Oregon, Gregoire and Pratt (1952) in an extensive survey of the parasites of the brill (Eopsetta jordani), recorded Lecithochirium exodicum McFarlane, 1936 from the s tomach of this fish.

Studies on digenetic trematodes parasitic in marine fish of California waters have been restricted mainly to littoral fish. Sleggs (1927) reported Distomum veliporum (Creplin, 1834) from Raja sp. and a hemiurid from a flounder. The description of the hemiurid is too meagre to permit of its proper identification. Park (1936, 1937A, 1937B) described two new hemiurids, eight new species of Podocotyle and a new genus of Allocreadiidae (now placed in the Opecoelidae) from Dillon's Beach. In the paper dealing with the Podocotyle spp. (Park, 1937A), he reviewed the genus and gave a key to all known species. Noble and Noble (1937) and Noble and Park (1937) described two new trematode species. Linton (1940) reported three trematodes from Oncorhynchus tshawytscha in California. Van Cleave and Vaughn (1941) studied the genus Otodistomum in California skates and compared the species with specimens from Alaskan skates and Atlantic skates from Maine. They concluded that only one species, O. cestoides van Beneden, 1871, occurs in North America. Four new species were created by Annereaux (1947A, 1947B) for trematodes from California marine fish. Johnson (1949) described a new species of Podocotyle from Monterey Bay. Manter and Van Cleave (1951) studied trematodes from fishes caught near La Jolla.

Their paper represents the most general trematode study in California marine fish. Seventeen species, of which eight were considered as new, as well as two unidentified immature hemiurids and unidentified species of *Phyllodistomum* and *Lepidapedon* were recorded.

CESTODA

The cestodes of British Columbia coastal fish from the Strait of Georgia, have been dealt with by Wardle (1932, 1933A, 1933B, 1934). Kuitunen-Ekbaum made small contributions (1933C, 1933D). Wardle recorded six adult species, of which one was described as new, and four larval cestodes.

From Alaska, Canavan (1928) described a new tetraphyllidean cestode from a salmon. This is an odd record since tetraphyllidean cestodes are normally parasites of Elasmobranchs. Hart (1936A) reported a trypanorhynchid larva from a shark.

Cestode studies in Puget Sound, Washington are those of Hart and Guberlet (1936), Hart (1936A, 1936B) and Kay (1942B). Hart and Guberlet studied the Spathebothridea, Hart (1936A) the Trypanorhyncha, and (Hart, 1936B) the Tetraphyllidea. Kay described a new species of *Phyllobothrium*. Linton (1898) described a new bothriocephalid, which was redescribed from the same material by

Cooper (1919).

Sleggs (1927) described rather poorly four cestode species from California marine waters and Pintner (1930) identified Gilquinia tetrabothrium (van Beneden, 1849) (= G. squali (Fabricius, 1794) from Squalus suckleyi of Pacific Grove.

CESTODARIA

Cestodarian parasites of the genus Gyrocotyle have been recorded from the rat-fish (Hydrolegus colliei) on the west coast of North America by Kofoid and Watson (1910), Watson (1911) and Ward (1912) from California waters, by Wardle (1932) from the Strait of Georgia, British Columbia and by Lynch (1945) from Washington State. Watson (1911) described G. fimbriata as a new species, as well as G. urna (Grübe and Wagener, 1852) from the spiral valve of the rat-fish. Ward (1912), Dollfus (1923) and Wardle (1932) consider G. fimbriata Watson, 1911 as a synonym of G. urna. Lynch (1945) examined large numbers of Gyrocotyle from rat-fish caught in Puget Sound and along the coast of Washington and concluded that two distinct species do exist in this host, namely G. urna (Grübe and Wagener, 1852) and G. fimbriata Watson, 1911. Wardle and McLeod (1952) do not accept the validity of G. fimbriata Watson, 1911 as a distinct species.

Riser (1948) described *Amphilina bipunctata* n. sp. from the body cavity of a sturgeon from Oregon.

NEMATODA

Stiles and Hassal (1899), in connection with a study of the parasites of the fur seal of the north Pacific Ocean, referred to the presence of encysted larval ascaroid nematodes in the Pacific cod (*Gadus macrocephalus*) and the Alaskan pollock or whiting (*Theragra chalcogramma*), off the Pribilof Islands, Alaska. The nematodes were identified as "*Ascaris capsularia*" which the authors indicated was probably a larval stage of *Ascaris decipiens* Krabbe, 1878 (= *Porrocaecum decipiens*), a common parasite of the stomach of the fur seal. This appears to be the first reference to a nematode parasite of North American Pacific fish. Scheffer and Slipp (1944) again referred to the presence of encysted *Porrocaecum decipiens* larvae in Pacific cod in the vicinity of the Aleutian Islands, Alaska.

In British Columbia, nematode studies were carried out by Smedley (1933, 1934) and Kuitunen-Ekbaum (see also Ekbaum) (1933A, 1933B, 1935) from fishes in the Strait of Georgia. Kuitunen-Ekbaum created a new genus in addition to two new species, while Smedley described three new species.

Gregoire and Pratt (1952) in their study of parasites of Eopsetta jordani from Oregon, reported 43 per cent of 213 fish harboured encysted larval ascaroids, which they referred to as Anisakis or Porrocaecum sp. larva.

Annereaux (1946) described a new species of Procamallanus from a jack smelt in Bolinas Bay, California. He provided a key to all described species of the genus.

ACANTHOCEPHALA

Ekbaum (1938) described three acanthocephalid species, of which one was new, from fishes of the Strait of Georgia, British Columbia.

Van Cleave (1940, 1945) described a new species, Illiosentis cetratus from croakers in California and Ward and Winter (1952) reported on juvenile acanthocephalids from a croaker in Southern California. They described one new species and recorded the presence of two other species.

COPEPODA

The copepod parasites of North American Pacific fish have been extensively reported on by Wilson (1908, (1935). His studies were conducted on collections made from Alaska to Mexico. Many new genera and species were described. These two papers plus several individual records on specific groups of copepods (1915, 1917, 1919, 1921, 1944) give a complete list of the known parasitic copepods of the North American Pacific coast fish. Dana (1852) also recorded copepod parasites from North American Pacific fishes. These were again listed by Wilson (1908) but not redescribed.

From Canada, at least five species were recorded. These are Argulus pugettensis Dana, 1852 from the coho salmon and Lepeophtheirus pravipes Wilson from an unknown host (Wilson, 1908); Clavella parva Wilson, 1912 and Clavellopsis robusta (Wilson, 1912) from a rock-fish (Wilson, 1915) and Anthosoma crassum (Abildgaard) from sharks (Wilson, 1932).

MYXOSPORIDIA

Systematic studies on myxosporidians of the urinary and gall bladders of California fish have been studied by Jameson (1929, 1931) and Noble (1938, 1941).

Reports of isolated cases of myxosporidiosis are those of Ward (1920), in a salmon (Oncorhynchus kisutch) from Alaska, Thompson (1916) and Davis (1924) in Pacific halibut and Shaw, Simms and Muth (1934) in Oncorhynchus kisutch from Oregon. Thompson's work dealt with the condition known as "wormy" halibut in British Columbia. The causative organism was more completely described and named by Davis. Fish (1939) reported on Henneguya salminicola Ward, 1920 in the muscles of Oncorhynchus spp. from Alaska and Oregon.

In a study of the nature of this thesis, it is imperative that a large number of papers dealing with parasites of fish from many regions of the world be consulted. Monographs on restricted groups of parasites are equally invaluable. It is not proposed to review here, fish parasite studies, even the major ones, from areas other than those already discussed. Such references as it was found necessary to consult during the course of this work are mentioned in their appropriate places.

The following host-parasite list, gives all the fish parasites recorded from marine and anadromous fish on the British Columbia coast. The host list is presented alphabetically by family.

PARASITE	HOST	AUTHOR

BOTHIDAE -- Sand dabs

Citharichthys stigmaeus -- Speckled sand dab

CESTODA

Gilquinia squali (Fabricius, 1794), larva
Kuitunen-Ekbaum, 1933D

NEMATODA

Anisakis sp. larva — Present thesis

Syn. *Contracaecum* sp. of Smedley, 1934 — Smedley, 1934

CHIMAERIDAE -- Chimeras

Hydrolagus colliei -- Rat-fish

CESTODARIA

Gyrocotyle urna (Grübe and Wagener, 1852) — Wardle, 1932

NEMATODA

Anisakis sp. larva — Present thesis

Syn. *Contracaecum* sp. of Smedley, 1934 — Smedley, 1934

CLUPEIDAE -- Herrings

Clupea pallasii -- Pacific herring

NEMATODA

Anisakis sp. larva — Present thesis

Syn. *Contracaecum* sp. of Smedley, 1934 — Smedley, 1934

COTTIDAE -- Sculpins

Leptocottus armatus -- Cabezon

TREMATODA (Digenea)

Podocotyle atomon (Rudolphi, 1802) Odhner, 1905 — McFarlane, 1936

Podocotyle reflexa (Rudolphi, 1802) Odhner 1905 — McFarlane, 1936

CESTODA

Bothriocephalus scorpii (Müller, 1776) — Wardle, 1932

Bothriocephalus occidentalis (Linton, 1898) — Wardle, 1932

NEMATODA

Contracaecum aduncum (Rudolphi, 1802)	Present thesis
Syn. Contracaecum magnum Smedley, 1934	Smedley, 1934

Myoxocephalus polyacanthocephalus --

Great sculpin

CESTODA

Bothriocephalus scorpii (Müller, 1776)	Wardle, 1933B

Scorpaenichthys marmoratus --

Giant marbled sculpin

TREMATODA (Digenea)

Prosorhynchus scalpellus McFarlane, 1936	McFarlane, 1936
Tubulovesicula nanaimoensis (McFarlane, 1936) Manter, 1947	Manter, 1947
Syn. Dinurus nanaimoensis McFarlane, 1936	McFarlane, 1936
Genolinea laticauda Manter, 1925	McFarlane, 1936

NEMATODA

Metabronema wardlei Smedley, 1934	Smedley, 1934

EMBIOTOCIDAE -- Seaperches

Cymatogaster aggregatus --

Viviparous perch

TREMATODA (Digenea)

Telolecithus pugetensis Lloyd and Guberlet, 1932	McFarlane, 1936

GADIDAE -- Cods

Theragra chalcogramma -- Whiting

CESTODA

Nybelinia surmenicola Okada, 1929, larva	Wardle, 1933A
Grillotia heptanchi (Vaullegeard, 1899), larva	Dollfus, 1942
Syn. G. erinacea (van Beneden, 1870), larva of Wardle, 1933	Wardle, 1933A

GOBIESOCIDAE -- Cling-fishes

Syciogaster maeandrica -- Common cling-fish

NEMATODA

Philometra americana Kuitunen-Ekbaum, 1933	Kuitunen-Ekbaum, 1933B

HEXAGRAMMIDAE -- Greenlings

Chiropsis decagrammus -- Kelp greenling

CESTODA

Bothriocephalus scorpii (Müller, 1776)	Wardle, 1932

Hexagrammos stelleri --

White-spotted greenling

TREMATODA

Podocotyle atomon (Rudolphi, 1802) Odhner, 1905	McFarlane, 1936

Lebius superciliosus -- Fringed greenling

CESTODA

Bothriocephalus scorpii (Müller, 1776)	Wardle, 1933B

Ophiodon elongatus -- Lingcod

TREMATODA (Digenea)

Prosorhynchus apertus McFarlane, 1936	McFarlane, 1936
Rhipidocotyle elongatum McFarlane, 1936	McFarlane, 1936
Stephanostomum tristephanum McFarlane, 1936	McFarlane, 1936
Lecithochirium exodicum McFarlane, 1936	McFarlane, 1936

CESTODA

Nybelinia surmenicola Okada, 1929, larva	Wardle, 1933A
Syn. *Nybelinia* sp. larva of Wardle, 1932	Wardle, 1932

NEMATODA

Contracaecum aduncum (Rudolphi, 1802)	Present thesis
Syn. *Contracaecum magnum* Smedley, 1934	Smedley, 1934
Anisakis sp. larva	Present thesis
Syn. *Contracaecum* sp. of Smedley, 1934	Smedley, 1934
Cucullanus elongatus Smedley, 1933	Smedley, 1933

HEXANCHIDAE -- Cow sharks

Hexanchus griseus -- Mud shark

CESTODA

Grillotia heptanchi (Vaullegeard, 1899)	Dollfus, 1942
Syn. *G. erinacea* (van Beneden, 1850) of Wardle, 1933	Wardle, 1933A

MERLUCCIIDAE -- Hakes

Merluccius productus -- Hake

CESTODA

Clestobothrium crassiceps (Rudolphi, 1819)	Wardle, 1933A

NEMATODA

Anisakis sp. larva	Present thesis
Syn. *Contracaecum* sp. of Smedley, 1934	Smedley, 1934

MOLIDAE -- Ocean Sun-fishes

Mola mola -- Ocean Sun-fish

TREMATODA (Digenea)

Mneiodhneria calyptrocotyle (Monticelli, 1893) Dollfus, 1935	Lloyd, 1938
Syn. *Odhnerium calyptrocotyle* (Monticelli, 1893) of Lloyd, 1938	

TREMATODA (Monogenea)

Capsala martinieri (Bosc, 1811)	De La Martiniere, 1787 Bosc, 1811 Price, 1939A

PHOLIDAE -- Gunnels

Apodichthys flavidus -- Pen-point blenny

CESTODA

Bothriocephalus scorpii (Müller, 1776)	Wardle, 1933B

NEMATODA

Contracaecum aduncum (Rudolphi, 1802)	Present thesis
Syn. *C. magnum* Smedley, 1934	Smedley, 1934

Pholis ornatus -- Saddled blenny

NEMATODA

Philometra americana Kuitunen-Ekbaum, 1933	Kuitunen-Ekbaum, 1933B

PLEURONECTIDAE -- Flounders

Hippoglossus stenolepis -- Pacific halibut

MYXOSPORIDIA

Unicapsula muscularis Davis, 1924 — Davis, 1924; Thompson, 1916

Lepidopsetta bilineata --

Rock sole

ACANTHOCEPHALA

Echinorhynchus lageniformis Ekbaum, 1938 — Ekbaum, 1938

Corynosoma strumosum (Rudolphi, 1802), juvenile — Ekbaum, 1938

NEMATODA

Philometra americana Kuitunen-Ekbaum, 1933 — Kuitunen-Ekbaum, 1933B

Parophrys vetulus -- Lemon sole

TREMATODA (Digenea)

Tubulovesicula nanaimoensis (McFarlane, 1936) Manter, 1947 — Manter, 1947

Syn. *Dinurus nanaimoensis* McFarlane, 1936 — McFarlane, 1936

Platichthys stellatus -- Starry flounder

ACANTHOCEPHALA

Echinorhynchus lageniformis Ekbaum, 1938 — Ekbaum, 1938

Corynosoma strumosum (Rudolphi, 1802), juvenile — Ekbaum, 1938

NEMATODA

Philometra americana Kuitunen-Ekbaum, 1933 — Kuitunen-Ekbaum, 1933B

SALMONIDAE -- Salmons

Oncorhynchus gorbuscha -- Pink salmon

CESTODA

Phyllobothrium ketae Canavan, 1928, larva	Wardle, 1932
Syns. Phyllobothrium sp. of Wardle, 1932	Wardle, 1933B
Phyllobothrium salmonis Fujita, 1922 of Wardle, 1932 and 1933	Wardle and McLeod, 1952

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776	Ekbaum, 1938

Oncorhynchus keta -- Chum salmon

CESTODA

Phyllobothrium ketae Canavan, 1928, larva	Wardle, 1932
Syns. Phyllobothrium sp. of Wardle, 1932	Wardle, 1933B
Phyllobothrium salmonis Fujita, 1922 of Wardle, 1932 and 1933	Wardle and McLeod, 1952

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776	Ekbaum, 1938

Oncorhynchus kisutch -- Coho salmon

CESTODA

Eubothrium oncorhynchi Wardle, 1932	Wardle, 1932
Phyllobothrium ketae Canavan, 1928, larva	Wardle, 1932
Syns. Phyllobothrium sp. of Wardle, 1932	Wardle, 1933B
Phyllobothrium salmonis Fujita, 1922 of Wardle, 1932 and 1933	Wardle and McLeod, 1952
Diphyllobothrium sp. larva of Wardle, 1932	Wardle, 1932

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776	Ekbaum, 1938

NEMATODA

Cystidicola walkeri Ekbaum, 1935	Ekbaum, 1935

COPEPODA

Argulus pugettensis Dana, 1852	Wilson, 1908

Oncorhynchus nerka -- Sockeye salmon

CESTODA

Phyllobothrium ketae Canavan, 1928, larva	Wardle, 1932
Syns. *Phyllobothrium* sp. of Wardle, 1932	Wardle, 1933B
Phyllobothrium salmonis Fujita, 1922 of Wardle, 1932 and 1933	Wardle and McLeod, 1952

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776	Ekbaum, 1938

NEMATODA

Philonema oncorhynchi Kuitunen-Ekbaum, 1933	Kuitunen-Ekbaum, 1933A

Oncorhynchus tshawytscha -- Spring salmon

CESTODA

Eubothrium oncorhynchi Wardle, 1932	Wardle, 1932
Phyllobothrium ketae Canavan, 1928, larva	Wardle, 1932
Syns. *Phyllobothrium* sp. of Wardle, 1932	Wardle, 1933B
Phyllobothrium salmonis Fujita, 1922 of Wardle, 1932 and 1933	Wardle and McLeod, 1952

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776	Ekbaum, 1938

SCORPAENIDAE -- Rockfishes

Sebastodes dallii (= auriculatus) -- Brown rockfish

COPEPODA

Clavella parva Wilson, 1912	Wilson, 1915
Clavellopsis robusta (Wilson, 1912) Wilson, 1915	Wilson, 1915

Sebastodes spp.

TREMATODA

Podocotyle abitionis McFarlane, 1936	McFarlane, 1936
Pharyngora bacillaris (Molin, 1859)	McFarlane, 1936
Aporocotyle simplex (Odhner, 1900)	McFarlane, 1936
Stephanostomum casum (Linton, 1910)	McFarlane, 1934 and 1936
Deretrema cholaeum McFarlane, 1936	McFarlane, 1936

CESTODA

Bothriocephalus occidentalis (Linton, 1898)	Wardle, 1932

NEMATODA

Anisakis sp. larva	Present thesis
Syn. Contracaecum sp. larva of Smedley, 1934	Smedley, 1934

SQUALIDAE -- Dog-fishes

Squalus suckleyi -- Dog-fish

CESTODA

Gilquinia squali (Fabricius, 1794)	Wardle, 1933A Dollfus, 1942
Syn. G. tetrabothrium (van Beneden, 1849) of of Wardle, 1932	Wardle, 1932

NEMATODA

Anisakis sp. larva — Present thesis

Syn. *Contracaecum* sp. of Smedley, 1934 — Smedley, 1934

SYNGNATHIDAE -- Pipe-fishes

Syngnathus griseo-lineatus

-- Pipe-fish

TREMATODA

Podocotyle atomon (Rudolphi, 1802) Odhner, 1905 — McFarlane, 1936

Podocotyle reflexa (Rudolphi, 1802) Odhner, 1905 — McFarlane, 1936

XIPHISTERIDAE -- Belted blennies

Epigeichthys atro-purpureus

-- Black blenny

TREMATODA (Digenea)

Podocotyle atomon (Rudolphi, 1802) Odhner, 1905 — McFarlane, 1936

NEMATODA

Philometra americana Kuitunen-Ekbaum, 1933 — Kuitunen-Ekbaum, 1933B

MATERIALS AND METHODS

Practically all of the material studied was collected by myself during the summer of 1951.

The teleostan fish were obtained mostly on the Vancouver waterfront either directly from commercial fishermen or from the owners of fish processing plants. These fish, except the albacore (Thunnus alalunga), were caught in many localities of the Strait of Georgia, Hecate Strait, Juan de Fuca Strait, Queen Charlotte Sound, and the west coast of Vancouver Island. These areas include all the fishing grounds of the British Columbia coast. The accompanying maps of the coastal waters of British Columbia indicate the localities from which the fish came. The albacore were caught forty-five to eighty-five miles off the coast of southern Oregon and northern California, between Cape Blanco and Cape Mendecino. Some specimens of rock-fish (Sebastodes spp.), eel-pouts (Lycodes brevipes) and slender soles (Lyopsetta gracilis) were obtained from English Bay, Vancouver, when on a trip with a shrimp fisherman. Nearly all the elasmobranchs were caught in a trawl net by the Pacific Biological Station's boat, the "Investigator No. 1." Specimens of lingcod (Ophiodon elongatus) were also obtained by this vessel.

The host fish collected from commercial fishermen and most of those caught from the shrimp-fishing vessel were examined in the fresh state in a small field laboratory on the Vancouver waterfront, provided by the Pacific Biological Station of the Fisheries Research Board of Canada. These fish were dead for a period varying from one to ten days, the fish being ice-packed on the boats during that time. Undoubtedly, some of the parasites were lost during the period that elapsed from the time of catching to the time I examined the fish. This would be particularly true of ecto-parasites which could easily be rubbed off. However, in a few cases it was observed that nematodes were capable of crawling out of the digestive tract, as was evidenced by their presence on the external surfaces of the fish. This applied mainly to small fish, such as smelts, harbouring large ascaroid nematodes. I do not believe that small nematodes, trematodes, or acanthocephalids are capable of this same migration. Occasionally an acanthocephalid was found in the body cavity, having previously pierced the intestinal wall. Adult cestodes were never observed outside the digestive tract and hence in all probability were not lost to this investigation.

Fish for parasitological examination were taken on two trips with the "Investigator No. 1" in the Strait of Georgia. On one of these I was present, and the fish were examined immediately after being taken on board. On the other voyage, the digestive tract (and other adhering parts of the viscera) were removed, tied at both ends, preserved in ten per cent formalin and sent to me for examination by Mr. K. Ketchen of the Pacific Biological Station. The digestive tracts of a few of the fish obtained on the shrimp-fishing boat were treated in the same manner.

The fish were first subjected to external examination for skin and gill parasites. The gills were also examined under low power magnification for small parasites. The hosts were then opened ventrally and the body cavity, viscera and musculature searched, particularly for larval helminths and protozoan (myxosporidian) cysts. The digestive tract was finally removed, laid open in a petri dish or tray of fresh water, in sections starting with the oesophagus and proceeding posteriorly, and the contents scraped out into the water. Each pyloric caecum was opened individually. The larger parasites were removed from the dish, which was then examined under the binocular dissecting microscope for small helminths. The gall bladder, urinary bladder and blood were not examined for either protozoa or helminths. The formalinised guts were examined at the temporary laboratory in Vancouver in the same manner as the digestive tracts from the fresh fish.

Trematodes were killed in hot ten per cent formalin or in hot fresh water, after relaxing in cold fresh water, and stored in five per cent formalin. Cestodes were extended on a glass plate, killed by pouring hot water over them and fixed in five per cent formalin. Cestode larvae and Cestodaria were treated in the same manner as the flukes. Nematodes were killed and fixed in hot seventy per cent alcohol and stored in seventy per cent glycerine alcohol. Acanthocephala were relaxed in cold fresh water and then killed and fixed in hot ten per cent formalin and stored in five per cent formalin. Immediate killing and fixation by use of hot seventy per cent alcohol was abandoned after attempting this method with three Acanthocephala from an albacore. In each of the three specimens the proboscis was retracted. Copepoda were killed and fixed in ten per cent formalin and preserved in five per cent formalin. The protozoa, consisting only of myxosporidian cysts were fixed in situ in ten per cent formalin and stored in five per cent formalin. Time was not available to study the Myxosporidia in the fresh state. Some tissues containing trematode cysts were also fixed in ten per cent formalin and stored in five per cent formalin. One lot of cestodes from a cod (Gadus macrocephalus) fixed in five per cent formalin was submitted by Mr. Ketchen. Mr. W. E. Barraclough, of the Pacific Biological Station submitted for examination some nematode larvae collected from the body cavity of the capelin (Mallotus catervarius) and four copepods collected from the mouth of a mackerel shark

(*Isurus nasus*) caught in the Strait of Georgia, August 31, 1948. These two groups of specimens were preserved in seventy per cent alcohol. Mr. G. Pike, also of the Biological Station, collected nematodes from the stomachs of whales and larval *Anisakis* sp. from a squid (*Gonatus* sp.) and a rag-fish (*Acrotus willoughbi*) from Coal Harbour, Vancouver Island.

In the fall of 1951, upon returning to the Institute of Parasitology, studies were commenced on the collected material. The material preserved in formalin was placed in running tap water for twenty-four to forty-eight hours to remove the formalin and stored in seventy per cent glycerine alcohol, until subjected to detailed examination.

The trematodes and acanthocephalids were stained for whole mounts either in Gower's alum carmine or Delafield's haematoxylin. Both methods gave satisfactory results. The cestodarian was stained with alum carmine. Clearing was carried out in methyl salicylate or beechwood creosote and the parasites were mounted in Canada balsam or permount. All methods used proved adequate. Some of the trematodes and cestodes were dehydrated under slight cover glass pressure to flatten them. This was necessary mainly with parasites recovered from formalinised guts. Serial sections of trematodes and particularly of cestodes were necessary in some cases. Material for sectioning was embedded in paraffin, microtome sections cut at seven to ten microns, stained with Delafield's haematoxylin, counterstained with eosinic acid and mounted in Canada balsam.

Nematodes were cleared in lactophenol and occasionally with large specimens in beechwood creosote. For study, they were temporarily mounted on slides in the clearing agent. Permanent mounts were not made.

Copepods were cleared in lactophenol and examined in the petri dish. Several whole mounts of Lepeophtheirus salmonis (Kroyer, 1863) were made, using the method suggested by Jones (1946) for the simultaneous staining and permanent mounting of Acarina. The results were satisfactory but more detail could be seen when studying unmounted material. It was not found necessary to dissect out the mouth parts in any of the specimens.

In situ microtome sections of tissue inhabiting trematodes or nematodes were cut at seven microns, stained with Delafield's haematoxylin and eosinic acid or with Mallory's triple stain technique and mounted in Canada balsam.

Tissues containing myxosporidian cysts were embedded in paraffin and microtome sections cut at seven microns. They were stained in Haidenhaim's iron haematoxylin, counterstained with eosin and mounted in Canada balsam.

All drawings were made with the aid of a camera lucida.

The identification of the host fish, in which I was greatly assisted by Mr. R. M. Wilson of the Pacific Biological Station, followed the outline in Clemens and Wilby's "Fishes of the Pacific Coast of Canada" (1949).

RESULTS

The digenetic trematodes were classified mainly according to the system adopted by Dawes (1946) with modifications following Manter's work (1940, 1947).

The works of Price (1937B, 1937C, 1938A, 1938B, 1939A, 1939B, 1942, 1943A, 1943B) on monogenetic trematodes were consulted for the classification of this group of parasites.

Cestoda and Cestodaria taxonomy followed the system adopted by Wardle and McLeod in their "Zoology of Tapeworms" (1952). The Trypanorhyncha was reviewed recently by Dollfus (1942), whose work is closely followed in Wardle and McLeod's treatise of the cestodes.

Meyer (1932, 1933) and Van Cleave (1936) were broadly followed for acanthocephalid systematics.

Yorke and Maplestone (1926) and Baylis and Daubney (1926) were found useful as a general guide to classifying the nematodes.

Authoritative works consulted for copepod taxonomy were the many papers of Wilson (1902, 1905, 1907A, 1907B, 1911, 1915, 1922, etc.) and T. and A. Scott's volumes (1912,1913).

The classification of the Myxosporidia in general followed Kudo (1920, 1933).

In addition to these major works, the many papers dealing with specific parasites and groups of parasites falling within the scope of this thesis were consulted for general views on taxonomic relationship of parasites.

Information pertaining to host and geographical distribution, pathology, economic importance and any other pertinent information are given in a general discussion of each recorded parasite.

Class T R E M A T O D A

Order DIGENEA Carus, 1863

Sub-order PROSOSTOMATA Odhner, 1905

Family OPECOELIDAE Ozaki, 1925, emended Manter, 1947

The family Opecoelidae was proposed by Ozaki in 1925 to include certain allocreadiid-like trematodes which possessed secondary external openings of the digestive tract. Many authors gave this group of trematodes only sub-family status within the family Allocreadiidae. As the number of new species and new genera, closely allied to Ozaki's genus Opecoelus, increased, the acceptance of the family rank of Opecoelidae became more widespread. However, with this description of new genera, it became apparent that there were trematodes very similar to

Opecoelus in which the caeca ended blindly and it became very difficult to separate genera of Opecoelidae from the Allocreadiidae on the basis of morphological characters of the adults alone. The work of Hopkins (1941) and Cable and Hunninen (1942), stressing the importance of life histories in indicating relationships of these trematodes, led to the restriction of the Allocreadiidae to forms in which the cercariae are of the ophthalmoxiphidiocercous type developing in rediae in bivalves, and the Opecoelidae to trematodes developing a cotylomicrocercous cercaria in sporocysts in snails. Many of the genera which for years had been considered as typical allocreadiids were removed to the family Opecoelidae. The question is by no means finally settled and the classification proposed by Manter (1947) and adopted here, is only tentative. Manter grouped the Opecoelidae into four sub-families. Among the genera removed from the Allocreadiidae and placed with the Opecoelidae are Helicometra Odhner, 1902 and Podocotyle Odhner, 1905, representatives of which were found in this study. These two genera are grouped in Manter's sub-family Plagioporinae. Dawes (1946, 1947) retained Helicometra and Podocotyle in the family Allocreadiidae.

Sub-family OPECOELINAE Stunkard, 1931

Genus Pseudopecoelus Von Wicklen, 1946

Pseudopecoelus vancouveri n. sp. (Fig. 3)

Host: Sebastodes sp., rockfish

Location: intestine.

Locality: English Bay, Vancouver.

A single specimen, slightly contracted, was recovered from a formalin preserved intestine.

Description: The body is flat and elongate, measuring 2.66 mm. long by 0.58 mm. in maximum breadth just behind the acetabulum. The body tapers slightly anteriorly to a rounded anterior end and gradually posteriorly to a somewhat pointed posterior extremity. The body is constricted at several points, notably at the levels of the posterior testis and the acetabulum, possibly due to contraction of the specimen. The cuticle is non-spinous. The sub-terminal oral sucker is transversely elongated and measures 0.195 mm. by 0.270 mm. The oval pharynx, situated immediately behind the oral sucker is 0.18 mm. by 0.12 mm. It lies obliquely to the long axis of the body. This is possibly brought about by contraction of the specimen. The oesophagus is short and almost immediately, just anterior to the acetabulum, divides into two lateral caeca with narrow lumen, which extend almost to the posterior extremity, where they end blindly very close to one another. The acetabulum, transversely elongated, with a transverse slit-like opening, occupies almost the complete width of the trematode, and lies in the anterior one-fourth of the body. It appears to be protrusible, and measures 0.30 mm. long by 0.488 mm. wide. The testes are post-ovarian, intercaecal, tendem, separated by vitellaria, the posterior one lying 0.75 mm. from the posterior extremity. The anterior testis, lying immediately behind the ovary, is somewhat irregularly oval, with slightly lobulated margin and transversely elongated; 0.143 mm. by 0.195 mm. The posterior testis, 0.225 mm. long by 0.188 mm. wide, is elongated oval with slightly lobed margin and lies obliquely. The seminal vesicle, extending just posterior to the acetabulum is tubular, sinuous posteriorly, with one coil at about the mid-length, straight anteriorly, and is not enclosed in the cirrus sac. There is a pars prostatica, but no prostatic gland and a short cirrus enclosed in a muscular cirrus sac. The small genital atrium opens ventrally, to the left of the pharynx at the level of the junction of the oral sucker and pharynx. The ovary 0.53 mm. posterior to the ventral sucker is three-lobed, two of the lobes being directed ventrally and dorsally, so that in ventral or dorsal view the ovary does not appear lobulated, but somewhat transversely elongated oval or pear-shaped. It measures 0.112 mm. by 0.225 mm. The shell gland is anterior to the ovary. There is no distinct receptaculum seminalis. The vitelline reservoir lies dorsal to the median anterior portion of the ovary. The uterus is intercaecal and completely anterior to the ovary. The eggs are 72-75µ long by 41-43µ in diameter. The follicular vitellaria are extensive, extending dorsal and ventral and lateral and median to the caeca, from the posterior margin of the acetabulum to almost the posterior extremity, with interruptions at the level of the ovary and anterior testis and on the left side only at the level of the posterior testis. The vitellaria extend into the median field ventrally, between the two testes and behind the posterior testis. They also extend into the median field, dorsal to the uterus.

Seven other species of the genus *Pseudopecoelus* have been described. These are *P. vulgaris* (Manter, 1934) Von Wicklen, 1946, *P. japonicus* (Yamaguti, 1938) Von Wicklen, 1946, *P. elongatus* (Yamaguti, 1938) Von Wicklen, 1946, *P. tortugae* Von Wicklen, 1946, *P. priacanthi* (MacCallum, 1921) Manter, 1947, *P. gibbonsiae* Manter and Van Cleave 1951, and *P. umbrinae* Manter and Van Cleave, 1951.

Pseudopecoelus vancouveri is notably different from all these species in having the testes separated by considerable distance into which the vitellaria extend ventrally, the median extension of the vitellaria dorsal to the uterus, the interruption of the vitellaria at the level of the ovary and anterior testis and the loop at the mid-length of the seminal vesicle. The short oesophagus is also characteristic. It differs from *P. vulgaris*,

P. tortugae, P. elongatus, P. priacanthi, P. japonicus and P. gibbonsiae in the seminal vesicle extending just beyond the acetabulum, while in these species it extends a considerable distance posterior to the acetabulum. In P. umbrinae the seminal vesicle does not extend posterior to the ventral sucker. The eggs are larger than in P. tortugae, P. priacanthi, and P. elongatus and smaller than in P. vulgaris and P. gibbonsiae. The pharynx is considerably larger than in P. vulgaris, P. priacanthi, P. elongatus, P. japonicus and P. umbrinae. Pseudopecoelus vancouveri also differs from one or more of the above species in body shape, configuration, size and relation of testes and ovary to one another and their relative position in the body, the anterior extent of the vitellaria and the position of the genital pore.

The specific name of the fluke is derived from the locality from which the host was taken.

The genus Pseudopecoelus has so far only been found at Tortugas, Florida, the North American Pacific and Japan. There are no European records of this genus. Pseudopecoelus vancouveri is the fourth species to be recorded from the west coast of North America. Pseudopecoelus vulgaris (= Cymbephallus vulgaris Manter 1934) was recorded from Puget Sound, Washington by Lloyd

(1938) and P. gibbonsiae and P. umbrinae were described by Manter and Van Cleave (1951) from California littoral fishes.

Sub-family PLAGIOPORINAE Manter, 1947

Genus Podocotyle Odhner, 1905

Podocotyle wilsoni, n. sp. (Fig. 4)

Host: Eopsetta jordani (Lockington), brill.

Location: Pyloric caecum.

Locality: Gulf Islands, Strait of Georgia, B.C.

Two specimens were collected from one host fish.

Description: The body is 2.82-3.29 mm. long, slender, tapering from the posterior testis to a bluntly pointed posterior extremity. From the posterior testis to just posterior to the acetabulum, the body is of uniform diameter, 0.37-0.42 mm. The body is here somewhat constricted and then broadens to 0.48-0.68 mm. and gradually tapers to the anterior end. The cuticle is smooth. The terminal oral sucker measures 0.165-0.188 mm. long by 0.170-0.200 mm. broad. The acetabulum about 0.3 mm. behind the oral sucker measures 0.263-0.300 mm. by 0.315-0.353 mm. The ratio of oral sucker to ventral sucker is 1:1.75 to 1:1.85. The prepharynx visible only in one specimen is 0.015 mm. long and the pharynx is 0.113-0.120 mm. by 0.090 mm.

The sinuous oesophagus, 0.12-0.15 mm. long, bifurcates midway between the pharynx and the acetabulum. The two slender caeca follow a lateral course to near the posterior extremity, where they end blindly. The oesophagus is surrounded by a series of glandular cells. The excretory pore is terminal. The anterior extent of the excretory vesicle could not be determined. The ventral genital pore lies in front of the intestinal bifurcation and about midway between the oesophagus and the left margin of the body. There is a short genital atrium. The well developed cirrus sac is more or less pear-shaped and extends posteriorly to the middle of the acetabulum in the larger specimen and about three-quarters of the length of the ventral sucker in the smaller specimen. The apparent difference in posterior extent of the cirrus sac is mainly due to the smaller acetabulum in the smaller specimen, as the cirrus sac is approximately 0.30 mm. long in both specimens, with about half this length anterior to the acetabulum. The cirrus sac contains the seminal vesicle, ejaculatory duct, a short cirrus and prostatic cells. The seminal vesicle consists of a large straight posterior portion and a narrow coiled anterior portion. The elongated oval, smooth margined, testes, measuring 0.240-0.255 mm. by 0.188-0.218 mm., lie intercaecally, tandem, behind the middle of the body and are separated by a distance about one-half the length of the testes. The four-lobed ovary lies medially a short distance anterior to the testes. The ovary measures 0.143-0.150 mm. by 0.173-0.188 mm. The seminal receptacle is large, somewhat elongated pear-shaped, lying diagonally transverse, dorsal to the anterior lobe of the ovary. It extends the full width between the caeca. The left extremity is the more anterior and is drawn out into a tube which is directed posteriorly at first and then loops anteriorly to give rise to Laurer's canal which opens latero-dorsally near the left caecum. Laurer's canal is constricted near its base. The yolk reservoir is anterior to the ovary, slightly to the left of the midline. It is dorsal to the ovary but ventral to the seminal receptacle. Mehlis' gland is a diffuse structure, lying intercaecally anterior to the ovary and ventral to the vitelline reservoir and seminal receptacle. The coiled uterus, filled with eggs occupies the space between the seminal receptacle and the acetabulum and passes to the left of the acetabulum, its distal end modified into a metraterm, that opens to the genital atrium close to the cirrus. The metraterm is about one-half the length of the cirrus sac. The yellowish eggs measure 0.064-0.074 mm. long by 0.030-0.040 mm. in diameter. The vitellaria, consisting of many follicles, almost completely fill the post-testicular space, and extend laterally, partly extra-caecal and partly intra-caecal, to almost the posterior edge of the acetabulum, with interruptions at the levels of both testes. They are present laterally, but do not extend medially, between the testes.

The genus Podocotyle Odhner, 1905 contains at present at least twenty-four species. Park (1937A) reviewed the species of the genus and added eight new species from California littoral fish. The main characters that he used as the basis for separation of species are (1) the form of the seminal vesicle, (2) extension of cirrus sac anterior or posterior to the acetabulum, (3) morphological structures of genital organs and (4) relative position of testes in relation to one another. Of the species listed in Park's key and those since described, with a coiled seminal vesicle, the new species most closely resembles P. syngnathi Nicoll, 1913 from British marine fish, and P. apodichthysi Park, 1937 from California. It differs from P. syngnathi Nicoll, 1913 in the nature of the coils of the anterior portion of the seminal vesicle, in the smaller eggs (64-74µ by 30-40µ as compared to 82-102µ by 45-50µ), in the vitellaria being interrupted at the level of both testes, whereas they are only sometimes interrupted, on one or both sides, at the level of the posterior testis and never at the level of the anterior testis in P. syngnathi. The shape of the seminal receptacle and relationship of the organs in the female genital complex are also different. The ratio of oral sucker to ventral sucker is at most 1:1.5 in P. syngnathi whereas it is at least 1:1.75 in P. wilsoni. P. wilsoni differs from P. apodichthysi in having entire testes which are longer than the ovary, whereas they are lobed and of the same size as the ovary in P. apodichthysi. The oral sucker and acetabulum are almost equal in size in P. apodichthysi, but the acetabulum is about $1\frac{3}{4}$ as large as the oral sucker in the new species. The cirrus pouch does not extend as far posteriorly in P. apodichthysi as in P. wilsoni and the details of the female genital complex differ.

Other species of Podocotyle recorded from the North American Pacific are P. abitionis McFarlane, 1936, P. atomon (Rudolphi, 1802) Odhner, 1905 and P. reflexa (Creplin, 1825) Odhner, 1905 from British Columbia by McFarlane, 1936. Podocotyle endophrysi, P. apodichthysi, P. blennicottusi, P. californica, P. kofoidi, P. elongata, P. pedunculata and P. pacifica were described as new species from California littoral fish by Park in 1937. Johnston (1949) described P. gibbonsia from California. Linton (1940) described an unnamed species of Podocotyle from a Pacific salmon in California.

The specific name, wilsoni, is in honour of Mr. R. M. Wilson of the Pacific Biological Station.

Genus Helicometra Odhner, 1902

Helicometra sp.

Host: Sebastodes sp., rockfish.

Location: intestine.

Locality: English Bay, Vancouver.

Eight specimens were recovered from the formalin preserved intestine of one host. All the specimens were highly contracted rendering it difficult to observe certain structures, or their true position and relation to other organs. From the general topography of the organs and the large filamented eggs in the uterus, spirally coiled between the ovary and the genital pore, the flukes can be definitely allocated to the genus Helicometra. Other characters which could be made out, at least in some specimens, are the cirrus sac, which extends posteriorly about one-third the length of the acetabulum, the oral sucker being somewhat larger than the ventral sucker, and the vitellaria extending anterior to the acetabulum both dorsally and ventrally and completely filling the posterior region, but interrupted at the level of the testes. The cuticle is smooth and the genital pore is ventral, median and anterior to the acetabulum. The form and relative position of the testes and ovary are obscured. The shape of the body and distance between oral and ventral suckers is completely misleading because of the high degree of contraction. Measurements are not given here, because even where possible, they would undoubtedly be misleading, except for the ova which are about 67µ long by 25µ in diameter. The length of the polar filaments could not be determined.

Palombi (1929) and Manter (1933) have reviewed the species of this genus. Since then Yamaguti (1934A), and

Woolcock (1935) have each added two species and Crowcroft (1947A) has added one species to the genus.

Of the eleven recognized species, H. bassensis Woolcock, 1935, H. sinuata (Rudolphi, 1819), H. fasciata (Rudolphi, 1819) Odhner, 1902, H. pulchella (Rudolphi, 1819) Odhner, 1902, H. execta Linton, 1910, H. epinepheli Yamaguti, 1934 and H. hypodytis Yamaguti, 1934 differ from the specimen from Sebastodes in that the oral sucker is smaller than the ventral sucker. The specimens on hand differ from H. torta Linton, 1910, H. plovmornini Issaitschikow, 1928, H. tenuifolia Woolcock, 1935 and H. neosebastodis Crowcroft, 1947, in the vitellaria extending anterior to the acetabulum.

These specimens of Helicometra appear to belong to a previously undescribed species. However, a specific description and naming of this parasite must await examination of more favourable material.

Trematodes of the genus Helicometra have not been found previously in a species of Sebastodes. Crowcroft (1947A) reported H. neosebastodis in the related genus of fishes, Neosebastes, from Tasmania. Helicometra sinuata, H. fasciata and H. torta have been reported by Manter (1940) as occurring in fish from the Pacific coast of Mexico and Central America. There are no records of Helicometra in the North American Pacific, north of Mexico.

Family ACANTHOCOLPIDAE Lühe, 1909

Genus Stephanostomum Looss, 1899

Stephanostomum dentatum (Linton, 1900) Manter, 1931

Host: Sebastodes sp., rockfish.

Location: intestine.

Locality: English Bay, Vancouver.

Five specimens were collected from one fish. They were identified as Stephanostomum dentatum (Linton, 1900) by referring to Linton's (1900, 1940) descriptions and drawings and to the brief discussions of Manter (1947) and Manter and Van Cleave (1951). The eggs are slightly longer (about 70µ) than the size usually recorded for S. dentatum. Stephanostomum pagrosomi (Yamaguti, 1939) Manter, 1947, considered a synonym of S. dentatum by Manter and Van Cleave (1951) has still larger eggs ranging from 72-80µ long.

This fluke evidently has a wide geographical distribution. It has been recorded previously from the Atlantic coast of the United States, the Gulf of Mexico, the coast of California and Japan. Manter and Van Cleave recorded S. dentatum from a flounder at La Jolla, California. The present record extends the distribution on the west coast of North America from British Columbia to California.

Flounders (Pleuronectidae) have been recorded as the primary hosts from the American Atlantic and California. Other families of fish serve as hosts in the Gulf of Mexico and Japan. The finding of S. dentatum in Sebastodes sp. constitutes a new host record.

Family AZYGIIDAE Odhner, 1911

Genus Otodistomum Stafford, 1904

Otodistomum veliporum (Creplin, 1837) Stafford, 1904

Hosts: Hexanchus griseus (Bonnaterre), mud shark; Squalus suckleyi Girard, dogfish; Raja rhina Jordan and Gilbert, long-nosed skate.

Location: stomach.

Locality: Baynes Sound, Vancouver Island.

Two mature specimens, one complete and one with the portion anterior to the acetabulum missing, were collected from Raja rhina. The whole specimen measures 16 mm. long and the fragment measures 15 mm. in length. The mud shark (only one specimen was examined) yielded three mature specimens and one immature specimen. The mature specimens are 38-48 mm. long and the immature one is 6.3 mm. long. From Squalus, seven specimens were obtained of which one, 29 mm. long, is mature. The remaining six specimens, all immature, range from 4-11 mm. long. The measurements were made on specimens fixed in situ in formalin and the flukes are somewhat contracted and bent.

Selachians from other localities in British Columbia waters were not available in any numbers and hence only one locality is here cited in which Otodistomum adults were found. Three dogfish from the southern Strait of Georgia (off Sidney) and one Raja binoculata from the middle west coast of Vancouver Island were free of this trematode.

Otodistomum veliporum has not heretofore been recorded from Canadian Pacific waters or Otodistomum from Raja rhina and Squalus suckleyi in any locality. Otodistomum specimens, however, have been recorded from Raja binoculata from Alaska (Manter, 1926), Washington State (Manter, 1926 and Lloyd, 1938) and California (Sleggs, 1927 and Van Cleave and Vaughn, 1941) and from Hexanchus griseus in Puget Sound (1947).

Manter (1926), Dollfus, (1937A, 1937B), Van Cleave and Vaughn (1941) and Dawes (1946, 1947) reviewed the literature on the genus Otodistomum. Dollfus (1937B) gave a complete list of hosts and their geographical distribution.

Manter studied the anatomy of Otodistomum of North American Raja spp. in great detail and concluded that there were two species, corresponding to the two European species, O. veliporum (Creplin, 1837) and O. cestoides (van Beneden, 1870). Otodistomum veliporum, according to Manter, occurred in R. binoculata of Alaska and Washington and O. cestoides in R, stabuliforis from the coast of Maine. After a thorough morphological comparison of the Pacific and Atlantic coast specimens, and comparisons with descriptions of European forms, Manter concluded that the only constant difference was in the size of the eggs, those from the Pacific coast specimens, which he identified with O. veliporum, being larger than those from the Atlantic specimens, which he considered as O. cestoides. He also pointed out that the characters, except egg size, which Odhner (1911) tabulated as differentiating O. veliporum from O. cestoides were valueless, because his specimens from R. stabuliforis showed all of the conditions involved in this differentiation.

Dollfus (1937A), in his review of the genus Otodistomum, considered both the Atlantic and Pacific forms from North America as belonging to two sub-species of O. cestoides. He had at his disposal for examination only specimens from R. binoculata from California, identified by Sleggs (1927) as Distomum veliporum (Creplin). The specimens from Raja in the North Atlantic and from Raja in California waters were designated as O. cestoides cestoides. Otodistomum material in Washington and Alaska from R. binoculata he called O. cestoides pacificum. Dollfus thus considered that two sub-species of O. cestoides occurred in R. binoculata of the North American Pacific. For the differentiation of these two sub-species he accepted Manter's conclusion of discontinuity of egg size between American Atlantic and Pacific forms of Otodistomum. Dollfus' measurements of eggs of Distomum veliporum (Creplin) of Sleggs, 1927 fell in the range cited by Manter for O. cestoides of R. stabuliforis from Maine. He therefore considered these two lots of material similar. The Washington and Alaskan material he considered as a sub-species of O. cestoides and not O. veliporum because of the thinner egg shell than recorded for European O. veliporum. The only constant difference between O. cestoides and O. veliporum which Dollfus used to separate these species, is the thicker egg shell in O. veliporum. Dollfus also divided O. veliporum into three sub-species. He used host and geographical distribution along with egg size and thickness of shell to separate his six forms (three sub-species of veliporum, two of cestoides and a separate species of O. pristiophori from Australia).

Van Cleave and Vaughn (1941) apparently accepted Dollfus' differentiation of O. cestoides and O. veliporum but demonstrated that the range of egg size of specimens of Otodistomum (which according to Dollfus should be O. cestoides cestoides) from R. binoculata and R. stabuliforis from California and Maine respectively, overlap one another and the supposed larger range of egg size of O. cestoides pacificum of Dollfus (=O. veliporum of Manter). These authors thus concluded that only one highly variable species of Otodistomum occurs in North America, which they referred to as Otodistomum cestoides (van Beneden, 1870).

Kay (1947) described O. plicatum as a new species from Hexanchus griseus in Puget Sound, on the basis of larger egg size and cirrus sac than in other species of the genus. However, her measurements of eggs, 110µ long by 70µ wide, with a shell 7.5-8µ thick are identical with those cited by Dollfus (1937A) for O. veliporum veliporum from H. griseus of Europe. The measurements of the cirrus pouch were given by Kay as 1.43-2.36 mm. by 0.84-1.57 mm. The lower limit of these measurements coincide with the upper limit of records for O. veliporum, thus forming a continuous range, and not two distinctly separate ranges. Furthermore, the cirrus pouch of a 40 mm. long specimen in my collection from H. griseus from the Strait of Georgia (adjacent to Puget Sound, Washington) measured only 1.05 mm. by 0.88 mm. I am thus considering O. plicatum Kay, 1947 a synonym of O. veliporum (Creplin, 1837).

Dawes (1946, 1947) in the light of the work done by Van Cleave and Vaughn, suggested that egg size as a criterion of separating sub-species within the genus Otodistomum as used by Dollfus is not satisfactory. He considered that one species of the genus Otodistomum parasitizes selachians throughout the world and Otodistomum veliporum (Creplin, 1837), by the laws of priority, is the correct name.

In the material at hand, in view of the foregoing, attention was directed mainly to the size of the eggs and the thickness of the egg shell. The eggs were removed from the uterus and measured in water. Eggs were taken from both distal and proximal portions of the uterus. Fifty eggs were measured in each case. As the eggs from the proximal extremity of the uterus differed only slightly in size (2 to 4 per cent shorter and up to 7 per cent less in diameter) from the eggs from the distal portion and there was no significant difference in thickness of egg shell between these two regions, the following table is based on measurements of eggs in the distal end of the uterus. All measurements are in microns.

TABLE 1

COMPARISON OF EGG SIZE OF SIX OTODISTOMUM SPECIMENS FROM BRITISH COLUMBIA SELACHIANS.

Host	Length		Diameter		Shell thickness (equatorially)
	range	average	range	average	range
Raja rhina (2 specimens)	78-90	86.9	45-60	56	2-3.7
Squalus suckleyi	79-112	100.0	60-82	74	4.5-6.7
Hexanchus griseus (1)	97-111	104.8	67-82	76	6.7-8.3
(2)	112-135	123.5	75-86	79.8	6-7.5
(3)	142-150	146.3	88-96	91.6	6.7-8.3

The specimens from Raja rhina clearly fit into the species O. cestoides on the basis of egg size and shell thickness as given by Van Cleave and Vaughn. The average size of the eggs is somewhat larger than that given by these authors, but is very close to the average as cited by Manter for Otodistomum from R. binoculata of Alaska and Washington State.

The specimen from *Squalus suckleyi* fits into Dollfus' sub-species *Otodistomum veliporum leptotheca* from squaliform fishes of the Mediterranean and the Atlantic of southern Europe and northern Africa. In his key to the sub-species he gave the dimensions of the eggs as 85-97μ long by 62-70μ in diameter, with a maximum shell thickness between 6 and 7μ. However, in his citation of the measurements recorded by other authors, it is noticed that a minimum diameter of 53μ has been recorded and the thickness of the egg shell has been given as low as 4μ. The specimen from the dogfish thus exceeds somewhat both the lower and upper limits previously recorded for the length and the upper limit of the diameter of the eggs. The minimum shell thickness of 4.5μ encroaches on the upper limit (up to 5μ) of the shell thickness of eggs of *O. cestoides* as recorded by Van Cleave and Vaughn and Dollfus, although it is distinctly above the range found for eggs of *O. cestoides*.in the specimens from *Raja rhina*. Also, the size of eggs of *O. veliporum leptotheca* includes a large part of the range of egg size of *O. cestoides*. It is thus apparent that it is difficult to separate these two species on the basis of egg size and shell thickness.

The specimens from *Hexanchus griseus*, although showing considerable variation in egg size between specimens, agree essentially with specimens from European Hexanchidae (including H. griseus), which Dollfus assigned to the sub-species O. veliporum veliporum. Dollfus gave two sets of measurements for eggs of this sub-species as follows.

1) maximum thickness of egg shell between 6.5 and 7.5µ (minimum 6µ); length of eggs 118-130µ and diameter of eggs 86-92µ.

2) maximum thickness of egg shell between 7.5 and 8µ (minimum 6µ); length of eggs 110-120µ and diameter 69-75µ.

The measurements of eggs of specimen number 2 from Hexanchus are very similar to the group (1) measurements of Dollfus. The maximum egg length is here slightly larger (135µ as compared to 130µ) and the egg diameter slightly smaller (75-86µ as compared to 86-92µ). Specimen number 1 is close to group (2) of Dollfus' egg measurements for O. veliporum veliporum. The egg shell thickness is the same but the minimum egg length is less (97µ as compared to 110µ) and the range of egg diameter is wider (67-82µ as compared to 69-75µ). The equatorial shell thickness of specimen number 3 from Hexanchus is like Dollfus' group (2) of veliporum veliporum. However, measurements at the anopercular pole give values of 8.5-11µ, which is more in line with Dollfus' O. veliporum pachytheca, but the egg dimensions are considerably larger than in this sub-species. In egg dimensions it is closest to Dollfus' group (1) of veliporum veliporum, but still somewhat larger, particularly in length. This specimen would thus appear to be intermediate between O. veliporum veliporum and O. veliporum pachytheca.

It will be noticed from Table 1 that there is considerable overlapping of egg size of specimen number 1 from Hexanchus (similar to O. veliporum veliporum of Dollfus) and egg size of the specimen from Squalus (similar to Dollfus' O. veliporum leptotheca). Similarly, the diameter of the eggs and shell thickness of specimen number 2 from Hexanchus include part of the range of these two groups of measurements from the specimen from Squalus. It thus becomes difficult to separate O. veliporum veliporum from O. veliporum leptotheca. The egg size of specimen number 3 from Hexanchus is clearly larger than that obtained for the other specimens of Otodistomum found in this study, but it is not so largely differentiated from the maximum egg size of O. veliporum veliporum of Dollfus.

From the foregoing it is seen that although certain maximum limits of egg measurements separate the two subspecies of O. veliporum recorded here, there is considerable overlapping within the complete ranges of egg measurements, which render it difficult to distinctly separate these subspecies. Furthermore, there is also overlapping between the measurements of egg shell thickness of O. cestoides and

O. veliporum leptotheca, which increases the difficulty in separating these two species. Dollfus was aware of the difficulty inherent in using egg size and shell thickness as a criterion for separating his sub-species of O. veliporum, particularly O. veliporum veliporum and O. veliporum pachytheca, for which he admitted finding intermediate forms.

In view of the above mentioned difficulties in separating Dollfus' sub-species of O. veliporum on the basis of egg size and shell thickness, and in separating O. veliporum leptotheca from O. cestoides on the basis of shell thickness, together with the large variation in egg size of specimens recorded from H. griseus, I am here following Dawes in considering O. veliporum (Creplin, 1837) a highly variable species with O. cestoides (van Beneden, 1870) as a synonym.

Otodistomum veliporum (Creplin, 1837), metacercaria

Hosts: Eopsetta jordani (Lockington), brill;
Parophrys vetulus Girard, lemon sole;
Lepidopsetta bilineata (Ayres), rock sole;
Citherichthys sordidus (Girard), mottled sand dab,

Location: cysts in connective tissue of stomach wall.

Locality: Ucuelet, west coast of Vancouver Island; Two Peaks, Hecate Strait; Cape Scott, Vancouver Island; Cape Lazo, Vancouver Island; Goose Island Grounds, Queen Charlotte Sound.

The metacercaria occur singly or occasionally in pairs in cysts in the deep layers of the submucosa of the stomach wall, and cause the wall to bulge externally. The cyst may be up to 7 mm. in diameter. The cyst wall laid down by the host consists solely of fibrous tissue about 150µ thick. There is no cellular reaction. Pressure of the cyst compresses the muscle fibres in contact with the cyst. Inside the cyst, the worm lies with the posterior end usually bent anteriorly against the ventral surface. There is a brownish semi-fluid substance surrounding the worm which imparts to the cyst a yellowish-brown or blackish-brown color. On rupturing the cyst, the flukes are found to be quite active.

These metacercariae were found only in flat-fishes (Pleuronectidae and Bothidae), all of which constitute new records for the intermediate hosts of the genus *Otodistomum*. Although adult *Otodistomum* have been described from the northwest Pacific, intermediate fish hosts in this area have not been recorded. Flat-fish are known to harbour these metacercaria in the American Atlantic and Europe.

Infected intermediate hosts have been found from the most northerly to the most southerly of British Columbia waters. Selachians along the whole of the B. C. coast must apparently harbour the adults. In the northern part of Hecate Strait (Two Peaks), the lemon sole were noted to be particularly heavily infected in the latter part of June. One commercial load of fish from that area, consisting of several thousand fish, appeared to be nearly all infected. The maximum number of worms per fish was forty. Similar heavy infections of the brill on the west coast of Vancouver Island were noted during the same period. Whether there is actually a seasonal variation in intermediate host infection, which might coincide with the emission of cercariae from the molluscan host, is not known. Further studies are required to establish or disprove this point.

The specimens measured 2.2-8.7 mm. long and are similar in morphology to the immature specimens found in the stomach of Squalus suckleyi and Hexanchus griseus. The morphology has been adequately dealt with by Manter (1926) and Dollfus (1937A) and need not be repeated here.

Family DIDYMOZOIDAE Poche, 1907

Genus Platocystis Yamaguti, 1938

Platocystis alalongae Yamaguti, 1938

Host: Thunnus alalunga (Gmelin), albacore.

Location: cysts in the skin.

Locality: Pacific, between Cape Blanco, Oregon and Cape Mendecino, California, 45-85 miles off shore.

The trematodes were found in pairs, in cysts in the dermis, particularly posterior to the base of the pectoral fin. The trematodes consist of a flat, laterally compressed, semicircular hindbody and a slender forebody and lie in the cyst with their straight margins of the hindbody adjacent, giving the cyst a circular or slightly oval outline. Both flukes of one cyst are approximately equal in size. The trematodes are surrounded by a thin transparent cyst wall, which appears to be derived from the parasite, which becomes surrounded by host fibrous tissue. There is no cellular infiltration. The cyst appears yellow due to the vast number of yellow eggs present in the uterus which occupies all the space in the hindbody not taken up by the vitellaria or gonads. This yellow appearance of the cysts has given rise to the term "yellow-spot", by which this condition is referred to by commercial fishermen. The cysts measure from less than 1 mm. in diameter to 3 by 4 mm. , somewhat smaller than those recorded by Yamaguti (1938B).

Yamaguti adequately described and figured this parasite. The excretory system and intestinal crura after leaving the forebody were not seen. In serial sections of Platocystis alalongae I was not able to make out these structures either. The specimens examined are smaller than Yamaguti's. Comparative measurements are given in Table 2.

TABLE 2

MEASUREMENTS OF PLATOCYSTIS ALALONGAE

YAMAGUTI, 1938 IN MM.

	From Yamaguti (1938)	Present Specimens
Forebody - length	2.5-3.1	1.4-2.0
- width at oesophagus	0.25-0.4	0.16-0.24
Hindbody	2.5-3.6 x 4.7-6	0.9-1.6 x 1.8-2.9
Oral sucker	0.033-0.036 x 0.030-0.033	0.033-0.039 x 0.030-0.033
Pharynx	0.032-0.034	0.028-0.035
Length of oesophagus	0.27-0.35	0.26-0.32
Ova	0.015-0.018 x 0.011-0.012	0.013-0.017 x 0.010-0.012

This trematode has only been recorded from the albacore, Thunnus alalunga.

Genus Metanematobothrium Yamaguti, 1938

Metanematobothrium guernei (Moneiz, 1891) Yamaguti, 1938

Host: Thunnus alalunga (Gmelin), albacore.

Location: Free in the submaxillary muscles, parallel to the muscle fibres.

Locality: Pacific, between Cape Blanco, Oregon and Cape Mendecino, California, 45-85 miles off shore.

This parasite was abundantly found in all of twelve albacore examined and conformed in all details with Yamaguti's (1938B) description and figures of this species.

It was first recorded by Moneiz in 1891 from albacore in Gascony as Nematobothrium guernei. Yamaguti, in describing specimens from the albacore caught in the Pacific Ocean near Japan, pointed out that several differences exist between this species and other known species of Nematobothrium, which are sufficient to justify the erection of a new genus, for which he proposed the name Metanematobothrium. These differences are (1) the free existence of the parasite in the host's tissue (2) the exceedingly long recurrent testes and (3) the bifurcate ovary.

Two other Didymozoidae were found in the albacore. One occurred in pairs in cylindrical cysts attached to the gill filaments and the other one in flat oval cysts on the fifth gill arch. They were preserved in situ in formalin which proved to be unsatisfactory to permit of specific identification. The parasites from the gill filaments belong to the genus Didymozoon (Tascheuberg, 1879) Odhner, 1907 and the ones from the gill arch are a species of Didymocystis Ariola, 1902.

Family HEMIURIDAE Luhe, 1901

Sub-family HEMIURINAE Looss, 1907

Genus Parahemiurus Vaz and Pereira, 1930

The genus Parahemiurus was named by Vaz and Pereira in 1930 for a fluke which resembled species of the genus Hemiurus Rudolphi, 1809, but in which the seminal vesicle was undivided, whereas in Hemiurus it is bipartite. Parahemiurus parahemiurus was named the type of this new genus. Woolcock (1935) showed that Hemiurus merus Linton, 1910 belonged to the genus Parahemiurus because of the undivided seminal receptacle. Linton (1910), when naming this new species suggested that a new genus should possibly be created for its reception because of the undivided character of the seminal vesicle. Manter (1940) regarded P. parahemiurus and P. merus as synonyms and P. merus therefore became the valid name of the type species, by the law of priority. Since the creation of this new genus, a number of new species have been described, some of which Manter (1940) considered as synonyms of P. merus.

Dawes (1946) doubted the validity of the genus *Parahemiurus*, stating that the difference in the character of the seminal vesicle is insufficient to warrant the erection of a new genus. Manter (1934) first adopted this view also, but with the description of more new species of *Parahemiurus* he accepted it as a valid genus (1940, 1947) and discussed his reasons for doing so. Woolcock (1935) also discussed the probable validity of this genus.

To date, species of this genus have been reported from the North and South American Atlantic, the American and Asiatic Pacific and Australia. There are no European records of the genus *Parahemiurus*.

Parahemiurus merus (Linton, 1910) Woolcock, 1935

Hosts: *Lyopsetta exilis* (Jordan and Gilbert), slender sole; *Ophiodon elongatus* (Ayres), lingcod.

Location: stomach.

Locality: English Bay, Vancouver and Baynes Sound, Vancouver Island.

Nine specimens were taken from *Lyopsetta* and one specimen from *Ophiodon*.

The specimens from the slender sole agree with the descriptions and figures of Linton (1910) and Manter (1940). The specimen from the lingcod is smaller than the measurements previously given for this species. Body measurements are 0.76 mm. long by 0.21 mm. wide, in contrast to earlier records of 1.14-3.0 mm. long by 0.3-0.5 mm. in width. The extent of cuticular plications, which Manter (1940) considered of prime importance, the egg size and the topography of organs are identical with that of P. merus. The size of the suckers and genital organs are of the same relative size as in P. merus. The specimen is probably a young individual of P. merus.

Parahemiurus platichthyi Lloyd, 1938 was described as a new species from Platichthys stellatus of Puget Sound, Washington. This is the only other record of Parahemiurus on the west coast of North America. Manter (loc. cit.) has shown that this species is synonymous with P. merus. He also gave a list of other synonyms and discussed the variations in the species. Egg size (18-34μ by 8-14μ), and the form of the vitellaria, which may be unlobed or slightly lobed are the two main variable characters. The vitellaria in my specimens are either lobed or entire and the eggs measure 22-25u by 10u. The wide geographical and host distribution range of this species has been commented on by Manter (loc. cit.). Lyopsetta exilis and Ophiodon elongatus are new host records.

Parahemiurus oncorhynchi n. sp. (Figs. 5 and 6)

Hosts: Oncorhynchus tshawytscha (Walbaum), spring salmon; Oncorhynchus kisutch (Walbaum), coho salmon.

Location: stomach.

Locality: Point Gray, Vancouver and Nanoose Bay, Vancouver Island.

Thirty specimens were collected from three spring salmon (grilse) and about seventy specimens from three coho salmon (grilse).

Description: The worms are small, elongated and cylindrical. They are divided into two portions, the body proper (soma) and a retractable caudal appendage (ecsoma). The soma is 1.05-1.63 mm. long with a maximum width of 0.275-0.41 mm. at the level of the vitellaria, when the ecsoma is completely extended. At the level of the ventral sucker the width is 0.150-0.225 mm. From the level of the vitellaria, the soma tapers slightly to the posterior end and gradually to the rounded anterior extremity. The ecsoma is about one-quarter as long as the soma. The cuticular plications, characteristic of the Hemiurinae, are present both ventrally and dorsally along the whole length of the soma and are also present on the ecsoma. They are fine anteriorly, becoming coarse posterior to the acetabulum and then finer posteriorly. On the ecsoma the plications are very fine.

The oral sucker, situated at the anterior extremity, measures 0.053-0.071 mm. in diameter. The acetabulum, situated a short distance behind the oral sucker, at about the middle of the anterior one-third of the body length, protrudes somewhat from the ventral surface. It measures 0.120-0.169 mm. in diameter. The ratio of oral to ventral sucker is about 1:2.2 to 1:2.3. The spherical pharynx, 0.038-0.047 mm.,is situated immediately behind the oral sucker. There is no prepharynx. The pharynx leads into a short narrow oesophagus which gives rise to the two intestinal crura a short distance anterior to the acetabulum. The crura extend laterally into the ecsoma to about one-half its length and end blindly.

The two testes situated medially in the posterior portion of the anterior one-half of the soma are round or oval in outline, with smooth margins, and tandem. They may or may not be separated by a short distance, but are never separated by folds of the uterus. The oval, undivided seminal vesicle has a thick muscular wall, and lies mostly anterior and dorsal to the testes, with its long axis parallel to the length of the body. It measures 0.100-0.158 mm. by 0.055-0.09 mm. When the worm is viewed ventrally, the posterior portion of the seminal vesicle is overlaid by the anterior testis. From the seminal vesicle a sinuous prostatic duct arises which proceeds anteriorly for a short distance, then turns and pursues a ventro-anterior course. About mid-way between the seminal vesicle and acetabulum, the prostatic duct makes a V-turn and then proceeds anteriorly to about one-third the distance of the acetabulum, where it is joined by the uterus to form a common genital duct which leads to the median genital pore at the level of the middle of the oral sucker. The prostatic duct is surrounded for all of its length by prostatic cells lying free in the parenchyma. The common genital duct or ductus hermaphroditicus is enclosed for nearly all of its length in a sinus sac.

The oval ovary, transversely elongated, lies medially, a short distance posterior to the testes (about two thirds the length of the soma from the anterior extremity), from which it is separated by folds of the uterus. The ovary is 0.825-0.143 mm. long by 0.105-0.217 mm. wide. Immediately behind and in direct contact with the ovary are the two compact, oval vitellaria. In none of the specimens did they appear even slightly lobed. They measure 0.098-0.167 mm. long by 0.090-0.134 mm. in breadth. A seminal receptacle, lying dorsal to and partially to the left of the posterior portion of the ovary, is visible. The uterus is much convoluted and contains many eggs. It proceeds posteriorly, looping several times, into the anterior portion of the ecsoma, where it turns anteriorly, passing dorsal and to the left of the vitellaria. It then coils several times, filling up most of the space between the ovary and testes, and proceeds dorsal to the testes. At the level of the seminal vesicle the uterus turns ventrally and proceeds anteriorly, in a dorso-ventral sinuous course, to join the prostatic duct dorsal to the posterior portion of the acetabulum. The eggs are slightly concave on one side and measure 20-25μ by 10-12μ.

Parahemiurus oncorhynchi differs from all other described species of the genus in possessing cuticular plications on the ecsoma as well as on the soma. It is very closely related to P. merus (Linton, 1910) and P. anchoviae Pereira and Vaz, 1930 from which it can only be differentiated by the extent of the cuticular plications. Parahemiurus merus and P. anchoviae can only be distinguished by the extent of the cuticular plications on the dorsal side of the soma. In P. merus they extend dorsally only to the level of the acetabulum, whereas in P. anchoviae they are present both dorsally and ventrally to near the posterior extremity of the soma. Other species of the genus are P. ecuadori Manter, 1940 in which the oral sucker is larger than the ventral sucker; P. sardinae Yamaguti, 1934, which is distinguished by the extreme posterior position of the ovary; P. seriolae Yamaguti, 1934 which possesses a voluminous seminal vesicle and P. australis Woolcock, 1935 in which the vitellaria are deeply lobulated. Parahemiurus lovettiae Crowcroft 1947 was described from Tasmania. Crowcroft's paper (1947B) was not available to me at this time, thus rendering it impossible for me to list its distinguishing characteristics. Parahemiurus parahemiurus Vaz and Pereira, 1930, P. platichthyi Lloyd, 1938, P. atherinae Yamaguti, 1938 and P. harengulae Yamaguti, 1938 are considered as synonyms of P. merus (Linton, 1910) Woolcock, 1935 by Manter (1940).

Oncorhynchus tshawytscha (Walbaum) is designated as type host and Point Gray, Vancouver as type locality. The specific name oncorhynchi is derived from the generic name of the hosts.

Sub-family DINURINAE Looss, 1907

Genus Tubulovesicula Yamaguti, 1934

Tubulovesicula nanaimoensis (McFarlane, 1936) Manter, 1947 (Fig. 7)

Hosts: Oncorhynchus tshawytscha (Walbaum), spring salmon; Oncorhynchus kisutch (Walbaum), coho salmon.

Location: stomach.

Locality: Nanoose Bay, Vancouver Island and Strait of Georgia, B. C.

Two specimens, one mature and one immature, were collected from a spring salmon grilse and one mature specimen from a sexually mature coho salmon on its spawning migration.

Dinurus nanaimoensis McFarlane, 1936 was described from Scorpaenichthys marmoratus and Parophrys vetulus from Departure Bay, Vancouver Island. Manter (1947) placed this species in its correct genus, Tubulovesicula Yamaguti, 1934.

The trematodes from the salmon agree in practically all details with the description and figures of McFarlane (1936). The mature specimen from the spring salmon differs only in the size of the ovary. McFarlane gave the measurements as 0.24 mm. long by 0.13 mm. broad, whereas the ovary in this specimen is 0.19 mm. by 0.16 mm. In the specimen from the coho salmon the oral sucker and pharynx measure 0.225 and 0.105 mm. respectively, slightly larger than the maximum size of 0.212 and 0.089 mm. respectively for these structures in McFarlane's specimens. The ovary is the same size as that of the spring salmon specimen. McFarlane described the seminal vesicle as being tubular and coiled and extending between the testes, but it is not drawn in his figures. Figure 7 shows the character of the seminal vesicle.

To date, T. nanaimoensis has only been recorded from British Columbia. The two species of salmon increase to four the number of known hosts for this parasite.

Sub-family STERRHURINAE Looss, 1907

Genus Lecithochirium Luhe, 1901

Lecithochirium exodicum McFarlane, 1936

Host: Eopsetta jordani Lockington, brill.

Location: stomach.

Locality: middle west coast of Vancouver Island.

Lecithochirium exodicum was originally described by McFarlane (1936) from the stomach of Ophiodon elongatus taken from the Strait of Georgia, B. C., in the vicinity of Nanaimo. Lloyd (1938) reported it from the same host and also less commonly in Sebastodes maliger at Friday Harbour, Washington. He added some details to the description. Gregoire and Pratt (1952) noted this fluke as frequently parasitizing Eopsetta jordani in the coastal waters of Oregon. This is the first report of L. exodicum in the brill of Canadian waters, where it was found to be very common on the west coast of Vancouver

Island. Up to fifty trematodes were found in a single host. Its distribution seems to be confined to the north Pacific coast of North America, where it extends from Oregon to British Columbia, and has been found in three hosts of unrelated families.

Lloyd noted several differences between his specimens and the description as given by McFarlane. McFarlane stated that the caeca extend into the ecsoma, whereas Lloyd remarked that they "only rarely pass into it". In my specimens in which the ecsoma was completely extended, the caeca reach only to the posterior extremity of the soma. Lloyd described the seminal vesicle as being tri-partite, a condition observed in the specimens I examined, whereas McFarlane referred to this structure as "convoluted, not bipartite." An examination of one of McFarlane's paratypes, loaned to me by Dr. J. L. Hart of the Pacific Biological Station, Nanaimo, revealed this structure to be tri-partite. The eggs of my specimens measured slightly larger than the measurements given by Lloyd and by McFarlane. They were, as measured in Canada balsam, 25-32µ long by 13-18µ wide in contrast to Lloyd's values of 21-25µ by 12-14µ and McFarlane's measurements of 23µ by 11µ. The egg size is thus extended to 21-32µ long by 11-18µ wide. In one specimen the ventral sucker was abnormally large, measuring 0.698 mm. by 0.713 mm. The size of the acetabulum has been recorded previously as 0.34-0.59 mm. in diameter, a range which included all my other specimens.

Acena (1941) described L. medius from Sebastodes ruberrimus of Puget Sound. Manter (1947) considered it a synonym of *L. exodicum*.

Specimens of a trematode recovered from formalinized stomachs of *Ophiodon elongatus* from Baynes Sound, Vancouver Island, probably belong to this species. The flukes were highly contracted and bent, and did not permit of a critical morphological study.

Sub-family DEROGENETINAE Odhner, 1927

Genus *Derogenes* Luhe, 1900

Derogenes varicus (Müller, 1784) Looss, 1901

Hosts: *Citharichthys sordidus* (Girard), mottled sand dab;
Lyopsetta exilis (Jordan and Gilbert), slender sole.

Location: stomach.

Locality: Goose Island Grounds, Queen Charlotte Sound, B.C., English Bay, Vancouver.

One specimen was recovered from the sand dab and two specimens from the slender sole. One of the specimens from the slender sole is a young adult, as indicated by the presence of few eggs in the uterus and its small size.

Lloyd (1938) found this well-known and widely-distributed parasite in *Ophiodon elongatus* and *Sebastodes maliger* at Friday Harbour, Washington and in *Leptocottus armatus* near Seattle. Manter (1934) and Dawes (1946, 1947) have reported on the number of hosts and geographical distribution of this trematode. Dawes (1946), Lloyd (1938) and Manter (1926) referred to *Derogenes varicus* as the most common and widely distributed digenetic trematode of marine fishes. It apparently exhibits little host preferences. As pointed out by Manter (1926) it is usually present in the host in small numbers. The literature shows that D. varicus has been recorded from many parts of Europe, the Canadian and United States Atlantic, the Gulf of Mexico, in the western Pacific from the Galapagos Islands to British Columbia and in Japanese seas.

This is the first record of this parasite in Canadian Pacific fish and the two hosts in which it was found are new.

Lloyd (1938) pointed out a discrepancy between his specimens and the description of Odhner (1905). Odhner recorded the presence of a complete sinus sac in this species, whereas Lloyd stated "we fail to find any semblance of a complete sinus sac. A few isolated muscle fibres, relatively even fewer than in Lecithochirium, are all that could be considered as representing even an incomplete sinus sac (Fig. 8). The living worm or whole mount sometimes appears to possess a sinus sac but study of sections fails to reveal its presence." Dawes (1946) described the sinus sac as consisting of a few isolated fibres forming a rudimentary incomplete sinus sac. In my specimens a weakly developed sinus sac appears to be present in examination of whole mounts. Sections were not cut because of the lack of material.

The size of Derogenes varicus is extremely variable. Dawes (1946), quoting Stossich, gave 1.5-7 mm. as the range of length. Manter (1926) cited Nicoll as reporting mature specimens as small as 1 mm. in length and Dawes (1947) recorded mature specimens as small as 0.76 mm. The following measurements, in mm., were obtained from the three specimens collected in this study.

	From Citharichthys	From Lyopsetta	
Length	1.58	1.37	0.96
Width (at acetabulum)	0.54	0.48	0.35
Oral sucker (diameter)	0.16	0.21	0.18
Ventral sucker (diameter)	0.36	0.42	0.315
Pharynx (diameter)	0.085	0.082	--
Testes	0.13 x 0.13	0.075 x 0.10	--
Ovary	0.17 x 0.17	0.12 x 0.15	--
Ova	0.060-0.065 x 0.030	0.062-0.065 x 0.030-0.035	0.065 x 0.030-0.035

From a comparison of the above measurements, it is apparent that the oral and ventral suckers in the specimens from the slender sole are larger than those of the sand dab specimen, while the ovary and testes are somewhat smaller. However, these variations fall within the limits cited by various authors for D. varicus. Other differences between these specimens from the two hosts are the somewhat more anteriorly placed acetabulum and genital pore and the more voluminous and sinuous intestinal crura in the specimens from *Lyopsetta*. In these characters it resembles *Derogenes crassus* Manter, 1934. It differs mainly from *D. crassus* in having a smaller acetabulum, the oral sucker to acetabulum ratio in *D. crassus* being 1:3 as compared to about 1:2 in my specimen, which is the ratio cited for *D. varicus*. Dawes (1946, 1947) considered *D. crassus* a synonym of *D. varicus*. Yamaguti (1938A) accepted the validity of *D. crassus* and recorded this species from Japan. Manter (1934) considered the large size of the ova, 64µ by 36µ, as the most distinguishing character of *D. crassus*. However, it has been shown since (Dawes, 1946) that *D. varicus* eggs can attain a similar size. The specimens from *Lyopsetta* appear to be intermediate between *D. varicus* and *D. crassus*. These specimens may constitute a new species but due to lack of material to study the constancy of the characters, they are being included in the species *D. varicus*. It is possible that Dawes is correct in assuming *D. crassus* as synonymous with *D. varicus*. Further material of *D. crassus* from the type host *Callionymus agassizii* from Tortugas, Florida is required to settle this question.

Morphological characters of interest are the vitellaria. In *D. varicus* the long axis of each oval vitelline mass has been described as parallel to the length of the fluke. In *D. crassus*, Manter described the vitellaria as transversely elongated, a character which he considered of some importance in separating D. crassus from D. varicus. In the specimen from Citharichthys, one of the vitelline masses is elongated in an antero-posterior direction, while the other is directed transversely. In all other characters it is identical with D. varicus, and on the basis of this one minor character it cannot be considered as a distinct species. It thus appears that no taxonomic importance can be attached to the direction of elongation of the oval vitellaria.

Sub-family intermediate between STERRHURINAE Looss, 1907 and HEMIURINAE Looss, 1907

Genus Brachyphallus Odhner, 1905

Brachyphallus crenatus (Rudolphi, 1802) Odhner, 1905

Host: Oncorhynchus keta (Walbaum), chum salmon.

Location: stomach.

Locality: Strait of Georgia, British Columbia.

One specimen was found in the stomach of a mature chum salmon on its spawning migration. The anterior portion, containing the oral sucker, pharynx and terminal genital ducts is missing. However, there are sufficient characters present to enable its identification. The cuticle is transversely ringed as far as the posterior extent of the uterus. The marked pre-somatic pit and the vesicular parenchyma are readily visible. The general arrangement of the reproductive organs agrees with descriptions of B. crenatus. The seminal vesicle, lying dorsal and mainly anterior to the acetabulum is bilobed, the posterior portion being much the larger. The vitellaria, situated immediately behind the ovary, are lobed, the left and right ones having three and four lobes respectively. They are not noticeably longer than wide. The intestinal crura extend to the posterior end of the ecsoma, which is retracted in this specimen.

Measurements, in mm., of the specimen are as follows:

Length (minus the anterior end)	2.1
Width	0.54
Acetabulum	0.31 by 0.30
Testes -- anterior	0.15 by 0.19
posterior	0.14 by 0.19
Ovary	0.17 by 0.26
Vitellaria -- right	0.23 by 0.19
left	0.23 by 0.23
Ova	0.023-0.024 by 0.011-0.012

Brachyphallus crenatus is a widely distributed parasite of marine fish. It has been found in several parts of Europe, North American Atlantic and Pacific coasts and in Japan. Lander (1904), Linton (1940) and Manter (1926) recorded this parasite from the east coast of the United States in many species of fish. Heller (1949) found it in herring, smelt and salmon in the Canadian Atlantic. Odhner (1905) reported it from Scandinavian waters and Markowski (1933) from the Baltic. Among the hosts cited by Odhner is the Atlantic salmon (Salmo salar). Nicoll (1907) described this hemiurid from Great Britain. In the Pacific it has been recorded by Yamaguti (1934A) from Oncorhynchus milktschitsch in Japan and in the northwest Pacific (Puget Sound, Washington) by Lloyd (1938) from Oncorhynchus tshawytscha. The present record is the first from western Canada. Oncorhynchus keta is a new host record. Babaskin (1928) found this host in Siberia harboured another species of Brachyphallus, B. amuriensis Babaskin, 1928.

Detailed descriptions of the parasite have been given by Lander (1904), with additional information by Manter (1926) and Lloyd (1938).

The systematic position of the genus Brachyphallus, within the family Hemiuridae, has been the subject of some discussion. Odhner (loc. cit.) and Fuhrmann (1928) included it in the sub-family Hemiurinae. Looss (1907), although recognizing that it possesses characters allying it with the Hemiurinae, but also shows affinities to the Sterrhurinae, and is thus intermediate between these two sub-families, placed it with the Sterrhurinae on the basis of the absence of a complete sinus sac. However, Lander, Odhner and Lloyd described or figured a complete sinus sac in B. crenatus. Lloyd agreed with Looss in considering *Brachyphallus* as occupying a systematic position between the Hemiurinae and the Sterrhurinae and did not assign it to either of these sub-families. Dawes (1946) placed the genus within the Sterrhurinae, but recognized, as Lloyd pointed out, that it possesses some characters of both sub-families.

The characters allying *Brachyphallus* to the Hemiurinae are the complete sinus sac and the cuticular plications. In the Sterrhurinae, the sinus sac is incomplete (i.e. it consists of isolated muscle fibres) and the cuticle is smooth. Characters possessed by *Brachyphallus* which show its affinities to the Sterrhurinae are the vesicular parenchyma, the pre-somatic pit, the distinct ejaculatory duct and the short prostatic duct. In the Hemiurinae the parenchyma is not vesicular, a pre-somatic pit and a distinct ejaculatory duct are wanting, and the prostatic duct is long.

Family SYNCOELIIDAE Dollfus, 1923

Genus *Syncoelium* Looss, 1899

Syncoelium filiferum (Sars, 1885) Lloyd and Guberlet, 1936

Host: *Thunnus alalunga* (Gmelin), albacore.

Location: branchial chamber.

Locality: Pacific Ocean, between Cape Blanco, Oregon and Cape Mendecino, California, 45-85 miles off shore.

Seven of these trematodes were found in the branchial chamber of one of twelve albacore examined.

Syncoelium filiferum (Sars, 1885) adults were first described and figured by Lloyd and Guberlet (1936) from the gills of Pacific salmon (Oncorhynchus spp.) caught in Puget Sound, Washington. Yamaguti (1938B) described and figured a new species, Syncoelium katuwo from the gills of Euthynnus pelamys from the Japanese Pacific. According to Yamaguti, his species differed from Lloyd and Guberlet's S. filiferum mainly in egg size. Lloyd and Guberlet gave the egg size of S. filiferum as 40-50μ in length by about 30μ in width. Yamaguti gave the egg size of S. katuwo as 36-42μ by 24-27μ which is not significantly different from the measurements of S. filiferum. Furthermore, Yamaguti (1951) gave measurements of the eggs of specimens recovered from the pharynx of Decapterus muroadsi as 33-48μ by 24-30μ, a range which includes the egg size of S. filiferum as cited by Lloyd and Guberlet. From a critical comparison of the descriptions of S. filiferum (Sars) of Lloyd and Guberlet and Yamaguti's S. katuwo the only noticeable difference is in the description of the terminal genital ducts. Lloyd and Guberlet described the uterus and seminal vesicle as uniting to form a common genital sinus opening at the tip of a genital papilla which was often seen protruding ventral to the oral sucker. They also described a group of prostate cells free in the parenchyma, surrounding the seminal vesicle just before its union with the uterus. They stated that there was no cirrus sac, nor did they figure any structure equivalent to a sinus sac. Yamaguti (1938B) described the presence of a hermaphroditic pouch (sinus sac) surrounding a muscular hermaphroditic duct, whose distal extremity projected outside ventral to the oral sucker. He also stated that prostatic glands were absent.

The structure of the terminal genital ducts as described by Lloyd and Guberlet was verified by examining their specimens (in longitudinal sections) kindly loaned by the Department of Zoology, University of Washington. Yamaguti did not make his specimens available to me.

However, from an examination of my own specimens, it was revealed that Yamaguti was very likely dealing with S. filiferum of Lloyd and Guberlet, and the discrepancies in the description appear to be due to misinterpretation of structure. On examining whole mounts of specimens in side view, particularly specimens in which the genital papilla is retracted, one gets the impression of a genital sinus surrounded by a pouch such as figured by Yamaguti (1938B). However, when examining sagittal sections it becomes evident that a hermaphroditic pouch is not present at all and that actually, the genital sinus (hermaphroditic duct) opens at the tip of a genital papilla, projecting into the genital atrium, and which can be protruded to a greater or lesser extent (shown clearly in Lloyd and Guberlet's figures). The prostatic cells described and figured by Lloyd and Guberlet are difficult, if not impossible to see in whole mounts, which probably accounts for Yamaguti's statement of the absence of such structures. All other structures of Yamaguti's S. katuwo, Lloyd and Guberlet's S. filiferum and my specimens are identical. The eggs of my specimens are 34-44µ by 25-27µ. The vacuolated syncitial cells under the subcuticular musculature, as described by Yamaguti, but not mentioned by Lloyd and Guberlet, are present in my specimens.

I am here proposing that Syncoelium katuwo Yamaguti, 1938 is a synonym of Syncoelium filiferum (Sars, 1885), Lloyd and Guberlet, 1936.

The known hosts and distribution of S. filiferum adults thus becomes Oncorhynchus gorbuscha, O. nerka and Thunnus alalunga from the North American (United States) Pacific coast and Euthynnus pelamys and Decapterus muroadsi from the Japanese Pacific. The normal habitat of this fluke appears to be the branchial chamber.

Order MONOGENEA Carus, 1863

Sub-order MONOPISTHOCOTYLEA Odhner, 1912

Super-family CAPSALOIDEA Price, 1936

Family CAPSALIDAE Baird, 1853

Sub-family CAPSALINAE, Johnston, 1929, emended Price, 1939

Genus Capsala Bosc, 1811

Capsala martinieri Bosc, 1811

Host: Mola mola (Linnaeus), ocean sun-fish

Location: gills, skin.

Locality: West coast Vancouver Island.

These trematodes were collected from British Columbia about fifteen years ago and are in the collection of the Institute of Parasitology.

The morphology has been dealt with adequately by Price (1939) and Dawes (1947).

Price discussed the records of this parasite on the Pacific coast of North America. A brief discussion of the previous record of this trematode in British Columbia has already been given in the "Historical Resume".

Capsala martinieri is a common ecto-parasite of the ocean sun-fish in many parts of Europe, and the Pacific and Atlantic coasts of North America.

Sub-family BENEDENIINAE Johnston, 1931

Genus Entobdella Blainville in Lamarck, 1818

Entobdella hippoglossi (O. F. Müller, 1776) Johnston, 1856

Host: Hippoglossus stenolepis Schmidt, Pacific halibut.

<u>Location:</u> skin surfaces.

<u>Locality:</u> Hecate Strait, B. C.

Three specimens were collected from a halibut. The parasite is probably fairly common, but halibut were not available, in numbers, for examination. <u>Entobdella hippoglossi</u> is a well-known parasite of the Atlantic halibut (<u>Hippoglossus hippoglossus</u>). Price (1939A) and Dawes (1946, 1947) have described and figured this parasite, as well as many earlier authors.

Guberlet (1937) recorded <u>Entobdella squamula</u> (Heath) from this same host in Alaska.

The three specimens measured 14-16.5 mm. long by 6.6-8.5 mm. wide. The haptor is 3.6-3.8 mm. in diameter, with a marginal membrane of about 2µ. The three pairs of hooks on the haptor are 0.47-0.53 mm., 0.79-1.09 mm. and 0.098-0.12 mm. long, respectively. The pharynx is 0.825-0.875 mm. by 0.975-0.990 mm. The testes are elongated oval, measuring 1.63-2.01 mm. by 1.14-1.44 mm. and the ovary, almost globular, measures 0.975-1.24 mm. by 1.05-1.34 mm. Eggs were not present.

This appears to be the first record of <u>E. hippoglossi</u> on the Pacific halibut.

Entobdella squamula (Heath, 1902) Johnston, 1929

Host: Eopsetta jordani Lockington, brill.

Location: on fins and skin of "blind" side.

Locality: off Sydney Inlet, west coast of Vancouver Island.

Three flukes were obtained from two fish. The parasite, seemingly is not common, as hundreds of brill from the west coast of Vancouver Island were examined. On the other hand, the incidence could be much higher than indicated, since these external parasites might easily be lost during handling by the fishermen.

Entobdella squamula was originally described by Heath (1902) as Epibdella squamula n. sp. from a flounder, Paralichthys californicus (Ayres), caught in California waters. He described and figured the parasite in detail. The present record adds another hostfor E. squamula. Price (1939A) described this trematode from an unknown host from the Gulf of Mexico. Guberlet (1937) recorded this parasite from the halibut in Alaska. All records indicate that the parasite has never been found on the "eyed" side of the flounder hosts.

Measurements of the specimens are as follows: length, 8.8-9.5 mm.; width, 3.7-3.9 mm.; haptor diameter, 2.5 mm.; hooks, first pair 0.278-0.285 mm. long, second pair, 0.840-0.863 mm. long, and third pair 0.123-0.138 mm, long;

pharynx 0.375- 0.450 mm. long by 0.428-0.525 mm. wide; testes 0.775-0.90 mm. long by 0.600-0.675 mm. wide; ovary 0.675-0.713 mm. long by 0.713-0.835 mm. wide; eggs were not present.

Class C E S T O D A

Order TETRAPHYLLIDEA

Family PHYLLOBOTHRIIDAE Braun, 1900

Genus Phyllobothrium van Beneden, 1849

Phyllobothrium ketae Canavan, 1928, larva

Hosts: Oncorhynchus keta (Walbaum), chum salmon; Oncorhynchus gorbuscha (Walbaum), pink salmon; Oncorhynchus nerka, sockeye salmon; Eopsetta jordani Lockington, brill.

Location: stomach, intestine and pyloric caeca in the salmon, and the liver in the brill.

Locality: Strait of Georgia; mouth of Fraser River; Rivers Inlet; off Sydney Inlet, west coast of Vancouver Island.

Larval stages of the cestode were commonly found, in large numbers, free in the digestive tract of salmon. Only one specimen, encysted on the liver, was found in a brill from the west coast of Vancouver Island. The larvae from the salmon measured from 3.1 mm. to 24 mm. in length, the smallest ones being found in the stomach and the larger ones in the intestine and pyloric caeca. The encysted individual from the brill measured 3.88 mm. long and was identical morphologically with the small specimens from the salmon.

Wardle (1932) figured and described this larva which he found in large numbers in all five species of Oncorhynchus from the Strait of Georgia. Several morphological points may be added to Wardle's description. The posterior half of the larva forms the larval tail (pars postica), which is lost in the definitive host. The pars postica is much thinner and less muscular than the metabothridial region. Wardle stated that no internal structures were visible. In my larger specimens four sinuous excretory ducts can be seen, one dorsal and one ventral in each lateral half of the body, and conspicuous longitudinal median muscle bundles are visible. As stated by Wardle, segmentation is not present but the body is transversely striated. The scolex is as described by Wardle, except that the accessory suckers may be up to one-half the length of the bothridia (one-third, cited by Wardle). The apical sucker is small, about 0.18 mm. in diameter, approximately three-quarters the diameter of the accessory suckers.

Wardle originally identified this cestode with Phyllobothrium salmonis Fujita, 1922, a larval cestode from O. keta and O. masou in Japan. An adult tetraphyllidean, Phyllobothrium ketae described by Canavan (1928) from O. keta from Alaska, was considered the adult of the larva Wardle was dealing with and consequently he pointed out that by the law of priority, P. salmonis Fujita, 1922 was the valid name. In 1934, Yamaguti described Pelichnibothrium sp. larvae from O. keta and O. milktschitsch in Japan. He stated that Phyllobothrium salmonis Fujita, 1922, as well as P. caudatus Zschokke and Heitz, 1914 (from Oncorhynchus sp. in Siberia) belong to his Pelichnibothrium sp., which he considered as the larval stage of Pelichnibothrium speciosum Monticelli, 1889. Yamaguti's Pelichnibothrium (and hence P. salmonis Fujita, 1922) differs from P. ketae larvae essentially in having the accessory suckers on the scolex anterior to the bothridia and not on the anterior portion of the bothridia. Wardle and McLeod (1952) accepted the validity of the genus Pelichnibothrium Monticelli, 1889 on the basis of Yamaguti's work, and the identity of P. salmonis Fujita with Yamaguti's Pelichnibothrium larva. The larva recorded by Wardle from British Columbia salmon are distinct from Yamaguti's Pelichnibothrium, but they are still considered as the larvae of P. ketae Canavan. Since P. salmonis is not synonymous with P. ketae, this latter is retained as the valid name for the Phyllobothrium larva from British Columbia salmon.

As pointed out by Wardle, a phyllobothriid cestode attaining maturity in a teleost is indeed rare. However, Canavan's species appears to be valid. The evidence suggests that normally the parasite does not develop to maturity in salmon, but does undergo considerable growth in these hosts. The larval stage found in the brill, equivalent to the smallest larvae found in the stomach is probably the infective larva, and the brill might be considered as a true intermediate host for this cestode. When the plerocercoid (in an intermediate host not necessarily the brill) is ingested by the salmon, the cyst wall is evidently digested in the stomach and the larvae pass into the intestine where they increase in size but do not normally mature. They do not appear to reencyst in the salmon. Canavan's report of a mature P. ketae in O. keta is undoubtedly an abnormal condition, the true definitive host probably being a selachian. The possibility also exists that the bottle containing this cestode was mislabelled, since Canavan examined the parasite some twenty years after it was collected by Dr. H. B. Ward, and actually the host may have been a selachian.

Phyllobothrium sp., larva (Fig. 8)

Host: Hippoglossoides elassodon Jordan and Gilbert, flathead sole.

Location: intestine.

Locality: Baynes Sound, Vancouver Island.

Four phyllobothriid larvae (plerocercoids) were recovered from the intestine of one host.

The larvae are of the type commonly referred to as Scolex pleuronectis Müller, 1788, a name which includes many different tetraphyllidean larvae. It can scarcely be used to refer to any one species.

The larvae are 1.2-1.91 mm. long and consist of a more or less conical scolex, 0.2-0.233 mm. long by 0.225 mm. in maximum breadth, followed by an unsegmented growth zone (p.26-0.37 mm. long) and the pars postica (0.74-1.31 mm. long) with parallel sides and a bluntly rounded posterior extremity. The pars postica is 0.19-0.21 mm. wide. The only visible structures in the body are two lateral excretory vessels. There are four shallow biloculate bothridia on the scolex. The margins of the bothridia are entire and distinctly thickened. The bothridia, 0.159-0.162 mm. long, are divided into two loculi, the anterior one 0.042 mm. in diameter and the posterior one 0.114-0.117 mm. long by 0.077-0.09 mm. broad. The diameter of the conspicuous apical sucker is 0.084-0.085 mm.

Adult cestodes with a scolex of this type have not been described from the west coast of North America.

Order TRYPANORHYNCHA Diesing, 1863

Sub-order ATHECA Dollfus, 1942

Family TENTACULARIIDAE Poche, 1926, emended Dollfus, 1930

Genus Nybelinia Poche, 1926

Nybelinia surmenicola Okada, 1929, postlarva (Fig. 9)

Hosts: Merluccius productus (Ayres), hake; Parophrys vetulus Girard, lemon sole; Lepidopsetta bilineata (Ayres), rock sole; Eopsetta jordani (Lockington), brill; Hippoglossoides elassodon Jordan and Gilbert, flat-head sole; Lyopsetta exilis Jordan and Gilbert, slender sole; Microstomus pacificus Lockington, dover sole.

Location: stomach wall.

Locality: Gulf Islands, Strait of Georgia; Two Peaks, Hecate Strait; Swiftsure Lightship, west coast of Vancouver Island; Goose Island Grounds, Queen Charlotte Sound; Baynes Sound, Vancouver Island; English Bay, Vancouver; San Juan Buoy, Juan de Fuca Strait.

About forty specimens were collected from the above hosts. The maximum number, nine, in a single host was found in a brill from the Gulf Islands and a dover sole from Juan de Fuca Strait, Usually only one or two of these postlarval cestodes were found in one fish. In the hake, lemon sole, rock sole, brill, flat-head sole and slender sole the larvae were found free in cavities in the submucosa of the stomach wall. In the dover sole and one slender sole the postlarvae were surrounded by a closely applied cyst wall. The two forms are considered as identical because of the similarity in morphology and measurements. The unencysted forms in the stomach wall are very active when removed and placed in water. Wardle (1934) discussed the movements and viability of this cestode in artificial media.

Wardle (1932) described as _Nybelinia_ sp. larva, this trypanorhynchid postlarva from the stomachs of _Ophiodon elongatus_ and all species of _Oncorhynchus_ in the Strait of Georgia. In 1933 he tentatively assigned this larva to _N. surmenicola_ Okada, 1929, which was described and figured by Dollfus (1929). The parasite was originally found by Okada in a cephalopod in Japanese waters. Wardle added _Theragra_ sp. (probably _T. chalcogramma_) as a host, the parasite occurring in the epaxonic musculature of this fish. In this paper and in later publications, Wardle did not refer to _Oncorhynchus_ spp. as hosts of this cestode postlarva. It thus appears doubtful that _Oncorhynchus_ spp. harbour this parasite. In _Ophiodon_, Wardle (1933A) described the post-larva as wandering over the stomach mucosa, and eventually burrowing into the submucosa where it ultimately dies and becomes calcified. The presence of the postlarvae in the stomach causes a severe inflammation and leaves open routes of entry for nematode larvae. He described the condition as an acute gastritis.

Hart (1936B) described this same postlarval cestode from the intestine, just below the pyloric valve, of _Hexanchus_ *griseus* from Puget Sound, Washington and Alaska. He realized that he was dealing with the same cestode as Wardle described, but did not believeit was identical with *N. surmenicola* Okada. Following Southwell's classification (1930), in which *Nybelinia* is considered as a synonym of *Tetrarhynchus*, Hart described his postlarvae under the name of *Tetrarhynchus* sp. larva. Yamaguti (1934B) redescribed *N. surmenicola* from the cephalopod and eleven species of teleosts from Japan. Dollfus (1942) in his review of the Trypanorhyncha, considered Wardle's specimens as identical with *N. surmenicola* and *Tetrarhynchus* sp. of Hart, 1936 as a synonym.

Descriptions of the postlarva are to be found in Wardle (1932), Hart (1936A), Yamaguti (1934B) and Dollfus (1942).

The length of the larva and the measurements of the various regions depend to a large degree on the extent of contraction, since these larvae are extremely muscular and capable of extension to twice the length of that when completely contracted. The pars post bulbosa appears to be the region most shortened by contraction. The following measurements are divided into those taken from the extended specimens, those from the contracted specimens and those from specimens within the cysts. Measurements are in millimeters, except for hooks, which are in microns.

	Extended	Contracted	Encysted
Length (not including appendix)	4.3-6.5	3-6	2.74-3.25
Parswaginalis and pars bothridialis	1.99-2.8	1.55-2.8	1.39-1.65
Pars bulbosa	0.70-1.08	0.68-1.1	0.44-0.73
Pars postbulbosa	1.28-2.85	0.75-2.25	0.75-1.2
Proboscis length	1.20-1.95	1.32-2.1	?
Proboscis width	0.09-0.13	0.09-0.13	0.07-0.083
Hooks -- length	30-33	30-33	30-33
length of base	25-29	25-29	25-27
Height	25-30	25-30	25-27

The hooks on the proboscis are arranged in spiral rows. The number of hooks on one surficial surface, in each spiral row, varies from four anteriorly to eight, several rows posteriorly.

The seven hosts of N. surmenicola reported here are all new and increase to twenty-one the number of known fish hosts for this parasite. A cephalopod, Ommastrephes sloani pacificus (Steenstrup) is also known to harbour the postlarva in Japan, and it was from this invertebrate that the type specimen was described. This postlarval cestode is known only from the north Pacific (Japan and North America). The adult has not been found.

Family LACISTORHYNCHIDAE Guiart, 1927, emended Dollfus, 1935

Sub-family GRILLOTIINAE Dollfus, 1942

Genus *Grillotia* Guiart, 1927

Grillotia heptanchi (Vaullegeard, 1899)

Host: *Hexanchus griseus* (Bonnaterre), mud shark.

Location: spiral valve.

Locality: Baynes Sound, Vancouver Island.

This cestode appears to be very common in the mud shark. The identification of *G. heptanchi* was based on the examination of twenty-five specimens collected from one host. The longest worm, containing mature segments, measured 60 mm.

Wardle (1933A) discovered this cestode in *Hexanchus caurinus* from the Strait of Georgia and described it tentatively under the name of *Grillotia erinacea* (van Beneden). He also described a larval trypanorhynchid from the musculature of *Theragra chalcogramma* as *G. erinacea*, larva, although he was aware that certain characters of his specimens differed from *G. erinacea*. Hart (1936B) described this same cestode, as a new species, from the spiral valve of *Hexanchus griseus* in Puget Sound, Washington. Using Southwell's (1930) classification, he called his new species *Tentacularia megabothridia*. He did not relate this species to Wardle's *G. erinacea*. However, Hart also described a larva from the musculature of *Ophiodon elongatus* of Puget Sound, as *Tentacularia* sp., which he considered as identical with Wardle's *G. erinacea* larva but stated that no species found in northern Pacific waters could be identified with G. erinacea (van Beneden). Hart did not indicate the relationship of his Tentacularia sp. larva to his T. megabothridia. Dollfus (1942) clarified the situation. He studied material collected by Wardle and by Hart and found that Hart's T. megabothridia and Tentacularia sp. larva were identical with Wardle's G. erinacea adults and larvae and all were identical with a European species, Grillotia heptanchi Vaullegeard, 1899, closely related to G. erinacea (van Beneden).

In addition to the descriptions and figures of Hart and Wardle, based on Pacific material, Dollfus (1942) has given a detailed description and drawings of G. heptanchi and a list of synonyms.

This cestode is evidently common in sharks of the family Hexanchidae in many parts of the world. It has been recorded from several parts of Europe, China and the northwest Pacific.

Sub-order THECOPHORA, Dollfus, 1942

Family GILQUINIIDAE Dollfus, 1942

Sub-family GILQUINIINAE Dollfus, 1942

Genus Gilquinia Guiart, 1927

Gilquinia squali (Fabricius, 1794)

Host: Squalus suckleyi (Girard), dogfish.

Location: spiral valve.

Locality: Baynes Sound, Vancouver Island.

Gilquinia squali was found to be a very common parasite of the dogfish in Baynes Sound. The specimens measured up to 45 mm. long.

Pintner (1930) identified cestodes from Squalus suckleyi of Pacific Grove, California as Tetrarhynchus tetrabothrium (van Beneden) (= Gilquinia tetrabothrium = G. squali (Fabricius). This cestode was described from dogfish in the Strait of Georgia by Wardle (1932) under the name of Gilquinia tetrabothrium (van Beneden, 1849). The following year (1933A) he corrected the name to Gilquinia squali (Fabricius, 1793), as Dollfus (1930) pointed out that G. tetrabothrium (van Beneden) was a synonym of G. squali (Fabricius, 1794). Hart (1936B) found this tapeworm in the dogfish of Puget Sound, realized it was identical with Wardle's G. squali but insisted it was a new species and not identical with either G. squali (Fabricius, 1794) or G. tetrabothrium (van Beneden, 1849), each of which he considered a valid species. He named this cestode Tetrarhynchus anteroporus. The generic name Tetrarhynchus as used by Southwell (1930) included Gilquinia Guiart as a synonym. Dollfus (1942) restudied Hart's material, compared it with European material from Squalus acanthias and found them to be identical. He also presented arguments to show that G. tetrabothrium is a synonym of G. squali, which is the valid name for this common cestode of the dogfish. One of the characters that Hart used to distinguish anteroporus, squali, and tetrabothrium was the degree of constriction between the scolex and neck. My specimens from Squalus suckleyi show varied amounts of constriction, ranging from none to marked constriction. Dollfus had already pointed out that this character is valueless, as it is not constant. He also showed that the other characters enumerated by Hart as differentiating these three species, in reality, do not exist.

Order PSEUDOPHYLLIDEA, Carus, 1863

Family PTYCHOBOTHRIIDAE Lühe, 1902 emended Wardle and McLeod, 1952

Genus Clestobothrium Rudolphi, 1808

Clestobothrium crassiceps (Rudolphi, 1819)

Host: Merluccius productus (Ayres), hake.

Location: intestine.

Locality: Gulf Islands, Strait of Georgia.

This cestode is a common parasite of the hake. The specimens collected were 8-160 mm. long, the small worms without mature segments and the longer ones with gravid segments.

Wardle (1933A) recorded and briefly described this parasite from M. productus, of the Strait of Georgia. A detailed description, list of synonyms, and review of the literature dealing with C. crassiceps is to be found in Cooper's (1919) review of pseudophyllidean cestode parasites of North American fish. His specimens were collected from the silver hake, Merluccius bilinearis, on the east coast of Canada. Clestobothrium crassiceps is an extremely common cestode of Merluccius spp. in many parts of Europe, from where it was originally described. Its distribution thus extends from Europe to the North American Atlantic and in the northwest Pacific. It has not been described from the Japanese Pacific, where extensive fish parasite studies have been carried out.

Family BOTHRIOCEPHALIDAE Blanchard, 1849, emended Wardle and McLeod, 1952

Genus Bothriocephalus Rudolphi, 1808, emended Lühe, 1899

Bothriocephalus scorpii (Müller, 1776)

Host: Delolepis giganteus Kittlitz, wry-mouth.

Location: pyloric caeca and intestine.

Locality: Gulf Islands, Strait of Georgia.

Six specimens were obtained from two fish. They measured in length, up to 150 mm. The parasites were evidently fairly young as only a few of the posterior segments were gravid. The specimens agreed closely with B. scorpii from New Brunswick as described and figured by

Cooper (1919), who reviewed the literature on this cestode. Hilmy (1929) again reviewed the literature and generally discussed B. scorpii.

Wardle (1932, 1933B) recorded this cestode from the Strait of Georgia in Leptocottus armatus, Enophrys bison, Chiropsis (= Hexagrammos) decagrammus, Lebius (= Hexagrammos) superciliosus, Myoxocephalus polyacanthocephalus and Apodichthys flavidus. He pointed out several minor differences between his Pacific specimens and Atlantic specimens, which were mostly noted in my specimens. The first segments are wider than long and funicular. The median proglottids are compressed and the posterior segments become longer with respect to width, but not longer than wide as found by Wardle (1932). This is possibly due to Wardle's specimens being longer than the ones from the wry-mouth, consequently the posterior segments being older, may have increased in length. Posteriorly each segment is divided into four secondary segments, each of which contains two sets of genitalia. The internal anatomy of the segments is similar to that described by Cooper (1919). In B. scorpii from the Atlantic, as described by Cooper, the anterior segments are longer than broad, with weakly prominent posterior borders, the middle and posterior segments much compressed and the posterior ones less so. The posterior segments are ultimately divided into thirty-two segments, each with a double set of genital organs.

Delolepis giganteus is a new host record for *B. scorpii*.

Sleggs (1927) recorded as *Dibothrium occidentale* Linton 1898 (= *Bothriocephalus occidentalis* (Linton)), a cestode from a species of *Sebastodes* in California waters. He did not describe the worm. Wardle (1932) believed that his figures resembled *B. scorpii* more than *B. occidentalis*.

Bothriocephalus scorpii has a wide geographical and host range (Cooper, 1919, Hilmy, 1929).

Family AMPHICOTYLIDAE Nybelin, 1922, emended Beaver and Simer, 1940

Sub-family AMPHICOTYLINAE Lühe, 1900, emended Nybelin, 1922

Genus *Eubothrium* Nybelin, 1922

Eubothrium oncorhynchi Wardle, 1932

Host: *Oncorhynchus keta* (Walbaum), chum salmon.

Location: pyloric ceaca and partially projecting into the intestine.

Locality: Strait of Georgia.

This cestode was commonly found in mature chum salmon returning via the Strait of Georgia to spawn in fresh waters connected with the Fraser River.

Wardle (1932) described this species from *Oncorhynchus tshawytscha* and *O. kisutch* from the same locality and later (1933B, 1952) he inferred that all five species of *Oncorhynchus* of the North American Pacific are hosts, although he did not specifically mention hosts other than *O. tshawytscha* and *O. kisutch*.

Eubothrium oncorhynchi is not known from any other locality.

Sub-family ABOTHRIINAE Nybelin, 1922

Genus *Abothrium* van Beneden, 1871

Abothrium gadi (van Beneden, 1871) (Fig. 10)

Hosts: *Gadus macrocephalus* (Tilesius), Pacific cod;
Theragra chalcogramma (Pallas), whiting.

Location: intestine.

Locality: Horseshoe Grounds, Hecate Strait and Gulf Islands, Strait of Georgia.

Abothrium gadi was found to be a common cestode parasite of these two Gadidae. It is apparently present along the whole coast of British Columbia. It is extremely common in marine gadids of Europe and the North American Atlantic, and in the same two hosts as reported here, in Japan. Yamaguti (1934B) recorded it as *Abothrium rugosum* (Goeze, 1782) from Japan. This is the first report of *A. gadi* in the North American Pacific.

Cooper (1919) dealt extensively with its morphology, having at his disposal specimens from the cod of the east coast of Canada. The scolex deformatus as described and figured by Cooper was seen in the Pacific specimens in some of its stages (Fig.10).

For many years two cestodes, Abothrium gadi and Eubothrium rugosum were confused one with the other and considered as one species, Abothrium rugosum, since rugosum had date priority over gadi. It was not until the work of Nybelin (1922) that these two species were shown to be distinct and the original name rugosum applied to the parasite of fresh water gadids, Lota lota maculosa and Lota vulgaris, for which Nybelin erected a new genus, Eubothrium. The specimens from marine Gadidae retained the generic name Abothrium and were reassigned the specific name gadi, used by van Beneden in 1871 for material from European marine codfish. Nybelin redescribed Abothrium gadi from European marine Gadidae.

PSEUDOPHYLLIDEA Plerocercoids

Seven different pseudophyllidean plerocercoids were found in five species of fish. No attempt was made to classify these larvae, as it is almost a hopeless task to do so.

Pseudophyllidea plerocercoid I (Fig. 11)

Host: *Oncorhynchus tshawytscha* (Walbaum), spring salmon (grilse).

Location: cyst in stomach wall.

Locality: Strait of Georgia.

A single plerocercoid of this type was recovered.

It is 4.35 mm. long, dorso-ventrally flattened, with a maximum breadth just posterior to the scolex, of 1.05 mm. The scolex, sharply demarcated from the body is 0.6 mm. long and gradually widens posteriorly. The breadth of the scolex anteriorly, in the middle, and posteriorly is respectively 0.08 mm., 0.28 mm. and 0.51 mm. The two dorso-ventrally located bothria, 0.55 mm. long, are narrow for most of their length, expanding considerably in the anterior quarter. The maximum breadth anteriorly is 0.12 mm., with a diameter of 0.01 mm. at the middle of their length. Immediately posterior to the scolex, the body widens to about twice the width of the scolex, giving the appearance of shoulders, and gradually tapers to a bluntly rounded posterior extremity. The body is not segmented but transverse striations are visible in the anterior three-quarters of its length. Two excretory ducts, one in each lateral half of the body, can be seen extending from the posterior margin of the scolex to about two-thirds the length of the body. They could not be traced further. The ratio of scolex length to total length is approximately 1:7.

This larval cestode resembles in general morphology, a plerocercoid described by Wardle (1932) as Diphyllobothrium sp. from the peritoneal surface of Oncorhynchus kisutch in the Strait of Georgia. However, Wardle's specimen was 35 mm. long. The ratio of scolex to total length was given as 1:10, fairly close to the 1:7 ratio for the specimen at hand. It is possible that these two specimens represent the larval stage of the same species. Wardle believed that his specimen was similar to a form described by Linton from Salmo mykiss in Yellowstone Lake, which is the larval stage of Diphyllobothrium cordiceps, parasitic in pelicans. The larva from the spring salmon also seems to bear some resemblance to the scolex of Cordicephalus arctocephalus Johnston, 1937, when in a certain state of contraction, as figured by Wardle, McLeod and Stuart (1947), These authors recorded C. arctocephalus from the fur seal in Alaska.

Pseudophyllidea plerocercoid II (Figs. 12 and 13)

Host: Oncorhynchus tshawytscha (Walbaum), spring salmon (grilse).

Location: cyst in stomach wall.

Locality: Strait of Georgia.

One specimen was obtained from the same host as the previously described plerocercoid.

The specimen is 3.5 mm. long, with a maximum width of 0.63 mm. just posterior to the scolex, from where it gradually tapers to the bluntly rounded posterior extremity. The body is not compressed, the depth being approximately the same as the width. The scolex, when viewed surficially is not constricted off from the body, but dorsal and ventral constrictions, evident when the specimen is viewed laterally, mark off the scolex from the growth zone. The scolex, 0.49 mm. long, 0.45 mm. wide at half its length and 0.55 mm. deep at the same level, is convex on the dorsal and ventral surfaces, but flat and tapering anteriorly on the lateral surfaces. The anterior width is 0.3 mm. The scolex is grooved anteriorly, both laterally and dorso-ventrally. The dorso-ventral groove is 0.06 mm. deep by 0.068 mm. wide. The two bothria, dorso-ventrally placed, are widest anteriorly (0.21 mm.), taper posteriorly, only to expand slightly at about one-half the length (0.083 mm. wide) and then tapers again to the posterior end (0.05 mm. wide). The bothria are 0.3 mm. long and have well developed muscular margins. When viewed surficially two excretory ducts in the lateral halves of the body can be seen passing posteriorly from the scolex to unite near the posterior extremity. The excretory pore is terminal. The scolex is 1/7 the body length.

Pseudophyllidea plerocercoid III (Fig. 14)

Host: Lepidopsetta bilineata (Ayres), rock sole.

Location: cyst in stomach wall.

Locality: Cape Lazo, Vancouver Island.

The single specimen obtained is about 15 mm. long with a maximum breadth of 0.98 mm., and dorso-ventrally flattened. The scolex, 1/12 the body length, is 1.28 mm. long by 0.8 mm. wide and is marked off from the body by a slight constriction. The sides of the scolex are almost parallel and the anterior extremity is rounded. The bothria, one dorsally and one ventrally, are 1.2 mm. long, widest anteriorly (0.225 mm.), and taper abruptly to slender grooves, 0.09 mm. wide at the middle of their length. The margins are muscular. The body tapers gradually to a bluntly rounded posterior extremity. Transverse wrinkles are present in the anterior 3.75 mm. of the body, disappear for about 3 mm. and reappear in the posterior half of the body and are again lacking in the posterior 1.65 mm. The excretory pore is terminal, the common excretory duct being 0.15 mm. long. The lateral excretory ducts could not be made out.

Pseudophyllidea plerocercoid IV (Fig. 15)

Host: Lepidopsetta bilineata (Ayres), rock sole.

Location: cyst in stomach wall.

Locality: Goose Island Grounds, Queen Charlotte Sound.

This specimen is 16 mm. long with a maximum breadth, posterior to the scolex, of 1.05 mm. The body is dorso-ventrally flattened and tapers posteriorly. Near the posterior extremity there is a notable constriction. Transverse striations are noticeable for most of the length of the body. The scolex, constricted off from the body, is 1.35 mm. long by 0.653 mm. wide at the middle. The lateral margins are nearly parallel and the anterior extremity is rounded. The surficial surfaces of the scolex are convex and the depth of the scolex is almost twice the width. From a lateral view, the scolex is oval in outline. The bothria, dorso-ventrally located, extend almost the full length of the scolex and are expanded anteriorly to a width of 0.263 mm. At the level of the middle, the width is 0.075 mm. The bothria are deep, with muscular margins. When viewed surficially, two lateral excretory ducts, arising near the scolex, can be traced to near the posterior extremity. The excretory pore was not seen.

This plerocercoid is very similar to the previous one described from the rock sole. They may possibly be of the same species. The notable difference between these two pseudophyllidean plerocercoids is the presence of the posterior constriction in the specimen from Queen Charlotte Sound. This specimen also possesses a more slender scolex.

Pseudophyllidea plerocercoid V

Host: Gadus macrocephalus (Tilesius), Pacific cod.

Location: cyst in stomach wall.

Locality: Horseshoe Grounds, Hecate Strait.

The one specimen collected from the cod is lacking the scolex. It is about 30 mm. long with a maximum breadth of about 0.9 mm. It tapers very gradually to a rounded posterior extremity. The anterior portion is transversely striated. Excretory ducts are not visible. The excretory pore is terminal.

Pseudophyllidea plerocercoid VI

From the body cavity of a dover sole (Microptomus sacificus) caught in Juan de Fuca Strait, a flat oval cyst measuring 3.5 mm. long by 2 mm. in maximum width, containing a coiled plerocercoid larva, was recovered. The larva was fixed within the cyst and its morphology could not be studied.

Pseudophyllidea plerocercoid VII

Three cysts, similar to the one from the dover sole, containing coiled pseudophyllidean larvae, were collected from the liver capsule of a sockeye salmon (Oncorhynchus nerka) caught in the Strait of Georgia. The cysts measured 6.5 mm. by 3.3 mm., 12 mm. by 8 mm. and 16 mm. by 8 mm., each with a prolongation at one extremity containing one end of the larva.

Class C E S T O D A R I A

Order AMPHILINIDEA Poche, 1922

Family AMPHILINIDAE Claus, 1879

Sub-family AMPHILINAE Poche, 1926

Genus Amphilina Wagener, 1858

Amphilina bipunctata Riser, 1948

Host: Acipenser transmontanus Richardson, white sturgeon.

Location: body cavity.

Locality: Mouth of Fraser River, British Columbia.

Only one sturgeon was available for examination during the course of this work. This fish yielded but a single specimen of an immature A. bipunctata. This species was created by Riser (1948) for six specimens of a cestodarian collected in 1923 from the coelom of an unidentified sturgeon caught near Dodson, Oregon, and has not been reported since.

The specimen from the white sturgeon, although markedly smaller than Riser's A. bipunctata, agrees with his detailed description of that species. The smaller size is undoubtedly due to immaturity as evidenced by the absence of eggs in the uterus. The specimen measured only 4.2 mm. long by 1.39 mm. in maximum breadth, whereas Riser's mature specimens measured 44-60 mm. long by 18-24 mm. in width. Measurements of other organs are as follows:

Apical organ -- depth	0.3 mm.
Bulbus propulsorius -- length	0.14 mm.
maximum width	0.082 mm.
Testes -- diameter	0.018 - 0.035 mm.
Ovary -- length	0.091 mm.
width	0.188 mm.
Seminal receptacle -- length	0.075 mm.
Vaginal pore lateral to male papilla	0.065 mm.

The ratio of body width to length and of size of organs to length of body is approximately the same in this specimen as in Riser's original material, except for the ratio of the apical organ to the total length. In Riser's specimens this structure measured 0.49-0.51 mm., a ratio of 1:90 to 1:120 as compared to 1:14 in the specimen from the white sturgeon. These measurements indicate that all organs, except the boring mechanism, grow at the same rate as the length and width of the body. The apical organ evidently grows much less rapidly, its final size being much smaller in relation to body length, than in an immature individual. The ratio of 1:90 for a 44 mm. individual and 1:120 for a 60 mm. individual supports this hypothesis. The distance between vaginal pore and male papilla, apparently does not change from immature to fully mature individuals. Riser described the vitellaria as tubular and suggested that "possibly, younger specimens would show a follicular development." The specimen at hand confirmed Riser's supposition.

The characters that Riser elucidated as differentiating his species from previously described ones, were noted in my specimens.

Other species of *Amphilina* are *A. foliacea* Rudolphi, 1819, the type of the genus, from *Acipenser sturio* of Europe; *A. neretina* Salensky, 1874, very similar to *A. foliacea* and also from *A. sturio* in Europe; and *A. japonica* Goto and Ishii, 1936 from *Acipenser mikado* in Japan. All described species of *Amphilina* are from sturgeons. Wardle and McLeod (1952) believe that the four species are possibly synonymous.

Class A C A N T H O C E P H A L A

Order PALAEACANTHOCEPHALA Meyer, 1931, emended Van Cleave, 1936

Family ECHINORHYNCHIDAE Cobbold, 1879.

Genus *Echinorhynchus* Zoega in Müller, 1776

Echinorhynchus gadi Zoega in Müller, 1776

Hosts: *Gadus macrocephalus* (Tilesius), Pacific cod; *Theragra chalcogramma* (Pallas), whiting; *Lepidopsetta bilineata* (Ayres), rock sole; *Eopsetta jordani* (Lockington), brill.

Location: intestine.

Locality: Horseshoe Grounds, Hecate Strait; Gulf Islands, Strait of Georgia; Cape Lazo, Vancouver Island; Cape Scott, Vancouver Island.

The material studied consisted of three females from the cod, four females from the rock sole, three females from the brill and nine each of males and females from the whiting.

Lühe (1911) described this cosmopolitan acanthocephalid in some detail. Van Cleave (1925), Markowski (1933) and Yamaguti (1935) also gave brief characterisations and measurements of this parasite. Van Cleave has stressed the extreme variability in form and size of the parasite indicating that these differences are possibly influenced by the host species. Nigrelli (1946) has found a high degree of variability between specimens from the same host. Linton (1933) after studying specimens from many hosts from the United States Atlantic seaboard, showed that the variations exist in certain details and size of structures as well as in size and form of the body.

The following measurements (Table 3) were obtained from the specimens from the different hosts. All measurements are in millimeters, except the size of the hooks and eggs, which are given in microns.

The hooks at the base of the proboscis are smaller than the rest. The measurements of these hooks are the lower limits cited for hook size. The 16 mm. and 12 mm. long females from <u>Eopsetta</u> and <u>Lepidopsetta</u> were immature. Nigrelli (1946) has stated that females only reach maturity

TABLE 3

MEASUREMENTS OF *ECHINORHYNCHUS GADI* FROM DIFFERENT HOSTS

Host		Length	Breadth	Proboscis	Proboscis Sheath	Proboscis Hooks	Size of Hooks	Lemnisci	Eggs
Lepidopsetta	Female	12-36	0.54-1.2	0.60-0.71 x 0.19-0.26	1.31-1.65 x 0.27-0.31	19-20 rows x 12	34-52	7/10-7/8 length of sheath	65-78 x 13-19
Eopsetta	Female	16-28	0.72-0.78	0.68-0.70 x 0.18-0.26	1.1-1.84 x 0.26-0.30	18-21 rows x 12-13	33-52	1/2-2/3 length of sheath	70-79 x 16-18
Gadus	Female	27-38	0.92-1.1	0.62-0.74 x 0.20-0.25	1.3-1.9 x 0.25-0.32	19-20 rows x 12-13	32-55	1/2-2/3 length of sheath	108-128 x 23-27
Theragra	Female	25-40	1-1.13	0.60-0.75 x 0.19-0.26	1.2-2.1 x 0.26-0.31	19-20 rows x 12	30-56	1/3-2/3 length of sheath	112-130 x 24-30
	Male	13-17	0.68-1.09	0.64-0.75 x 0.18-0.20	1.15-2.1 x 0.25-0.32	19-20 rows x 12-14	30-54	1/3-5/7 length	Testes 1.5-2 x 0.3-0.48

when they are about 20 mm. long. Ekbaum (1938) found specimens in the Pacific salmon up to 25 mm. long, all of which were immature. The color of living E. gadi has been described as either white, red or orange, the last color applying to all my specimens.

A very noticeable difference occurred between the egg size of specimens from the Pleuronectidae (Lepidopsetta and Eopsetta) and of specimens from the Gadidae (Gadus and Theragra). No other differences between specimens from these two families of fish were evident, and thus the egg size is not considered to constitute a specific difference. Some of the rock soles and the cod were caught in the same locality and at the same depth, indicating that the difference in egg size of E. gadi specimens from these two hosts is probably due to a host influence. The egg size of E. gadi is known to be highly variable. Van Cleave (1925) cited 76µ long by 13µ in diameter and Nigrelli (1946) gave the measurements as 80µ by 10µ for specimens from the American Atlantic coast. For European specimens Lühe (1911) recorded 76µ by 13µ and Markowski (1933) cited 108-117µ by 22-24µ. Yamaguti (1935) gave 111-138µ by 24-30µ as egg size of specimens from Gadus macrocephalus and Theragra chalcogramma from the sea of Japan. From two other hosts Yamaguti cited 69-75µ by 13-15µ and 75-84µ by 14-20µ. The size of the eggs from gadid specimens from Japan is about the same as the size recorded from the same hosts from British Columbia.

Ekbaum (1938) recorded *E. gadi* from British Columbia salmon caught in and around Departure Bay, Vancouver Island and at the mouth of the Fraser River. In no cases were mature parasites found. *Cyphocaris challengeri* Stebbing, an amphipod, was found to be the intermediate host of *E. gadi* responsible for the salmon infestations. There appears to be only one host necessary for the completion of the life cycle. Ekbaum indicated that other hosts of *E. gadi* occur in British Columbia waters, but did not mention them. Yamaguti (1935, 1939) recorded this acanthocephalid from twelve hosts, including *G. macrocephalus* and *T. chalcogramma* from the Japanese Pacific. *Echinorhynchus gadi* is here reported from *G. macrocephalus* and *T. chalcogramma* from British Columbia for the first time and the two flounders, *Eopsetta jordani* and *Lepidopsetta bilineata* are new host records for this parasite.

Family GORGORHYNCHIDAE Van Cleave and Lincicome, 1940

Genus *Gorgorhynchus* Chandler, 1934

Gorgorhynchus sp.

Host: *Thunnus alalunga* (Gmelin), albacore.

Location: intestine.

Locality: Pacific Ocean, between Cape Blanco, Oregon and Cape Mendecino, California, 45-85 miles off shore.

Two males and one female were recovered from the stomach of one of twelve albacore examined. In one male, and the female, the proboscis is completely retracted. In the other male the proboscis is slightly everted.

Description: Male: The body is cylindrical 5.7-6.0 mm. long, and tapers slightly to bluntly rounded anterior and posterior extremities. The maximum width (0.7-0.9 mm.) is at the posterior level of the proboscis sheath. Anteriorly the diameter is 0.45 mm. and posteriorly it is 0.26-0.30 mm. Anteriorly there are a few scattered spines in a single field extending ventrally about one-quarter the length of the lemnisci. They are more numerous ventrally than dorsally. The spines are deeply embedded, covered with cuticle and measure (including the embedded portion) 58-67μ long by 33-35μ wide at the base. The free portion is 38-42μ long. The retracted proboscis, approximately 1/6 body length, is 0.96-0.98 mm. by 0.08 mm. The posterior three or four rows of hooks can be seen in one specimen. They are heavier and more strongly curved on the ventral side but of the same length, about 42μ. There appears to be eleven or twelve longitudinal rows of hooks. The number of hooks per row could not be determined nor the nature of the hooks other than the few at the base of the proboscis. There does not appear to be a distinct group of hooks at the base of the proboscis. The slender lemnisci, 1 mm. long, are one-half the length of the proboscis sheath (when proboscis is retracted). The double walled proboscis sheath is 1.85-1.91 mm. long. The oval, elongated testes, situated one behind the other, occupy the middle one-third of the body. The anterior testis, 0.825 mm. by 0.375 mm. is overlapped anteriorly by the proboscis sheath. The posterior testis, 0.835-0.877 mm. by 0.338 mm., is slightly overlapped by the anterior testis and posteriorly by the anterior pair of cement glands. The four cement glands, arranged in two pairs, are elongated oval and occupy two-ninths to two-sevenths the body length (1.26-1.76 mm. long) and are 0.98-1.12 mm. from the posterior extremity. They completely fill the diameter of the body. The posterior pair of cement glands overly most of the anterior cement glands. The genital sheath is 0.6-0.72 mm. long. The bursa is retracted in both specimens.

Female: The general body shape is the same as the male, the length being 14.1 mm. The body hooks are more numerous than in the male, but of the same size, and extend to one-half the length of the lemnisci. The lemnisci are slender and measure 1.16 mm. long (1/3 length of the proboscis sheath). The completely retracted proboscis is 1.31 mm. long (1/11 total length of body). The eggs are 67-75μ long by 16-17μ in diameter. There are three shells, the middle one being elongated at the poles. The large number of eggs present obscured the female genital complex.

From the above description it is evident that the parasite belongs to the family Gorgorhynchidae Van Cleave and Lincicome, 1940, which is separated from Rhadinorhynchidae Travassos, 1923, emended Van Cleave and Lincicome, 1940 on the basis of possessing four cement glands instead of eight in the male. According to the key to genera of Gorgorhynchidae as set forth by Van Cleave and Lincicome (1940), these specimens would belong close to Gorgorhynchus Chandler, 1934 and Nipporhynchus Chandler, 1934, emended Van Cleave and Lincicome, 1940. These two genera are separated on the basis of a prominent group of hooks present on the base of the proboscis in Nipporhynchus and absent in Gorgorhynchus. Since this prominent group of hooks does not seem to be present, these specimens are being assigned to Gorgorhynchus. As the arrangement, number, form and size of proboscis hooks cannot be completely described, the acanthocephalids recorded here cannot be identified with any certainty. A more accurate description and specific identification awaits examination of further material.

Family POLYMORPHIDAE Meyer, 1931

Genus Corynosoma Lühe, 1904

Corynosoma strumosum (Rudolphi, 1802), juvenile.

Host: Eopsetta jordani (Lockington), brill.

Location: encysted in liver capsule.

Locality: off Sydney Inlet, west coast of Vancouver Island.

A single juvenile male specimen was found. It was encysted in the connective tissue capsule of the liver, the parasite being enclosed in a closely applied fibrous tissue capsule about 55µ thick. This was the only specimen found in several hundred of these flounders examined throughout the summer of 1951. Another flounder, Lepidopsetta bilineata, also examined in large numbers from the west coast of Vancouver Island did not yield any specimens of juvenile Corynosoma. This would indicate that these two flat fish of this area do not play an important role as transport hosts for the species of Corynosoma known to parasitize marine mammals of the North American Pacific coast.

The specimen has been assigned to C. strumosum on the basis of body shape, morphology of internal organs and distribution of body spines. The proboscis is retracted, consequently the proboscis hooks could not be studied.

Corynosoma strumosum juveniles have been reported from Platichthys stellatus and Lepidopsetta bilineata from Departure Bay, Vancouver Island by Ekbaum (1938). The final host for C. strumosum in the northwest Pacific has been found to be the harbour seal (Phoca vitulina richardii). Ball (1930) recorded more than 1000 of these parasites from the intestine of one seal in California. Scheffer and Slipp

(1944) found this parasite in the harbour seal in Washington State and Van Cleave (personal communication to Dr. T. W. M. Cameron) identified it from the harbour seal in Alaskan waters. I have collected several immature males and females of C. strumosum from two seals in British Columbia waters. One was caught at the mouth of the Fraser River and the other in Knight Inlet.

Eopsetta jordani is recorded for the first time as harbouring a species of Corynosoma. Gregoire and Pratt (1952) examined large numbers of this fish from Oregon but did not record any acanthocephalids. This emphasizes the rarity of C. strumosum in the brill. In view of the wide distribution and migration habits of Phoca vitulina of the North American Pacific coast, it is to be expected that a variety of fish species over this same range could harbour the juvenile stages of C. strumosum.

Two other species of Corynosoma, C. osmeri Fujita, 1921, which is very similar to, if not identical with C. strumosum and C. obtuscens Lincicome, 1943, were described from the California sea-lion (Zalophus californianus) by Lincicome (1943). Ward and Winter (1952) recorded the juvelines of these two species from a croaker (Umbrina roncador) in southern California waters. Neither of these hosts occur in British Columbia waters. The northern limit of the California sea-lion is Point Reyes, California (Bonnott, 1951).

Class N E M A T O D A

Order TRICHUROIDEA Railliet, 1916

Family TRICHURIDAE Railliet, 1915

Sub-family CAPILLARIINAE Railliet, 1915

Genus Capillaria Zeder, 1800

The genus Capillaria was created by Zeder in 1800 to include certain parasitic nematodes from birds. Since then a vast number of species have been described, particularly from birds, but also from mammals, reptiles, amphibians and fish. To date, at least thirty species have been described from fish, three more species are known only from their eggs, and the females of two further species and the male of one species have been referred to in the literature but were not described. One larval form was described by Moorthy (1938) from cysts in the mucus coat or peritoneal layer of fresh water fish in ponds in India. Of the thirty described species, ten are known only by the females and one only by the male. Many of these species have been inadequately described, often the descriptions being based on one or two specimens, on incomplete worms and even the eggs alone. Unfortunately, this cannot be remedied easily, as capillariid infestations in fish appear to be very light. Consequently, little is known about the variations, particularly in size, within a species. It is very likely that throughout the whole genus many of the accepted species are synonyms. The descriptions based on so few specimens indicate capillariid nematodes possibly are not common parasites of fish, although they are world-wide in distribution. On the other hand, these nematodes might be overlooked easily, because of their small size.

The genus Capillaria is circumpolar in distribution. Species from fish have been reported from Australia (Johnston and Mawson, 1940, 1944, 1945A, 1947, 1949), Tasmania and the sub-antarctic (Johnston and Mawson, 1945B), Brazil (Freitas and Lent, 1935), Japan and Japanese Sea (Yamaguti, 1935B, 1941, Layman, 1930), United States (Van Cleave and Mueller, 1932, Mueller and Van Cleave, 1932, Read, 1948, Pearse, 1924, MacCallum, 1925, 1926), England (Baylis and Jones, 1933), Scotland (Hesse, 1923) and various parts of Europe (Heinze, 1933, Freitas and Lent, 1935).

In North America, C. bakeri (Mueller and Van Cleave, 1932) Freitas and Lent, 1935, C. catenata Van Cleave and Mueller, 1932 and C. catostomi Pearse, 1924 have been described from fresh water fish. Capillaria hathawayi Read, 1948, named from one female, was recorded from Squalus acanthias in the Gulf of Mexico. Capillaria carcharhini MacCallum, 1925 and C. spinosa MacCallum, 1926 were named from the eggs only which were found in Carcharhinus lamna and Carcharhinus milberti of the Atlantic coast of the United States. The last three hosts are selachians. Capillariid nematodes have not been reported from marine teleosts either on the

Pacific or Atlantic seaboard of North America or from any fish in Canada or the Pacific coast of North America. The first such report is presented in this thesis. Three new species are here described from two genera of flounders and an eel pout from the coastal waters of British Columbia. Baylis and Jones (1933) reported the presence of, but did not describe a species of Capillaria in a related flounder (Pleuronectes platessa) from Plymouth, England. Layman (1930) described C. helenae and Yamaguti (1934B) described an unnamed species, and the eggs of another species from marine teleosts in northeastern Asiatic waters adjoining the Pacific Ocean. My specimens do not agree with descriptions of these species, nor do they fit the descriptions of any species recorded from fish.

Unfortunately, my material was very scanty and I was thus unable to study variations within the species. However, since they differ from the descriptions and figures of other species, I am naming them as new.

Heinze (1933) and Freitas and Lent (1935) have reviewed the literature on capillariids of fish up to the date of their publications. Their works have been extremely useful. In the following list of species of Capillaria from fish, the species described up to 1935 are taken from the paper by Freitas and Lent.

C. gracilis (Bellingham, 1840) Travassos, 1915

C. tomentosa (Dujardin, 1843) Travassos, 1915 (Female only)

C. brevispicula (Linstow, 1873) Travassos, 1915

C. tuberculata (Linstow, 1914) Travassos, 1915

C. fritschi Travassos, 1914 (Female only)

C. leucisci Hesse, 1923

C. catostomi Pearse, 1924 (Female only)

C. sentinosa Travassos, 1927

C. piscicola Travassos, Artigas and Pereira, 1928

C. helenae Layman, 1930

C. bakeri (Mueller and Van Cleave, 1932) Freitas and Lent, 1935

C. catenata Van Cleave and Mueller, 1932

C. lewaschoffi Heinze, 1933

C. pterophylli Heinze, 1933

C. maxillosa Vaz and Pereira, 1934

Capillaria sp. Yamaguti, 1935 (Female only)

C. carioca Freitas and Lent, 1937 (Male only)

C. magalhaesi Lent and Freitas, 1937

Capillaria sp. larva, Moorthy, 1938

C. plectroplites Johnston and Mawson, 1940

C. murrayensis Johnston and Mawson, 1940 (Female only)

C. tandeni Johnston and Mawson, 1940

C. mogurndae Yamaguti, 1941 (Female only)

C. ugui Yamaguti, 1941 (Female only).

C. lepidopodis Johnston and Mawson, 1944 (Female only)

C. rhinobati Johnston and Mawson, 1945

C. latridopsis Johnston and Mawson, 1945

C. tasmanica Johnston and Mawson, 1945

C. cooperi Johnston and Mawson, 1945

C. physiculi Johnston and Mawson, 1945

C. hathawayi Read, 1948 (Female only)

Species inquirenda

C. carcharhini MacCallum, 1925 (Eggs only)

C. spinosa MacCallum, 1926 (Eggs only)

Capillaria sp. Yamaguti, 1935 (Eggs only)

Capillaria sp. Baylis and Jones, 1933 (Female only, not described)

Capillaria sp. Baylis and Jones, 1933 (Female only, not described)

Capillaria sp. Johnston and Mawson, 1949 (Male only)

Capillaria lepidopsettae n. sp. (Fig. 16)

Host: Lepidopsetta bilineata (Ayres), rock sole.

Location: intestine.

Locality: Goose Island Grounds, Queen Charlotte Sound.

Only one female was found in one of the many hosts examined.

Description: Slender, 16.6 mm. long, tapering gradually anteriorly, with an attenuated, rounded posterior extremity. The maximum diameter is 0.109 mm., with a diameter of 0.068 mm. at the base of the oesophagus and 0.012 mm. just behind the anterior extremity. The non-striated cuticle is 1.5µ thick. Bacillary bands are not visible. The anterior extremity is bluntly rounded, with a simple mouth leading into the oesophagus which is 5.51 mm. long. The oesophageal tube (before commencement of the para-oesophageal cells) is 0.44 mm. long. There are about forty para-oesophageal cells, which increase in size posteriorly. The posterior cells have crenulated margins. They measure 0.075 mm. to 0.15 mm. long. The nuclei of these cells, usually round but sometimes oval, are 0.017-0.035 mm. in diameter. The intestine gives rise to a rectum, 0.077 mm. long. The subterminal anus is 0.014 mm. from the posterior extremity. The vulva with a slightly prominent anterior lip, is 0.035 mm. behind the oesophagus and divides the body into the ratio of 1:2. The muscular vagina is 0.1 mm. long. The eggs, sometimes constricted at the center, measured near the vulva are 75µ long by 40µ in diameter. A non-striated, smooth inner egg shell, 3µ thick, extends along the sides of the polar plugs. This shell is enclosed in an outer smooth shell up to 5µ thick laterally, but less than 1µ at the poles. The more posterior eggs have a thinner egg shell.

The male is unknown.

This nematode differs from most species of Capillaria in fish in its length. Other species of similar size are C. fritschi Travassos, 1914, C. pterophylli Heinze, 1933, C. catenata Van Cleave and Mueller, 1932, C. maxillosa Vaz and Pereira, 1934, C. murrayensis Johnston and Mawson, 1940, C. lepidopodis Johnston and Mawson, 1944, C. rhinobati Johnston and Mawson, 1945 and C. latridopsis Johnston and Mawson, 1945. C. fritschi differs from C. lepidopsettae in possessing cuticular papillae, in having a terminal anus and a prominent mouth opening. C. rhinobati has a terminal anus, the posterior extremity ends abruptly and the eggs are smaller and with only one thin shell. The remaining species differ from C. lepidopsettae in the ratio of anterior to posterior portions of the body and in size and shape of the egg and character of the egg shell. Other individual differences also occur.

The specific name of the parasite is derived from the generic name of the host.

Capillaria parophrysi n. sp. (Fig. 17)

Host: Parophrys vetulus (Girard), lemon sole.

Location: intestine.

Locality: Gulf Islands, Strait of Georgia.

A single female comprises the material on which this species is based.

Description: The slender nematode is 10.8 mm. long and tapers gradually anteriorly. The diameter at the head, the base of the oesophagus and the maximum diameter are 0.008 mm., 0.053 mm. and 0.084 mm. respectively. The cuticle is smooth, striated and 3.34µ thick. Bacillary bands were not seen. The anterior end is rounded and bears a simple mouth. The oesophagus 3.5 mm. long, consists of two regions. The anterior portion, 0.375 mm. long is a simple tube free of cells, while the greater portion passes through a single row of para-oesophageal cells, which are about forty in number. The cells are 0.050-0.093 mm. long, the posterior ones having crenated margins. The nuclei, not clearly visible in many cells, were not measured. The rectum is 0.040 mm. long. The anus is sub-terminal, opening a short distance anterior to the rounded posterior extremity of the worm. The simple vulva is 0.053 mm. posterior to the oesophagus and divides the body into the ratio of 1:2.05. The muscular vagina is 0.116 mm. long. The eggs, slightly constricted at the middle, are 66µ long by 23µ in diameter. The egg shell is thin (1.67µ), smooth and faintly striated.

Male unknown.

This species differs from C. lepidopsettae in the following characters.

(1) smaller size (however, the vulva divides the body into the same ratio)

(2) posterior end tapers gradually -- attenuated in lepidopsettae

(3) thicker and striated cuticle (3.34μ thick as compared to 1.5μ thick and non-striated in lepidopsettae)

(4) eggs smaller, only one egg shell that is thinner than corresponding shell of lepidopsettae (1.67μ compared to 3μ), and faintly striated (non-striated in lepidopsettae)

(5) no prominent vulvar lip.

Other species of a similar size and ratio of anterior to posterior portion of the body in the female are C. catostomi Pearse, 1924, C. leucisci Hesse, 1923 and C. mogurndae Yamaguti, 1941.

Capillaria parophrysi differs from C. catostomi in possessing about forty para-oesophageal cells as compared to 187, in having a striated cuticle, in the form and size of the eggs and the striated egg shell. C. leucisci can be distinguished from C. parophrysi by the presence of a non-striated cuticle, the shape of the egg and the conspicuous lateral bacillary bands. Capillaria mogurndae has larger eggs and the egg shell carries minute tubercles.

The specific name is derived from the generic name of the host.

Capillaria lycodi n. sp. (Fig. 18)

Host: Lycodes brevipes (Bean), short-finned pout.

Location: intestine.

Locality: English Bay, Vancouver.

Two females are the basis of the following description.

Description: The worms are long (15.1 and 15.5 mm.) and slender, tapering gradually anteriorly. The diameters at the head, at the base of the oesophagus and the maximum diameter are respectively 0.010 and 0.011 mm., 0.075 mm. and 0.105 mm. for the two specimens. The cuticle is striated and bears many large papilla-like projections (tubercles), particularly in the oesophageal region. They are irregularly placed and decrease posteriorly. Bacillary bands were not visible. The posterior extremity is rounded. In the specimen 15.1 mm. long, two small anterior projections, one on each of the dorsal and ventral surfaces, surround the mouth. These are not visible in the other specimen. The oesophagus is 5.6 and 6.1 mm. long. The anterior tubular portion, free of cells, is 0.035 mm. and 0.04 mm. long. The para-oesophageal cells, about forty in number, increase in size posteriorly. They measure 0.067-0.183 mm. long and 0.067-0.150 mm. long in the two specimens. The nuclei are oval elongated, the largest, measuring 0.030 mm. long by 0.019 mm. in diameter. The rectum is 0.080 and 0.090 mm. long. The anus is terminal. The vulva is 0.050 and 0.060 mm. posterior to the oesophagus and divides the body into the ratio of 1:1.68 and 1:1.51. The vagina is 0.2 mm. long. Its distal portion is modified into a funnel-shaped structure which can be everted or retracted within the vagina proper. In the 15.1 mm. specimen it is retracted. It is everted in the other specimen. The eggs are 71-72µ long by 24-28.4µ in diameter. Many of the eggs are slightly constricted at the middle. The finely serrated egg shell is 3.3µ thick and extends along the sides of the polar plugs. There is an irregular outer shell, not included in the dimensions of the egg.

This species differs from C. lepidopsettae in the following characters:

(1) anus is terminal (sub-terminal in lepidopsettae)

(2) posterior extremity not attenuated as in lepidopsettae

(3) two anterior projections surrounding the mouth (absent in lepidopsettae)

(4) striated cuticle with tubercles (non-striated and smooth in lepidopsettae)

(5) ratio of anterior to posterior portion of body 1:1.5 as compared to 1:2 in lepidopsettae

(6) longer vagina and peculiar structure of distal extremity in lycodi

(7) narrower eggs with finely serrated inner shell and irregular outer shell (both smooth in lepidopsettae)

It differs from C. parophrysi as follows:

(1) length of worm

(2) relatively longer oesophagus in lycodi

(3) projections surrounding the mouth (absent in parophrysi)

(4) terminal anus (sub-terminal in parophrysi)

(5) tubercles on cuticle (absent in parophrysi)

(6) longer vagina and peculiarity of distal extremity in lycodi

(7) larger eggs with two shells, the inner shell non-striated but finely serrated (only one smooth and striated shell in parophrysi)

Capillaria lycodi is very similar to C. fritschi Travassos, 1914. From the brief desctiption of C. fritschi (in Freitas and Lent, 1935), it would appear that it is almost identical with C. lycodi, the only difference being the non-attenuated, rounded posterior extremity in the female of C. lycodi. The character of the eggs and vulva, the body proportions and other minor characters are not given for C. fritschi. I am considering C. lycodi as a new species. The specific name is derived from the generic name of the host.

Order ASCAROIDEA, Railliet and Henry, 1915
Family HETEROCHEILIDAE Railliet and Henry, 1915
Sub-family ANISAKINAE Railliet and Henry, 1912
Genus Contracaecum Railliet and Henry, 1912

Contracaecum aduncum (Rudolphi, 1802)

Hosts: Gadus macrocephalus (Tilesius), cod; Theragra chalcogramma (Pallas), whiting; Ophiodon elongatus Girard, lingcod; Hippoglossoides elassodon Jordan and Gilbert, flat-head sole; Eopsetta jordani (Lockington), brill; Parophrys vetulus Girard, lemon sole; Glyptocephalus zachirus Lockington, rex sole; Hypomesus pretiosus (Girard), silver smelt; Delolepis giganteus Kittlitz, wry-mouth; Oncorhynchus nerka (Walbaum), sockeye salmon; Oncorhynchus kisutch (Walbaum), coho salmon (grilse); Sebastodes ruberrimus Cramer, red snapper; Sebastodes alutus (Gilbert), long-jawed rock-fish.

Location: stomach and intestine.

Locality: Baynes Sound, Vancouver Island; off Sydney Inlet, west coast of Vancouver Island; Gulf Islands, Strait of Georgia; Cape Scott, Vancouver Island; Firing range, west coast of Vancouver Island; Nootka, west coast of Vancouver Island; Strait of Juan de Fuca; Horseshoe Grounds, Hecate Strait; Point Gray, Vancouver, Strait of Georgia.

A large number of male, female and immature specimens, ranging in length from 4.2 to 101 mm. were collected. from the digestive tracts of the many host species mentioned. The parasite is evidently widespread in British Columbia waters, having been recorded from the most northerly to the most southerly regions of the mainland coast and around Vancouver Island.

The material agrees in all characteristics with the detailed descriptions of Kahl (1936) and Punt (1941). Kahl and many other authors recorded this parasite as _C. clavatum_ (Rudolphi, 1809) Baylis, 1920. Punt presented sound arguments to show that _C. clavatum_ is a synonym of _C. aduncum_. Johnston and Mawson (1943, 1945B) state that _Contracaecum clavatum_ (= _Ascaris clavata_ Rudolphi, 1809), was just a renaming of _Ascaris gadi_ Mueller, 1776, consequently the valid name should be _Contracaecum gadi_ (Mueller, 1776). The decision of these authors apparently rested on the fact that both these species were described from European marine gadids, since, as Punt pointed out, neither Ascaris gadi Mueller, 1776 nor Ascaris clavata Rudolphi, 1809 could be specifically recognized by their original descriptions and figures. Ascaris clavata can only be recognized now, since Rudolphi's type specimens were redescribed and drawn by A. Schneider (1886). I am in agreement with Punt that this common nematode of marine fish, particularly of gadids, should be known as Contracaecum aduncum (Rudolphi, 1802) and Ascaris gadi Mueller, 1776 can only be considered as a species inquirenda or nomen nudum.

Punt drew attention to the wide variability in the size of specimens and correspondingly of internal structures, even within the same host. Absolute measurements therefore are of no significance in specific diagnosis.

Smedley (1934) described C.magnum from Ophiodon elongatus, leptocottus armatus and Apodichthys flavidus, caught in the Strait of Georgia. Punt realized that this species was very similar to C. aduncum from European marine fish, and probably identical with it. He stated, "La description de Contracaecum magnum Smedley, 1934 d'Ophiodon elongatus Girard et d'autres correspond jusque dans les details a celle de Contracaecum aduncum (Rud.) avec le seul difference, que le caecum intestinal n'aurait que la moitie de la longeur de l'appendice oesophagien. Les mesures, que l'auteur mentionne pour un male, demontrent que ces appendices ont une longeur respectivement de 2:8

et 2.1 mm., un rapport qui est egalement normal chez C. aduncum." Punt evidently misinterpreted Smedley's statement concerning the relative length of the intestinal caecum. She stated that it is approximately one-half the length of the oesophagus and not one-half the length of the oesophageal appendix. According to Punt, the oesophageal appendix and intestinal caecum in C. aduncum are usually nearly equal in length, the intestinal caecum being somewhat longer than the appendix in the female. Such is actually the case in the specimens for which Smedley gave measurements and in most of my specimens. However, in some specimens the caecum was twice the length of the appendix and occasionally the appendix was slightly longer than the caecum. It should be stressed that the length of the intestinal caecum is highly variable, and therefore of no diagnostic value, a point which has been noted previously by Baylis (1916), Dollfus and Desportes (1945) and Nigrelli (1946) in discussing Porrocaecúm spp. Punt finally stated, in discussing C. magnum, that the oesophageal length as given by Smedley does not fall within the range cited for C. aduncum. However, his material, as extensive as it was, did not contain any specimens as large as those for which Smedley gave detailed measurements. Earlier in his paper, Punt stressed the uselessness of absolute measurements as criteria for defining this species. It therefore seems that his statement regarding the longer oesophagus in

C. magnum than in *C. aduncum* is valueless, particularly since the ratio of oesophagus to total length of *C. magnum* falls within the range cited for *C. aduncum*. Because of this apparent difference in oesophageal lengths, Punt hesitated to reduce *C. magnum* to synonymity with *C. aduncum*, reserving this decision until more specimens were examined and measured.

In my specimens measurements of many of the worms fall within the range cited by Punt for *C. aduncum*, and some larger specimens agree with the measurements of Smedley. Some of my *Contracaecum* specimens were collected from the same host and locality (*Ophiodon elongatus* from the Strait of Georgia (Baynes Sound)) as those examined by Smedley, and are undoubtedly similar to them. Several minor points of variation occur between my specimens and the description of Smedley. The ratio of the length of the intestinal caecum to length of oesophagus varies from approximately 1:4 to 1:2, the latter ratio only being cited by Smedley. Her ratio of oesophageal length to body length for a 93 mm. male and an 83 mm. female are respectively 1:15 and 1:14. In my specimen this ratio, in mature males of lengths 18-71 mm. is between 1:10 and 1:15.3, in mature females of lengths 30-101 mm., 1:9 to 1:14 and in immature specimens of 4.2 to 24 mm. long, it is 1:6.1 to 1:10. In general, the smaller ratio represents the shorter specimens. The ratio of 1:15.3 was found in a male specimen 57 mm. long. Other males, 55-58 mm. long, gave values of 1:12.6 to 1:14, demonstrating that there is a certain amount of variation in the length of the oesophagus, even within specimens of practically the same length. The 71 mm. male had a ratio of oesophagus length to body length of only 1:12.1. However, it still appears that the ratio of oesophagus to total length usually increases with increase in length of the worm. The ratio of tail length to total length also increases with increased body length, again demonstrating that various regions of the body grow at different rates. Punt has discussed these points in some detail. In Smedley's description of the lips, she stated that there are two papillae on each ventro-lateral lip, but does not mention the presence of an amphid on each of these lips. One of the papillae on each lip is very prominent, while the other is smaller, frequently difficult to see or may not be present at all. Smedley did not mention the four glands at the proximal end of the spicules, nor does she refer to the presence of the many spines on the terminal tail process, although her figure seems to indicate this character. The bilobed nature of the labial pulp is figured by Smedley, although it is not referred to in the text. These characters are common to C. aduncum individuals. The presence of a dorsal constriction of the body of the female at the level of the vulva, which Smedley described as being characteristic of C. melanogrammi

Smedley, 1934, is present in one of my large specimens. This character seems to lend some support to Punt's discussion on the possible identity of C. melanogrammi, from the intestine of Melanogrammus aeglefinus of the Canadian Atlantic, with C. magnum (= C. aduncum).

Since the Contracaecum specimens I have examined are similar to those Smedley described as C. magnum, and to C. aduncum, I consider C. magnum Smedley, 1934 as a synonym of C. aduncum (Rudolphi, 1802).

Contracaecum aduncum has an extremely wide host range in European fishes, no less than fifty-two species from the North Sea and off the coast of Portugal, have been recorded as hosts by Punt. Kahl (1936) also recorded it as common in the North Sea. Markowski (1933) reported it from a large number of fishes in the Baltic and it has been recorded from the Mediterranean by several authors. From the North American Atlantic, Linton (1900) in the United States, recorded it as Ascaris clavata and Heller (1949) recorded it from Canada. Baylis (1929) described it from gadids off the Falkland Islands (as C. clavatum). From fishes of Japanese coastal waters Yamaguti (1935B) described C. gracile Yamaguti, 1935 and C. pagrosomi Yamaguti, 1935 and in fishes of Chinese coastal waters Hsü (1934) described C. amoyensis Hsü, 1934. Punt considered these three species as probable synonyms of C. aduncum. The presence of C. adumcum in a wide range of fishes in North American Pacific waters adds proof to its circumpolar distribution and lack of host specificity. The hosts include pelagic fish and deep water and shallow water bottom fish. Punt's host list includes selachians as well as teleosts, but no fully mature specimens were recovered from selachians, indicating that the nematode may not reach maturity in these hosts.

Kahl (1939) and Punt claim that the largest host fish harbour the largest specimens of C. aduncum. This is not completely borne out in this study (although the largest specimen, a 101 mm. long female, was from a cod, one of the largest of my recorded hosts) as some of the larger specimens (60-70 mm. long) were taken from the intestine of the silver smelt, a fish which attains a maximum length of about ten inches.

ANISAKINAE Railliet and Henry, 1912, larvae

Three types of nematode larvae belonging to the sub-family Anisakinae were found encysted in various organs and the musculature of many species of fish. There were recognized essentially the three types of cysts described by Johnston and Mawson (1945B). The first type was somewhat lenticular, containing a coiled larva and often occurred in masses on the liver and mesenteries, particularly around the digestive tract. The second type of cyst was somewhat oval and elongated and contained a less coiled larva. These occurred in the musculature. The third type of cyst was usually long and narrow and contained a small larva which was very little coiled. It was either extended or somewhat sinuous. These cysts occurred chiefly in the mesenteries, liver or stomach wall. They were never found in the muscles. More than one type of these cysts may occur in a single host.

These three types of cysts were found to contain larvae of three different genera. The larvae possessing an intestinal caecum, reduced ventriculus and an oesophageal appendix, clearly belong to the genus Contracaecum. These occur in the third type of cyst. The larvae with an oval ventriculus and an intestinal caecum but without oesophageal appendix belong to the genus Porrocaecum. The second type of cyst is characteristic of this larva. Larvae in which neither an intestinal caecum nor an oesophageal appendix were visible but an oblong ventriculus was present, were assigned to the genus Anisakis. These larvae occur in the first type of cyst described. Baylis (1916, 1944) has stated that young Porrocaecum larvae do not possess an intestinal caecum, this structure developing slowly in the larvae in the intermediate fish host, and consequently may be mistaken for Anisakis larvae. However, in view of the following observed facts, I feel certain that the nematode larvae I have assigned to the genus Anisakis are not young stages of Porrocaecum larvae. (1) Anisakis sp. larvae were primarily found in species of fish which were not parasitized by Porrocaecum sp. larvae. (2) Anisakis sp.

larvae were found encysted in the visceral organs and mesenteries and in the musculature. The body musculature was the sole location in which *Porrocaecum* larvae were found. (3) *Anisakis* larvae when infecting the musculature, were always restricted to a small area immediately surrounding the body cavity. They did not appear to migrate to any considerable distance, such as was observed for *Porrocaecum* larvae. (4) A correlation between degree of infestation with *Anisakis* larvae and age of the fish was noted, the oldest fish being by far the most heavily parasitized. (See page 159). This fact is probably due to a building up of the infestation over a long period of time, since it is known that encysted Anisakinae larvae in fish may live for years. It is thus apparent that many of the larvae in older fish have reached their maximum development, and hence cannot be considered as or confused with young *Porrocaecum* larvae.. They must be true *Anisakis* larvae. (5) The area in which fish were observed to be most heavily infected coincides with the region in which whales and sea lions are known to harbour adult *Anisakis* spp. in large numbers, while areas of low infection coincide with scarcity of these marine mammals. (6) *Anisakis* larvae are whitish while *Porrocaecum* larvae are brownish. (7) *Anisakis* cysts are mainly circular in outline, while those of *Porrocaecum* are more elongated oval, the worms being more loosely coiled in the cyst than *Anisakis* sp. (8) Larvae up to 34.5 mm. long did not show any trace of a caecum. Baylis (1916, 1944) stated that the caecum begins to develop in *Porrocaecum* larvae when they attain a length of 28 mm. *Porrocaecum* larvae of 27.5 mm. long possessed a well developed caecum.

Genus *Contracaecum* Railliet and Henry, 1912

Contracaecum sp. (spp.) larvae

Hosts: *Clupea pallasii* Valenciennes, herring; *Ammodytes tobianus personatus* Girard, sand lance; *Hypomesus pretiosus* (Girard), silver smelt; *Parophrys vetulus* (Girard), lemon sole; *Eopsetta jordani* (Lockington), brill; *Lyopsetta exilis* Jordan and Gilbert, slender sole.

Location: encysted in the mesenteries, liver and stomach wall.

Locality: Point Gray, Vancouver; Nanoose Bay, Vancouver Island; Swiftsure, west coast of Vancouver Island; Cape Lazo, Vancouver Island; Horseshoe Grounds, Hecate Strait; English Bay, Vancouver.

Many of these larvae were obtained from the listed hosts. The type of cyst in which these larvae are found has already been described.

The larvae are 6.4-25.3 mm. long, with a maximum diameter of 0.13-0.34 mm. The head is typical, with three low lips and a boring tooth. The nerve ring is 0.25-0.47 mm. from the anterior end. The ventral excretory pore is a slight distance behind the nerve ring. The oesophagus is 0.79-2.2 mm. long and the ventriculus 0.068-0.112 mm. in diameter. The intestinal caecum and oesophageal appendix are respectively 0.32-1.2 mm. and 0.28-0.90 mm. long, the appendix usually slightly shorter than the caecum. The intestine has a straight and narrow lumen and is of greater diameter than the oesophagus. The rectum is 0.068-0.21 mm. long and the anus is 0.11-0.30 mm. from the posterior tip. This distance is always greater (as much as twice as long), in larvae of females than in the immature males. There are three pyriform shaped anal glands around the proximal portion of the rectum. The conical tail bears a pointed process. There are no spinelets on this process. Within the sheath of this larva, the tail of the next stage larva can be seen in larger specimens, which does bear a spiny tail process. Commencement of genitalia can be seen in specimens longer than 13 or 14 mm., as a straight tube, which becomes undulating in the larger specimens. It commences about the middle of the body and extends to within 1/7 of the body length from the tail. The vulva is not perforated nor are spicules evident.

These larvae are similar to the immature stages of C. aduncum found in the digestive tract of various fishes and are similar to larvae which Kahl (1936) and Punt (1941) described as C. aduncum larvae. Since C. aduncum adults are common in British Columbia waters, it is possible that these are larval stages of C. aduncum. A sand-lance removed from the stomach of a brill yielded several specimens of Contracaecum larvae. Since the brill is a known host of C. aduncum, the larvae found in the sand-lance might easily belong to this species. On the other hand, if other species of Contracaecum were concerned, it is highly doubtful if they could be differentiated in the larval stage.

The larvae which Smedley (1934) described from many species of fish from the Strait of Georgia, as Contracaecum sp. larva, from her description, do not appear to belong to Contracaecum at all, but rather seem to be a species of Anisakis. The oblong ventriculus is characteristic of Anisakis and not Contracaecum, which has a reduced ventriculus. The "short intestinal caecum lying beside the ventriculus in specimens in a somewhat more advanced stage of development", as described by Smedley was probably a misinterpretation. As pointed out by Johnston and Mawson (1943) the ventriculus extends further posteriorly on the dorsal side than ventrally and thus in side view one may get the impression of a developing caecum. Actually the intestine enters the ventriculus obliquely. The yellow rod of cytoplasm which Smedley described lying alongside the anterior portion of the intestine and interpreted as the developing oesophageal appendix is probably erroneous.

Genus Porrocaecum Railliet and Henry, 1912

Porrocaecum sp. larvae

Hosts: Gadus macrocephalus (Tilesius), Pacific cod; Ophiodon elongatus Girard, lingcod; Anoplopoma fimbria (Pallas) 1811, sable fish.

Location: cysts in the musculature.

Locality: Hecate Strait.

These larvae are particularly common in the cod and sable fish. The cysts have been described in an earlier section.

The larvae, enclosed in one previous cuticle are 27.5-47 mm. long by 0.68-0.97 mm. in maximum diameter. There are three low lips under the larval cuticle and a ventral boring tooth is present anteriorly. The cuticle is smooth and striated. The tail is rounded and there is a terminal spine which appears to be retractable. The muscular oesophagus is 1.86-2.36 mm. long. The ventriculus and intestinal caecum are respectively 0.98-1.43 mm. long, and 0.75-1.1 mm. long. The intestine is straight and leads to a rectum, 0.15-0.29 mm. long, surrounded proximally by three pyriform-shaped anal glands. The anus is 0.15 to 0.21 mm. from the posterior extremity. The nerve ring is 0.43-0.50 mm. from the anterior end. The excretory pore is anterior and ventral, between the ventro-lateral lips. This larva is identical with that described by Baylis (1916) as the larva of Ascaris (= Porrocaecum) decipiens (Krabbe, 1878), which is known to be present in seals of the North Pacific coast of North America (Stiles and Hassal, 1879, Scheffer and Slipp, 1944).

Stiles and Hassal, and Scheffer and Slipp, recorded the presence of ascaroid larvae in Gadus macrocephalus and Theragra chalcogramma in Alaskan waters, which they considered to be larval P. decipiens.

The host range of Porrocaecum larvae appear to be much more restricted than either Contracaecum or Anisakis larvae.

In cod and sable-fish (often called black cod, although not a cod at all) the presence of Porrocaecum larvae in the flesh presents a problem of economic importance. Cod are usually sold as fillets, which often have to be candled to remove the worms before sale. Sable-fish are normally smoked, and if this process is carried out while the fish is fresh, the worms will crawl out of the fillet. However, if the fish are frozen, and stored before smoking, the worms are killed in situ and must later be removed by hand-picking. The presence of these nematode larvae in cod is a serious threat to the marketability of this fish, which already has a bad name for being a "wormy fish".

Anoplopoma fimbria and Ophiodon elongatus are new host records for this parasite.

Genus Anisakis Dujardin, 1845

Anisakis sp. larvae

Hosts: The hosts consist of a wide variety of teleosts, selachians and one invertebrate (a squid). Both pelagic fish and bottom feeders were found to be heavily infected. The following is a list of hosts in which this parasite was found.
Clupea pallasii Valenciennes, herring; Mallotus catervarius (Pennant), capelin; Oncorhynchus tshawytscha (Walbaum), spring salmon; O. kisutch (Walbaum), coho salmon; O. keta (Walbaum), chum salmon; O. nerka (Walbaum), sockeye salmon; O. gorbuscha (Walbaum), pink salmon; Thunnus alalunga (Gmelin), albacore; Merluccius productus (Ayres), hake; Theragra chalcogramma (Pallas), whiting; Gadus macrocephalus Tilesius, Pacific cod;

Anoplopoma fimbria (Pallas), sable-fish; Delolepis giganteus Kittlitz, wry-mouth; Ophiodon elongatus (Girard), lingcod; Lycodes brevipes Bean, short-finned eel-pout; Sebastodes paucispinis (Ayres), bocaccio (a rock-fish); Sebastodes brevispinis (Bean), rock-fish; Acipenser transmontanus Richardson, white sturgeon; Squalus suckleyi Girard, dog-fish; Raja rhina Jordan and Gilbert, long-nosed skate; Acrotus willoughbyi Bean, brown rag-fish; Gonatus sp., a squid; Eopsetta jordani Lockington, brill; Lepidopsetta bilineata Ayres, rock sole; Atheresthes stomias Jordan and Gilbert, long-jaw flounder; Glyptocephalus zachirus Lockington, rex sole; Hippoglossoides elassodon Jordan and Gilbert, flat-head sole; Isopsetta isolepis Lockington, butter sole; Lyopsetta exilis (Jordan and Gilbert), slender sole; Microstomus pacificus (Lockington), dover sole; Parophrys vetulus Girard, lemon sole; Psettichthys melanostictus Girard, sand sole; Citharichthys sordidus (Girard), mottled sound dab.

Location: In all of the above fish hosts, except the herring, capelin, dog-fish, and skate, the larvae were found encysted in the mesenteries, under the liver capsule, in the stomach wall and musculature. They were often found in large masses around the digestive tract. In the herring, the larvae were nearly always confined to the body cavity, mainly around the distal portion of the intestine. Only one larva was found partially embedded in the musculature near the anus. Anisakis larvae in the dogfish and skate were only recovered from the stomach wall. Only a small percentage of the larvae found in salmon were located in the musculature. In the muscle the nematodes do not appear to migrate to any extent before becoming encysted. They are always confined to a small area surrounding the body cavity. This is particularly noticeable in flounders, where the body cavity is confined to a small antero-ventral area. This has important economic applications, since flounders usually appear on the market as fillets. The worms when present in these fillets, never occur more than an inch or so from the anterior edge of the fillet, which can be cut away. This process will completely free the fillet of worms and do away with the tedious process of candling.

Locality: All of British Columbia coastal waters -- no area was found to be completely free of this parasite, although the fish in some areas are more lightly infected than in others. The albacore were caught off the California-Oregon coast.

Morphology: The cylindrical larvae, enclosed in the cuticle of the last larval stage, possess three low lips and a ventral boring tooth characteristic of the Anisakinae. The mouth leads into an oesophagus, of which approximately the anterior two-thirds is muscular and the posterior portion, the ventriculus, is of different histological structure. It has a granular appearance microscopically and appears as a white region in the living larva. There is neither oesophageal appendix nor intestinal caecum. The diameter of the ventriculus is greater than that of the muscular oesophagus. The intestine is straight, with a narrow lumen and of smaller diameter, proximally, than the ventriculus, which it enters obliquely. The diameter increases posteriorly. There are three pyriform glands arranged around the proximal portion of the rectum. The tail is conical and bears a terminal spine. There is a group of muscles from the rectum to the dorsal body wall. The maximum diameter of the larva is about 2/3 from the anterior end, from where the larva tapers gradually anteriorly and posteriorly. The excretory pore is anterior and ventral, between the two ventro-lateral lips. There is no trace of genital organs.

The following measurements are based on fifty specimens taken at random from the brill, herring, albacore and sockeye salmon. The brill were caught on the west coast of Vancouver Island, the albacore off the coast of Oregon-California and the herring and sockeye salmon in the Strait of Georgia. No differences between specimens from any of the hosts and localities could be detected.

Total length, 18.8-34.5 mm.; body diameters at the head, level of the ventriculus, level of the anus, and maximum diameter are respectively 0.105-0.135 mm., 0.263-0.41 mm., 0.15-0.18 mm., and 0.380-0.563 mm., length of muscular oesophagus, 1.56-2.55 mm.; length of ventriculus, 0.75-1.61 mm.; diameter of muscular oesophagus 0.1-0.15 mm.; diameter of ventriculus 0.18-0.30 mm.; diameter of intestine anteriorly and maximum, respectively 0.128-0.2 mm. and 0.263-0.41 mm.; length of rectum 0.11-0.165 mm.; the anus is 0.08-0.16 mm. from the posterior extremity; the nerve ring lies 0.29-0.337 mm. from the anterior end.

Definitive host and nomenclature: The definitive hosts of these *Anisakis* larvae are undoubtedly marine mammals. To date at least two species are known to occur in marine mammals of the North American Pacific coast. The parasitic fauna of marine mammals has not been surveyed extensively in this area and possibly more species exist. Anisakis similis (Baird, 1853) has been recorded from the sea-lion (Zalophus californianus) by Schroeder and Wegeforth (1935). Anisakis simplex (Rudolphi, 1804) specimens from Balaenoptera physalis, the fin whale, were collected by Mr. G. Pike of the Pacific Biological Station and submitted to me for identification. Immature stages of Anisakis from the stomachs of these same whales are identical with the Anisakis larvae from the fish hosts. It is therefore possible that at least some of the larvae found in the fish are actually Anisakis simplex. However, there is no experimental evidence to support this. Yamaguti (1935B) and Johnston and Mawson (1943) have described similar Anisakis larvae from Japanese and Australian fish as definitely being the larval stage of A. simplex, without presenting any experimental evidence. Their conclusions were based solely on circumstantial evidence. Johnston and Mawson (1943) gave a long list of synonyms of their "A. simplex" larvae, completely reviewed the literature on this parasite and concluded that the correct name, by the law of date priority, should be Capsularia marina, the generic name given by Zeder in 1800 and the specific name by Linnaeus in 1767 to larval ascaroids from fish, which Johnston and Mawson considered identical with the Anisakis larvae. However true this last statement may be, in the absence of experimental proof of the life history of the

Anisakis from fish, I do not see that it can be considered as the larval stage of only one species, *A. simplex*. Baylis (1944) criticized Johnston and Mawson's logic for considering the name *Anisakis simplex* to be replaced by the combination *Capsularia marina*. In 1945 Johnston and Mawson, still adhering to the theory that their *Anisakis* larvae are the immature stages of *Anisakis simplex*, corrected the generic name to *Stomachus* Goeze (in Zeder, 1800) since Yamaguti (1935B) had already shown that *Capsularia* was a pre-occupied name. Previously, Johnston and Mawson (1943) considered *Stomachus* as a synonym of *Capsularia*.

Since at least two adult species of *Anisakis* occur in North American Pacific waters, the larvae recorded from fish cannot be assigned to any particular species. Furthermore, all descriptions of *Anisakis* larvae from various parts of the world appear to be identical but do not necessarily refer to one species. In fact, it is more likely that the larvae belong to different species of *Anisakis*, since at least five species are recognized from marine mammals. In view of these considerations, I am for the present retaining the generic name *Anisakis* Dujardin, 1845 and the larval stages from the fish will be referred to merely as *Anisakis* sp. larva.

Infection in Commercial Species of Fish: *Anisakis* sp. larvae were found to be by far the commonest parasite of British Columbia coastal fish. The host range, geographical distribution and numbers of worms per fish greatly exceeded that of any of the other parasites recorded in this study. It is also of the greatest economic importance.

It has already been stated that the degree of infection varied with the host and locality. Of the commercial species of fish, the herring and some species of flat-fish (Pleuronectidae), particularly the brill and rock sole, are heavily infected and constitute a serious economic problem. Salmon are not heavily infected and it does not seem to be an economic problem in this group of fish. The herring are knownto be infected in Hecate Strait, Strait of Georgia and on the west coast of Vancouver Island. Since the herring fishery was not in operation during my presence on the coast, I did not secure data dealing with *Anisakis* infection in this fish. Large numbers of flounders of several species and from many fishing areas were available for examination, in the Vancouver fishery. Several points worthy of note, were brought to light.

Of the three most important commercial species of flounders (brill, rock sole and lemon sole), the brill and rock sole are heavily infected, particularly on the west coast of Vancouver Island, while the lemon sole are very slightly infected. Most catches of brill appeared to be 95-100 per cent infected, rock sole about 25-90 per cent infected and lemon sole were frequently completely free of this worm. When present in lemon soles, the percentage of infected fish was never more than five per cent, with the maximum number of worms per fish about five or six. Brill and rock sole may harbour more than .500 worms per fish. While it is true that the lemon sole are usually caught in different areas than the brill or rock sole, this does not seem to be the complete explanation (although partially responsible) for the differences in degree of infection. Lemon sole are frequently caught near Cape Lazo, Vancouver Island; Two Peaks, Hecate Strait; and the Gulf Islands in the Strait of Georgia. In these areas infection in the lemon sole is very slight. A few brill and rock sole are always brought in with commercial lemon sole catches from these areas. The brill and rock sole usually harbour Anisakis larvae and sometimes they may number more than 100 in a fish. Lemon sole caught in the "brill fisheries" of the west coast of Vancouver Island are only slightly more heavily infected than lemon soles from the Strait of Georgia or Hecate Strait.

A more basic explanation perhaps lies in the food habits of these three flounders. The brill is essentially a shrimp and small fish-eater, but small crabs and occasionally molluscs are also eaten, while the rock sole is accustomed to a more mixed diet. According to Clemens and Wilby (1949), small crabs, shrimps, worms and clam siphons are the main food of the rock sole. In addition I have found snails, starfish and teleosts (sand-lance) in the stomachs of the rock sole. Shrimps when available in large quantities appear to be a favourite food. The food of the lemon sole, as stated by Clemens and Wilby, consists of small crabs, shrimps, worms, clam siphons and small molluscs. From my examination of several hundred lemon soles, I found the chief food to be small molluscs and clam siphons. Small crabs and worms were not common, while shrimps and fish were very scarce in the stomach contents. From the results of these studies of stomach contents, it appears that the choice of food possibly determines the degree of infection with Anisakis larvae, one of the food animals serving as a host for Anisakis. The sand-lance (Ammodytes tobianus personatus) which is the common teleostan food of the brill and rock sole was examined in large numbers and never found to harbour Anisakis larvae. It thus seems that shrimps, particularly Euphausica pacifica, the common shrimp food of the brill and rock sole on the west coast of Vancouver Island, may be implicated in the life history of Anisakis. This would account for the low infection in lemon soles. Unfortunately, shrimps were not available for examination.

Further circumstantial evidence of shrimps being involved in the life history was obtained by examination of three other species of flounders which were available in fairly large numbers. Rex sole and dover sole from the Strait of Juan de Fuca and northern Hecate Strait (Two Peaks) were found to be lightly infected. Of about 200 each of dover and rex soles examined from Juan de Fuca Strait, only about ten per cent were infected with one to three worms per fish. Of about 200 dover soles caught in the Two Peaks area, close to 20 per cent were infected but with always less than ten worms, and usually fewer than four worms. The food of these fish was found to consist mainly of polychaete worms and molluscs, with shrimps being a minor item. On the other hand, the long-jaw flounder from Two Peaks, Hecate Strait and the west coast of Vancouver Island, which feeds heavily on shrimp was found to be heavily infected, large specimens (more than 60 cm. long) often harbouring more than 500 worms.

If the shrimp is involved in the life cycle of these _Anisakis_ larvae, the question arises as to whether these nematodes have a three host life cycle or is the fish acting only as a carrier and not a true biological host. Further investigation is required to settle this question. The fact that larvae of widely different lengths occur in fish, indicates that growth of the worm probably takes place in the fish host, which might be an indication that the fish is a true biological host.

One other obvious point, controlling the distribution of Anisakis sp. larvae in fish, is the distribution of the definitive hosts.

In detailed studies on the infection in the brill, it was learned that fish on the west coast of Vancouver Island, particularly in the northern part around Cape Scott, Lanz Island and Cox Island, are most heavily infected. The brill in the Strait of Georgia are least infected, while those of Hecate Strait occupy an intermediate position. The British Columbia fishery is usually considered in terms of these three areas.

Another interesting point was determined by actual counts of worms per fish. Although admitting that insufficient numbers of fish were used for actual counts to be considered as representing a statistically significant sample, the results indicated that the number of larvae per fish increased with the size (and hence age) of the fish. This trend was first noticed through the handling of many hundreds of brill, before the actual counts were made. A similar trend was noted with the rock sole. The counts were restricted to female fish, so that fish of the same size would be approximately of the same age. The counts were made on fish caught near Cape Scott, Vancouver Island and are given in Table 4. The figures are not intended to be indicative of the number of worms to be expected in a fish of any given size, as the sample was much too small. From this same table it will be noticed that the larvae do not show a preference for any particular organ or tissue.

In general, it was noted that brill less than 35 or 36 cm. in length were almost free of Anisakis larvae. This was difficult to ascertain as small fish are not taken commercially. There seemed to be a slow increase in number of worms per fish up to fish of length 45 cm., the number of worms usually being less than 25. The number increases to about 50 in fish of about 50 cm. long and then increases rapidly in fish over 55 cm., fish of 60 cm. harbouring several hundred worms.

Most of the hosts from which Anisakis sp. were recorded are new. Previous records of Anisakis larvae in similar hosts are discussed in the following paragraph.

The larvae recorded by Gregoire and Pratt (1952) as Anisakis or Porrocaecum sp. larvae from Eopsetta jordani in Oregon are probably Anisakis sp. They have undoubtedly followed Baylis (1944) in classifying Anisakinae larvae with a ventriculus, but no intestinal caecum or oesophageal appendix, as *Anisakis* or *Porrocaecum* sp. larvae. The larvae, referred to as *Contracaecum* sp. larvae by Smedley (1934) from several species of fish in the Strait of Georgia also are probably *Anisakis* sp. (discussed under *Contracaecum* sp. larva). Her description and measurements of a 22 cm. specimen coincides with the description of the larvae reported here, except for the distance of nerve ring from anterior end which she gave as 1.17 mm. as compared to about 0.3 mm. in my specimens. The species of fish from which Smedley recorded this larva are *Clupea pallasii*, *Ophiodon elongatus*, *Scomber* sp. (probably incorrectly named, as *Scomber* spp. are not known to occur in Canadian Pacific waters), *Merluccius productus*, *Hydrolagus colliei*, *Citharichthys stigmaeus*, *Squalus suckleyi* and *Sebastodes* sp. Yamaguti (1935, 1941) recorded *Anisakis* sp. larvae from *Thunnus alalunga* in the Pacific and *Salmo* (=*Oncorhynchus*) *keta*, *Gadus macrocephalus* and *Theragra chalcogramma* from Japanese marine waters. Zschokke and Heitz (1914) recorded "*Ascaris capsularis*" (likely a species of *Anisakis*) from *Oncorhynchus tshawytscha*, *O. nerka*, *O. kisutch* and *O. keta* from Kamchatka. Fujita (1939) recorded *Anisakis salaris* (= *A. simplex*) larvae from *O. gorbuscha*, *O. keta* and *O. nerka* in Japanese waters.

TABLE 4

INFECTION OF FEMALE BRILL FROM CAPE SCOTT, VANCOUVER ISLAND, WITH *ANISAKIS* LARVAE, IN NO. OF LARVAE PER HOST AND PER INFECTED ORGAN OR TISSUE

Length of fish (cm.)	No. of Fish	Liver	Muscle	Mesenteries	Stomach wall	Total
59	1	169	187	188	70	614
57	1	100	100	130	40	270
56	1	55	75	59	36	224
54	1	33	35	96	--	164
51	3	22	51	41.4	12.3	126.7
50	4	14.25	16	22.75	6.75	59.75
49	1	10	50	19	22	101
48	5	9.2	18	11.8	9.8	48.8
47	2	8.5	7	10.5	5	31
46	1	9	10	2	--	21
44	2	4.5	5.5	5.5	3.5	19
43	2	4	6	9.5	0.5	20
42	2	3	1.5	2.5	1	8
41	2	1	--	3	--	4
39	2	0.5	--	0.5	--	1
38	2	1.5	2	1.5	--	5
37	1	--	--	--	--	--

Order SPIRUROIDEA Railliet and Henry, 1915

Family CUCULLANIDAE Cobbold, 1864

Sub-family CUCULLANINAE Yorke and Maplestone, 1926

Genus Cucullanus Müller, 1777

Cucullanus elongatus Smedley, 1933

Host: Ophiodon elongatus Girard, lingcod.

Location: intestine.

Locality: Baynes Sound, Vancouver Island.

Two male specimens were found in the intestine of one lingcod.

The species was created by Smedley (1933) for ten females and two male nematodes taken from the intestine of the lingcod in the Strait of Georgia.

As there are some small differences from Smedley's description and certain characters are not mentioned by her, a redescription of the male seems justified. In the following measurements, the figures in parentheses are those of Smedley.

Description: Male: The worms are whitish, 22-22.4 mm. long (up to 30 mm.) by 0.32-0.36 mm. in maximum width. The cephalic region, slightly enlarged, measures 0.225-0.263 mm. The body narrows slightly to the middle of the oesophagus, where it is 0.21-0.23 mm. in diameter, and then increases in width to its maximum, shortly posterior to the oesophagus. From here the diameter is uniform to the pre-cloacal sucker and then gradually tapers to the cloaca, from where it tapers abruptly to a point. The posterior tip is slightly constricted from the rest of the tail. The anterior region is straight, the posterior region curved ventrad. There are no lateral alae. The cuticle, consisting of an outer hyaline and inner granular and thicker layer is 0.0167 (0.0187) mm. thick. It is finely striated, the striations 0.0040 (0.0042 mm.) apart for the whole length of the worm. The lateral cercival papillae lie one-third the distance between the nerve ring and the intestine-oesophageal junction, the right papillae being slightly anterior to the left. There is another pair of papillae slightly beyond the junction of the anterior one-third and posterior two-thirds of the body length. There are eleven pairs of caudal papillae, of which three are pre-cloacal, four ad-cloacal and four post-cloacal. The pre-cloacal papillae are ventro-lateral, one pair anterior to the pre-cloacal sucker, one pair just posterior to it and one pair about mid-way between the sucker and the cloaca. The first two pairs are the largest papillae. Three pairs of the ad-cloacal papillae are more or less ventro-lateral, grouped closely together near the cloaca. The fourth pair ad-cloacal papillae are lateral lying posterior to the accessory piece. The first and third pair of post-cloacal papillae are lateral, while the second and fourth pairs are ventro-lateral. The nerve ring is 0.50-0.54 mm. (0.64 mm.) from the anterior end. The excretory pore is slightly anterior to the union of oesophagus and intestine. The mouth, a dorso-ventrally directed slit, surrounded by two thick lateral lips lined with striated cuticle, the striations of which are produced into denticles externally, and each bearing three external papillae, is characteristic of the genus. The oesophagus is dilated anteriorly to form a pseudo-buccal capsule 0.21-0.218 mm. wide with muscular walls 0.68 mm. The oesophagus narrows to 0.143 mm. in diameter, 0.5 mm. from the anterior end and then gradually increases in diameter to form a club-shaped swelling at the posterior end, where the diameter is 0.218-0.225 mm. The nerve ring divides the oesophagus into two regions. Both are muscular, but in the posterior region the muscular striations are closer together. The oesophagus is 1.9-1.99 mm. long, the oesophagus to body length ratio being 1:11-1:12 (1:18). This ratio is the major difference from Smedley's specimens. Between the oesophagus and intestine there is a bilobed valve. The intestine is dilated at its origin, but narrows immediately. There is a short rectum, which is wider at its origin than the intestine, according to Smedley. It was not visible in my specimens. The cloaca on an elevation is 0.23 mm. (0.24 mm.) from the posterior extremity. The testis arises in the middle of the body, proceeds anteriorly to within 4.2-4.65 mm. (4 mm.) of the oesophagus, then turns posteriorly and becomes convoluted. The spicules are equal 1.33-1.42 mm. (1.4 mm.) long. When the spicules are completely withdrawn, as in both my specimens, they extend slightly anterior to the pre-cloacal sucker. The spicules are slender and curved ventrad. The accessory piece is small, pointed at both ends, 0.10 mm. (0.125 mm.) long by 0.015 mm. (0.012 mm.) wide. The pre-cloacal sucker is elevated from the surface, muscular and without a cavity. It is thus not truly a sucker. Laterally, it appears as a fan-shaped group of muscles, 0.36-0.38 mm. in diameter, with the posterior margin 0.60-0.64 mm. from the cloaca.

Smedley stated that this species most closely resembles C. dodsworthi Barreto, 1922. The male differs from this species in being more than twice as large, in the oesophagus body length ratio (1:6 in C. dodsworthi), in the position of the cervical papillae, arrangement of the caudal papillae and in other minor characters.

Genus Dacnitis Dujardin, 1845

Dacnitis plicata n. sp. (Fig. 19)

Host: Parophrys vetulus Girard, lemon sole.

Location: intestine.

Locality: Baynes Sound, Vancouver Island.

Thirteen male specimens of this new species were obtained from the lemon sole. No females were found.

Description: Male: Small, slender nematodes, 4-4.4 mm. long, with the head bent dorsad and the tail bent ventrad, giving the body a somewhat S-shaped appearance. There is a slight swelling on the dorsal aspect of the head. The cuticle, 0.0025 mm. thick, is striated, the striations about 0.002 mm. apart. Ventrally, commencing just posterior to the pseudo-buccal capsule, the cuticle is thrown into folds or plications, which when viewed from the side give the cuticle a serrated appearance. The plications about 0.0084 mm. apart, extend slightly beyond the oesophagus. They are not present dorsally. The width at the cephalic region is 0.15 mm., narrowing slightly to the middle of the oesophagus and attaining a maximum width of 0.16 to 0.18 mm. just behind the oesophagus. The width is uniform to the pre-cloacal sucker, from where it tapers gradually to the cloaca and then abruptly to the pointed posterior extremity. The mouth is slit-like and at an angle of about 60° to the long axis of the worm. It is bounded by two lateral lips, lined with a striated cuticle, the striations of which are externally produced into denticles. There are three prominent papillae on each lip. The oesophagus, 0.62-0.68

mm. long (approximately 1/6 the body length) is enlarged anteriorly to form a pseudo-buccal capsule, narrows towards the mid-length and expands again to a club-shaped swelling posteriorly. The width of the pseudo-buccal capsule, oesophagus at the middle and posteriorly are respectively 0.135 mm., 0.049-0.053 mm., and 0.098-0.113 mm. The muscular wall of the pseudo-buccal capsule has a dorsal swelling corresponding to the swelling on the head. A two-lobed valve projects from the oesophagus into the intestine, which is 0.098 mm. wide at its commencement. The rectum was not clearly visible. The cloaca, on a slight prominence, is 0.10-0.12 mm. from the posterior end. The nerve ring is 0.27-0.30 mm. from the anterior extremity. There is a pair of lateral cervical papillae, 0.025-0.034 mm. anterior to the intestine, the left one slightly anterior to the right papillae. There are no lateral alae. The excretory pore appears to be slightly behind the oesophagus. The testis commences about 0.60 mm. anterior to the pre-cloacal sucker, proceeds anteriorly to within 0.21-0.45 mm. of the oesophagus and then turns on itself and proceeds posteriorly. It is not convoluted. The pre-cloacal sucker, 0.15-0.16 mm. in diameter, is cup-shaped and highly muscular, its posterior margin lying 0.19-0.26 mm. anterior to the cloaca. There are eleven pairs of caudal papillae. The first two pairs are the largest, one pair lying just anterior to the sucker and the second pair on its posterior margin. The third pair is about one-third the distance from the sucker to the cloaca. These papillae are ventro-lateral. The next four pairs of papillae are grouped around the cloaca, three pairs being ventro-lateral and one pair lateral. There are four pairs of papillae posteriorly on the tail. The eighth pair is small and lateral. The tenth pair is lateral and the ninth and eleventh pair are ventro-lateral. The slender spicules, 0.75-0.77 mm. long, curved ventrad, are pointed distally and slightly enlarged and bluntly rounded proximally. When completely retracted they extend slightly anterior to the pre-cloacal sucker. The accessory piece is small and obscure, slightly curved, and pointed at both ends. It measures 0.058 mm. by 0.009 mm.

The female is unknown.

This species can be distinguished from all other species of _Dacnitis_ by the antero-ventral cuticular plications, from whence the specific name is derived.

Order DRACUNCULOIDEA

Family PHILOMETRIDAE Baylis and Daubney, 1926

Genus _Philonema_ Kuitunen-Ekbaum, 1933

Philonema oncorhynchi Kuitunen-Ekbaum, 1933

Hosts: _Oncorhynchus nerka_ (Walbaum), sockeye salmon; _O._

<u>tshawytscha</u> (Walbaum), spring salmon.

<u>Location</u>: body cavity, free in entangled masses or in connective tissues surrounding the visceral organs.

<u>Locality</u>: Strait of Georgia, Mouth of Fraser River and Rivers Inlet.

This common nematode parasite of Pacific salmon in British Columbia, was originally described by Kuitunen-Ekbaum (1933A) from the sockeye salmon caught in English Bay, Vancouver. Smedley (1933) shortly afterwards also described this parasite from mature sockeye salmon arriving to spawn in Cultus Lake, British Columbia.

The female specimens are 37-155 mm. long and 0.30-0.75 mm. in diameter. The oesophagus, divided into two regions of different structure is 1.78-2.48 mm. long. The anterior portion is 0.50-0.72 mm. long by 0.043-0.075 mm. in diameter and the posterior portion is 1.28-1.74 mm. long by 0.12-0.19 mm. in diameter. The ratio of length of anterior portion to length of posterior portion of oesophagus is 1:2.4-1:2.5, the latter ratio being found in the smallest specimens. Smedley gave values of 1.21 mm. and 1.365 mm. as the length of the anterior and posterior portions of the oesophagus. However, her figure indicates a 1:2 ratio. Kuitunen-Ekbaum did not cite lengths of the two oesophageal regions but her figure indicates a 1:1.7

ratio. The implication is that the ratio of the two oesophageal regions changes with growth of the worms, the anterior region growing more rapidly than the posterior region, since Smedley's specimens were larger than mine and Kuitunen-Ekbaum's were still larger. The two oesophageal regions become less distinct and the difference in diameter between the two regions decreases, with increase in size of the worm. All of these female specimens were mature but not gråvid. The vulva and anus had atrophied but larvae were not present in the uterus. Large numbers of eggs were visible, particularly in the larger specimens. These eggs, spherical in shape, measured 45μ in diameter. The larvae were described by Kuitunen-Ekbaum and Smedley. In young females the uterus is somewhat convoluted. As it becomes filled with eggs it straightens out. The uterus reaches anteriorly to within 0.7-1.5 mm. of the anterior extremity and 0.7-1.2 mm. of the posterior tip.

The males measure 18-25.8 mm. long with a maximum width anteriorly of 0.25-0.3 mm. and posteriorly of 0.12-0.16 mm. The oesophagus is 1.89-2.44 mm. long. The anterior portion is 0.54-0.71 mm. by 0.04-0.08 mm. The posterior region is 1.35-1.84 mm. long with a maximum diameter of 0.19-0.22 mm. The two regions are more distinct than in the female and the posterior portion increases in diameter posteriorly to more than twice its anterior diameter. The nerve ring is 0.32-0.42 mm. from the anterior end, and the cloaca is 0.30-0.43 mm. from the posterior extremity. The two equal spicules are 0.37-0.4 mm. long by 0.005-0.006 mm. wide. The intestine is about 0.2 mm. wide. The testis lies dorsal to the posterior portion of the oesophagus.

Philonema oncorhynchi has not been reported outside of British Columbia. Oncorhynchus tshawytscha is a new host record. The absence of this parasite from O. keta, O. gorbuscha and O. kisutch caught in Johnstone and Georgia Straits, while on spawning migration, was conspicuous.

From Kamchatka (Siberia) Fujita (1939) reported a new species of Philonema, P. kondai in Oncorhynchus keta.

Genus Philometra Costa, 1845

Philometra americana Kuitunen-Ekbaum, 1933

Hosts: Platichys stellatus (Pallas), starry flounder;
Parophrys vetulus Girard, lemon sole.

Location: normally between the fin rays.

Locality: Point Gray, Vancouver; Two Peaks, Hecate Strait; Baynes Sound, Vancouver Island.

The fins of one starry flounder were found to be heavily infected. About 250 worms were present in this one fish. In the dorsal and ventral fins parasites were present between every pair of fin rays. Some worms were also found in the connective tissue at the edge of the operculum and near the dorsal lip. The two lemon soles were more lightly infected. One harboured about fifty worms in the fins, while the other harboured two nematodes and vestiges of a third in the connective tissue ventral to the pterygiophora muscles and between the dorsal longitudinal muscle layer and the median septum.

In the fins the parasite is principally located at the base. The dorsal and ventral fins are mainly attacked, with a few worms present in the paired fins and the caudal fin. The presence of the nematode in the fins causes the formation of a blister, which contains, in addition to the loosely coiled worm, a fair amount of reddish fluid. More than one worm may occur in each blister. The maximum number was three. The parasite is enclosed in this blister and not free to migrate between the fin rays. Fibrous connective tissue surrounds the nematode. All the nematodes found were females, mostly gravid. The female is apparently fertilized during its sojourn through the host, after which the male dies.

The parasites in the connective tissue between the muscles were evident on the white side of the fish as dark brownish-red elongated structures, lying completely stretched out, parallel to the length of the fish. This appears to be an abnormal location for these nematodes, the fins being the normal site of infection. Brownish masses in the same location as the complete worms, on microscopic examination proved to be masses of larvae, many of which were alive, in portions of the uterus. Worms in this location appear to die eventually, disintegrate with subsequent death of the larvae. The degeneration of the worm apparently takes place by a simultaneous disintegration at many points, as evidenced by a series of brownish spots in the connective tissue.

Fortunately, this parasite is not very common and hence of no economic importance. Even a heavy infection such as observed in the starry flounder, did not seem to affect the condition of the fish.

Kuitunen-Ekbaum (1933B) described from Platichthys stellatus, Lepidopsetta bilineata, Epigeichthys atropurpureus, Pholis ornatus and Caularchus maeandricus in Departure Bay, Vancouver Island. In attempting to elucidate the life cycle, she kept an infected starry flounder in an aquarium. The gravid female eventually penetrated the wall of the blister in the fin, made its way to the water, in which it ruptured, liberating thousands of larvae. The intermediate host was not found.

The following measurements were made on sixteen specimens taken at random. Total length, 32-65 mm.; maximum width, 1.08-2.0 mm.; oesophagus 0.9-1.35 mm. long by 0.090-0.128 mm. in diameter; pharynx, 0.225-0.398 mm. by 0.300-0.398 mm.; thickness of muscular pharyngeal wall 0.105-0.150 mm.; the uterus extends to within 0.26-0.56 mm. of the anterior extremity and 0.075-0.18 mm. of the posterior extremity; the ovaries are 1.16-2.1 mm. long by 0.10-0.15 mm. in diameter; the embryos measure 0.34-0.45 mm. long by 0.14-0.17 mm. in maximum width.

The lemon sole (Parophrys vetulus) is recorded as a new host for P. americana.

This parasite has not been found other than on the British Columbia coast.

Class C R U S T A C E A

Order COPEPODA, Müller

Tribe CALIGOIDA, Sars

Family CALIGIDAE

Genus Caligus Müller, 1785

Caligus gurnardi Kroyer, 1863

Host: Oncorhynchus tshawytscha (Walbaum) spring salmon (grilse)

Location: skin.

Locality: Strait of Georgia.

A single female specimen of this copepod was obtained from a young salmon. Wilson (1908) recorded this species from *O. tshawytscha* at Monterey, California and *Hydrolagus colliei* at La Jolla, California. The copepod was originally described from Norwegian seas and evidently has a wide distribution, occurring in both the Atlantic and Pacific Oceans. This record extends the known distribution of *C. gurnardi* on the Pacific coast of North America from California to British Columbia. The parasite has been described by T. and A. Scott (1912).

Genus *Lepeophtheirus* Nordmann, 1832

Lepeophtheirus salmonis (Kroyer, 1838)

Hosts: *Oncorhynchus gorbuscha* (Walbaum), pink salmon; *O. kisutch* (Walbaum), coho salmon; *O. tshawytscha* (Walbaum), spring salmon; *O. nerka* (Walbaum), sockeye salmon.

Location: skin, particularly around the vent.

Locality: Strait of Georgia.

These copepods were present on nearly every salmon examined, often in very large numbers. Only females were found. When present in large numbers, the scales and epidermis, sometimes even the dermis are destroyed, leaving the infected area quite raw. White (1940, 1942) has described L. salmonis as the cause of death of large numbers of Atlantic salmon on the east coast of Canada. A similar condition is not known to have occurred in British Columbia salmon.

Wilson (1908) reported L. salmonis from Oncorhynchus spp. in Alaska and Washington State and California. Descriptions and figures of this copepod are given by Wilson (1905) and T. and A. Scott (1912). Neither of these authors figure or describe the small curved seta on the outer, distal end of the first joint of the ramus on the fourth pair of legs. This is present in addition to the small nob with microscopic bristles. White (1940) described and figured this seta on the fourth pair of legs and also noted that in his specimens the rami of the sternal fork were truncated and not bluntly rounded as described by Wilson and Scott. Such is also the case in my specimens.

Lepeophtheirus salmonis is a very common parasite of Atlantic and Pacific salmon.

Genus Elytrophora Gerstaecker, 1853

Elytrophora brachyptera Gerstaecker, 1853
Host: Thunnus alalunga (Gmelin), albacore.
Location: underside of operculum.

Locality: Pacific, between Cape Blanco, Oregon and Cape Mendecino, California, 45-85 miles off shore.

This copepod was very common on the albacore. Only females were found. It was first described from the tunny (*Orcynus thynnus*) in Europe, where it is extremely common. Yamaguti (1936) recorded *E. brachyptera* from *T. alalunga* and *T. thynnus* in the Japanese Pacific. It has not been recorded previously from the North American Pacific. As with the previously mentioned two caligids, *E. brachyptera* is widely distributed in the Atlantic and Pacific Oceans. The hosts appear to be confined to the Scombridae.

The specimens agree fully with the description of T. and A. Scott (1912) and the measurements given by Yamaguti.

Family LERNAEIDAE

Genus *Phrixocephalus* Wilson, 1908

Phrixocephalus cincinnatus Wilson, 1908

Host: *Atheresthes stomias* (Jordan and Gilbert), long-jaw flounder.

Location: partially embedded in the eye.

Locality: Horseshoe Grounds, Hecate Strait.

A single female was found with the head and neck buried in the eye of the host. The tissue surrounding the parasite becomes hardened, which results in the blindness of the infected eye.

Wilson (1908) founded this genus and species on two females recovered from the eyes of a species of sand-dab (Citharichthys sp.) at Monterey, California. He noted that only one copepod was found per fish, thus total blindness did not occur. In 1935 he recorded two females from the eyes of sand-dabs (Orthopsetta sordida, probably = Citharichthys sordidus) from Pacific Grove, California, and four females from A. stomias at Point Reyes, California. All cases are presumably single infections. The males are as yet unknown.

This record extends the known distribution of P. cincinnatus from British Columbia to California on the North American west coast. It has not been recorded elsewhere. The hosts so far recorded are flat-fishes of the closely related families Bothidae (sand-dabs) and Pleuronectidae (flounders).

Family DICHELESTIIDAE

Genus Anthosoma Leach, 1816

Anthosoma crassum (Abildgaard, 1794)

Host: Isurus nasus (Bonnaterre), mud shark.

Location: mouth.

Locality: Strait of Georgia.

The material, collected in October, 1948, by Mr. H. E. Barraclough of the Pacific Biological Station, consisted of two males and two females. This copepod has been described and figured by T. and A. Scott (1912, 1913) and Wilson (1922, 1932) and described by Yamaguti (1936). The differences noted by Yamaguti between his specimens and the descriptions of T. and A. Scott and Wilson were observed in my specimens. Outstanding of these discrepancies are the possession of an auricular flap on each side of the carapace behind the base of the first antennae, and the failure of the dorsal plates and appendages to completely cover the genital segment.

Yamaguti's specimens were taken from Isurus nasus in Japanese waters. Anthosoma crassum has also been recorded from Isurus glaucus in Japan, Lamna cornubica from many parts of Europe, from New Zealand and California, Lamna punctata from the Atlantic coast of North America and Squalus sp. (probably Squalus suckleyi) from California. The records from California were made by Wilson (1935). In 1932, he also indicated that this copepod was found on sharks around Vancouver Island.

The distribution of this copepod is thus seen to be very extensive in the Atlantic and Pacific Oceans. The normal hosts seem to be the mackerel sharks (Lamnidae).

Class C N I D O S P O R I D I A

Order MYXOSPORIDIA Bütschli, 1881

Sub-order PLATYSPOREA Kudo, 1920

Family MYXOBOLIDAE Thelohan, 1892

Genus Myxobolus Butschli, 1882

Myxobolus squamae Keysselitz, 1908

Host: Oncorhynchus kisutch (Walbaum), coho salmon.

Location: cysts in the skin.

Locality: Strait of Georgia, B. C.

The presence of this parasite is visible externally as small nodules (up to 5 mm. in diameter) in the skin. This characteristic appearance of infected fish has led fishermen to refer to the condition as "measles". In tissue sections the nodules are seen to consist of a large number of myxosporidian spores enclosed in a fibrous connective tissue capsule. The cyst occurs in the dermis just beneath the scales. Only parasites in advanced stages of spore development were seen.

Although presenting an unsightly appearance, infected fish need not lose their value as food, since the flesh is not affected.

The incidence of this myxosporidian in Pacific salmon is not known, but from reports of commercial fishermen, it appears to be low. Shaw, Simms and Muth (1934) reported a case of this myxosporidiosis in a coho salmon caught in Oregon. These authors stated that the parasite is common in pond fishes and fishes in inland waters. It is not clear whether they are referring to the genus Myxobolus in general or the species involved here. A search of the literature has not revealed reports of this myxosporidian since the original description by Keysselitz.

Keysselitz in 1908 (in Kudo, 1920) described M. squamae from fresh water fishes in Germany. Although the spores of the specimens examined are identical in morphology with M. squamae (description in Kudo, 1920) it is possible that a different species is involved in view of the wide geographical separation of the two localities and the marine habitat of the salmon at the time of its capture, while the original description is from fresh water fish.

The infected coho salmon was a mature individual returning to fresh water to spawn. Its age would thus probably be three years, of which two years were spent at sea. The possibility exists that the fish became infected during its early life in fresh water and carried the infection to sea.

The spores measured in water, after in situ formalin fixation, were 9.8-10.7μ long, 7.7-8.5μ in breadth and 6-6.5μ thick. The polar capsules measured about 4.5μ in length.

In two spores in a stained smear the polar filament appeared to be extruded due to rupture of the spore. The lengths of these polar filaments were 15µ and 16µ.

DISCUSSION AND SUMMARY

Specimens of forty-two species of fish, mostly food-fish, were investigated for parasites from nearly all commercial fishing areas along the British Columbia coast. Fifty-six different species of parasites were recorded of which seven were named as new species and at least two others are considered as new but were not named due to lack of adequate material. The following list is the record of parasites found in this study.

TREMATODA (Digenea)

Pseudopecoelus vancouveri, n. sp.

Podocotyle wilsoni, n. sp.

Helicometra sp. (probably new)

* Stephanostomum dentatum (Linton, 1900) Manter, 1931

* Otodistomum veliporum (Creplin, 1837)

+* Otodistomum veliporum (Creplin, 1837), metacercaria

* Platocystis alalongae Yamaguti, 1938

\+ Metanematobothrium guernei (Moneiz, 1891) Yamaguti, 1938

\+ Didymozoon sp.

\+ Didymocystis sp.

* Parahemiurus merus (Linton, 1910) Woolcock, 1935

Parahemiurus oncorhynchi n. sp.

Tubulovesicula nanaimoensis (McFarlane, 1936) Manter, 1947

Lecithochirium exodicum McFarlane, 1936

* Derogenes varicus (Müller, 1784) Looss, 1901

* Brachyphallus crenatus (Rudolphi, 1802) Odhner, 1905

Syncoelium filiferum (Sars, 1885) Lloyd and Guberlet, 1936

TREMATODA (Monogenea)

+* Entobdella hippoglossi (Müller, 1776) Johnston, 1856

* Entobdella squamula (Heath, 1902) Johnston, 1929

Capsala martinieri Bosc, 1811

CESTODA

Phyllobothrium ketae Canavan, 1928, larva

+* Phyllobothrium sp. larva (Scolex pleuronectis Müller, 1788)

Nybelinia surmenicola Okada, 1929, postlarva

Grillotia heptanchi (Vaullegeard, 1899)

Gilquinia squali (Fabricius, 1794)

Clestobothrium crassiceps (Rudolphi, 1819)

Bothriocephalus scorpii (Müller, 1776)

Eubothrium oncorhynchi Wardle, 1932

+* Abothrium gadi (van Beneden, 1871)

Pseudophyllidean plerocercoids (7)

CESTODARIA

Amphilina bipunctata Riser, 1948

ACANTHOCEPHALA

Echinorhynchus gadi Zoega in Müller, 1776

Gorgorhynchus sp. (probably new)

Corynosoma strumosum (Rudolphi, 1802), juvenile

NEMATODA

Capillaria lepidopsettae n. sp.

Capillaria lycodi n. sp.

Capillaria parophrysi n. sp.

+* *Contracaecum aduncum* (Rudolphi, 1802)

+* *Contracaecum* sp. larva

* *Porrocaecum* sp. larva

* *Anisakis* sp. (spp.) larva

Cucullanus elongatus Smedley, 1933

Dacnitis plicata n. sp.

Philonema oncorhynchi Kuitunen-Ekbaum, 1933

Philometra americana Kuitunen-Ekbaum, 1933

COPEPODA

* *Caligus gurnardi* Kroyer, 1863

* *Lepeoptheirus salmonis* (Kroyer, 1838)

\+ *Elytrophora brachyptera* Gerstaecker, 1853

* *Phrixocephalus cincinnatus* Wilson, 1908

Anthosoma crassum (Abildgaard)

MYXOSPORIDIA

* *Myxobolus squamae* Keysselitz, 1908

* -- denotes not previously known from the Pacific coast of Canada.

+ -- denotes not previously known from any part of the Pacific coast of North America, but this record is not from the Canadian coast.

+* -- denotes not previously recorded from any part of the Pacific coast of North America, and this record is from the Canadian coast.

The following species are considered as synonyms of previously named species.

Syncoelium katuwo Yamaguti, 1938, synonym of *S. filiferum* (Sars, 1885) Lloyd and Guberlet, 1936.

Otodistomum plicatum Kay, 1947, synonym of *O. veliporum* (Creplin, 1837).

Contracaecum magnum Smedley, 1934, synonym of *C. aduncum* (Rudolphi, 1802).

Contracaecum sp. larva of Smedley, 1934, synonym of *Anisakis* sp. larva.

The reports here appear to contain first records of parasites from fifteen of the host species. These are indicated in the following list by *. Seventy new host records were also listed. These are marked + in the following host-parasite list, which is presented alphabetically by host.

* *Acipenser transmontanus*

Cestodaria: + *Amphilina bipunctata* Riser, 1948

Nematoda: + *Anisakis* sp. larva

* *Acrotus willoughbyi*

Nematoda: + *Anisakis* sp. larva

Ammodytes tobianus personatus

Nematoda: Contracaecum sp. larva

* Anoplopoma fimbria

Nematoda: + Porrocaecum sp. larva

+ Anisakis sp. larva

Atheresthes stomias

Nematoda: + Anisakis sp. larva

Copepoda: Phrixocephalus cincinnatus Wilson, 1908

Citharichthys sordidus

Trematoda (Digenea): + Derogenes varicus (Müller, 1784) Looss, 1901

+ Otodistomum veliporum (Creplin, 1837) metacercaria

Nematoda: + Anisakis sp. larva

Clupea pallasii

Nematoda: Anisakis sp. larva

+ Contracaecum sp. larva

* Delolepis giganteus

Cestoda: + Bothriocephalus scorpii (Müller, 1776)

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

+ Anisakis sp. larva

Eopsetta jordani

Trematoda (Digenea): Lecithochirium exodicum McFarlane, 1936

Podocotyle wilsoni n. sp.

+ Otodistomum veliporum (Creplin, 1837) metacercaria

Trematoda (Monogenea): + Entobdella squamula (Heath, 1902) Johnston, 1929

Cestoda: + Phyllobothrium ketae Canavan, 1928, larva

+ Nybelinia surmenicola Okada, 1929, larva

Acanthocephala: + Echinorhynchus gadi Zoega in Müller, 1776.

+ Corynosoma strumosum (Rudolphi, 1802), juvenile.

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

+ Contracaecum sp. larva

Anisakis sp. larva

Gadus macrocephalus

Cestoda: Abothrium gadi (van Beneden, 1871)

Pseudophyllidean plerocercoid

Acanthocephala: Echinorhynchus gadi (Zoega in Müller, 1776)

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

Porrocaecum sp. larva

Anisakis sp. larva

* Glyptocephalus zachirus

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

+ Anisakis sp. larva

Hexanchus griseus

Trematoda (Digenea): Otodistomum veliporum (Creplin, 1837)

Cestoda: Grillotia heptanchi (Vaullegeard, 1899)

* Hippoglossoides elassodon

Cestoda: + Phyllobothrium sp. larva (Scolex pleuronectis, (Müller, 1776)

+ Nybelinia surmenicola Okada, 1929, larva

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

+ Anisakis sp. larva

Hippoglossus stenolepis

Trematoda (Monogenea): +Entobdella hippoglossi Müller, 1776) Johnston, 1856

* Hypomesus pretiosus

Nematoda: +Contracaecum aduncum (Rudolphi, 1802)

* Isopsetta isolepis

Nematoda: +Anisakis sp. larva

Isurus nasus

Copepoda: Anthosoma crassum (Abildgaard, 1794)

Lepidopsetta bilineata

Trematoda (Digenea): +Otodistomum veliporum (Creplin, 1837) metacercaria

Cestoda: + Nybelinia surmenicola Okada, 1929, larva

Pseudophyllidean plerocercoids (2)

Acanthocephala: + Echinorhynchus gadi Zoega in Müller, 1776

Nematoda: Capillaria lepidopsettae n. sp.

+Anisakis sp. larva

*Lycodes brevipes

Nematoda: Capillaria lycodis n. sp.

+Anisakis sp. larva

* Lyopsetta exilis

Trematoda(Digenea): + Parahemiurus merus (Linton, 1910) Woolcock, 1935

+Derogenes varicus (Muller, 1784) Looss, 1901

Cestoda: + Nybelinia surmenicola Okada, 1929, larva

Nematoda: + Contracaecum sp. larva

+Anisakis sp. larva

* Mallotus catervarius

Nematoda: +Anisakis sp. larva

Merluccius productus

Cestoda: Clestobothrium crassiceps (Rudolphi, 1819)

+Nybelinia surmenicola Okada, 1929, larva

Nematoda: Anisakis sp. larva

* Microstomus pacificus

Cestoda: +Nybelinia surmenicola Okada, 1929, larva

Nematoda: +Anisakis sp. larva

Mola mola

Trematoda (Monogenea): Capsala martinieri Bosc, 1811

Ophiodon elongatus

Trematoda (Digenea): +Parahemiurus merus (Linton, 1910) Woolcock, 1935

(?) Lecithochirium exodicum McFarlane, 1936

Nematoda: Contracaecum aduncum (Rudolphi, 1802)

+Porrocaecum sp. larva

Anisakis sp. larva

Cucullanus elongatus Smedley, 1933

Oncorhynchus gorbuscha

Cestoda: Phyllobothrium ketae Canavan, 1928, larva

Nematoda: Anisakis sp. larva

Copepoda: Lepeophtheirus salmonis (Kroyer, 1838)

Oncorhynchus keta

Trematoda (Digenea): +Brachyphallus crenatus (Rudolphi, 1802) Odhner, 1905

Cestoda: *Phyllobothrium ketae* Canavan, 1928, larva

+*Eubothrium oncorhynchi* Wardle, 1932

Nematoda: *Anisakis* sp. larva

Oncorhynchus kisutch

Trematoda (Digenea): +*Tubulovesicula nanaimoensis* (McFarlane, 1926) Manter, 1947

Parahemiurus oncorhynchi n. sp.

Nematoda: +*Contracaecum aduncum* (Rudolphi, 1802)

Anisakis sp. larva

Copepoda: *Lepeophtheirus salmonis* (Kroyer, 1838)

Myxosporidia: *Myxobolus squamae* (Keysselitz, 1908)

Oncorhynchus nerka

Cestoda: *Phyllobothrium ketae* Canavan, 1928, larva

Nematoda: *Philonema oncorhynchi* Kuitunen-Ekbaum, 1933

+*Contracaecum aduncum* (Rudolphi, 1802)

Anisakis sp. larva

Copepoda: *Lepeophtheirus salmonis* (Kroyer, 1838)

Oncorhynchus tshawytscha

Trematoda (Digenea): *Parahemiurus oncorhynchi* n. sp.

+*Tubulovesicula nanaimoensis* (McFarlane, 1936) Manter, 1947

Cestoda: Pseudophyllidean plerocercoids (2)

Nematoda: +*Philonema oncorhynchi* Kuitunen-Ekbaum, 1933

Anisakis sp. larva

Copepoda: *Caligus gurnardi* Kroyer, 1863

Lepeophtheirus salmonis (Kroyer, 1838)

Parophrys vetulus

Trematoda (Digenea): + Otodistomum veliporum (Creplin, 1837) metacercaria

Cestoda: + Nybelinia surmenicola Okada, 1929, larva

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

+ Contracaecum sp. larva

+ Anisakis sp. larva

Dacnitis plicata n. sp.

Capillaria parophrysi n. sp.

+ Philometra americana Kuitunen-Ekbaum, 1933

Platichthys stellatus

Nematoda: Philometra americana Kuitunen-Ekbaum, 1933

* Psettichthys melanostictus

Nematoda: + Anisakis sp. larva

Raja rhina

Trematoda (Digenea): + Otodistomum veliporum (Creplin, 1837)

Nematoda: + Anisakis sp. larva

* Sebastodes alutus

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

* Sebastodes brevispinis

Nematoda: + Anisakis sp. larva

Sebastodes paucispinis

Nematoda: + Anisakis sp. larva

Sebastodes ruberrimus

Nematoda: + Contracaecum aduncum (Rudolphi, 1802)

Sebastodes sp.

Trematoda (Digenea): +Stephanostomum dentatum (Linton, 1900) Manter, 1931

Pseudopecoelus vancouveri n. sp.

+Helicometra sp.

Cestoda: +Nybelinia surmenicola Okada, 1929, larva

Squalus suckleyi

Trematoda (Digenea): Otodistomum veliporum (Creplin, 1837)

Cestoda: Gilquinia squali (Fabricius, 1794)

Nematoda: Anisakis sp. larva

Theragra chalcogramma

Cestoda: Abothrium gadi (van Beneden, 1871)

Acanthocephala: Echinorhynchus gadi Zoega in Müller, 1776

Nematoda: +Contracaecum aduncum (Rudolphi, 1802)

+Anisakis sp. larva

Thunnus alalunga

Trematoda: +Syncoelium filiferum (Sars, 1885) Lloyd and Guberlet, 1936

Platocystis alalongae Yamaguti, 1938

Metanematobothrium guernei (Moneiz,1891) Yamaguti, 1938

Didymozoon sp.

Didymocystis sp.

Acanthocephala: +Gorgorhynchus sp.

Nematoda: Anisakis sp. larva

Copepoda: Elytrophora brachyptera Gerstaecker, 1853

Of the sixteen recorded species of digenetic trematodes, P. alalongae and S. filiferum adults are known only from the Pacific (North American and Asiatic), T. nanaimoensis and L. exodicum are known only from the North American Pacific, while all the other species (excluding, of course, the new ones) are known from both the Atlantic and Pacific Oceans. Tubulovesicula nanaimoensis has been reported only from British Columbia. Three species were described as new.

The monogenetic trematodes E. hippoglossi and C. martinieri are common both in the Atlantic and Pacific Oceans. The former is specific for halibut, and the latter is parasitic only on the ocean sun-fish (Mola mola). Entobdella squamula appears to be specific for flounders. It is known from the North American west coast and the Gulf of Mexico.

The cestodes G. heptanchi, G. squali, C. crassiceps, B. scorpii, A. gadi and Scolex pleuronectis (Phyllobothrium sp.) are common parasites in Atlantic and Pacific fish. Nybelinia surmenicola is known only from the Japanese and North American Pacific, while P. ketae and E. oncorhynchi have only been recorded from the North American Pacific. The cestode species found both in the Atlantic and Pacific, parasitize very closely related, if not the same hosts in both Oceans, except for B. scorpii which has a very wide host range.

The cestodarian, Amphilina bipunctata is known only from sturgeons of the North American Pacific. It is very similar to Amphilina spp. of European and Japanese sturgeons.

The Acanthocephala here recorded, except Gorgorhynchus sp. (which is probably new) are cosmopolitan and have wide host ranges.

The nematode fauna of North American Pacific coast fish appears to contain many species not found elsewhere. Four of the ten species recorded here are new. Three others, C. elongatus, P. oncorhynchi and P. americana are known only from the Canadian Pacific coast. Three other species, not found in this study, again have not been recorded from other geographical localities. These are Metabronema wardlei Smedley, 1934 from a sculpin in British Columbia, Cystidicola walkeri Ekbaum, 1935 described from British Columbia, salmon and Procamallanus pereira Annereaux, 1946 from Bolinas Bay, California. The cosmopolitan nematodes recorded here, C. aduncum, Contracaecum sp. larva, Porrocaecum sp. larva and Anisakis sp. larva are all ascaroids. They do not show the host or geographical specificity of the other recorded groups of nematodes.

Four of the five species of copepods found in this study are known from Atlantic and Pacific Oceans. Phrixocephalus cincinnatus is known to occur only in flounders of the North American Pacific.

The only myxosporidian encountered in this study, Myxobolus squamae, appears to be known only from fresh water fish in Germany and in salmon of the Pacific coast of North America, near the end of the marine stage of their life. This peculiar distribution and difference in hosts and their habitat, causes one to wonder if the same species is involved, even though the morphology of the parasite from the German fresh water fish is identical with that from the Pacific salmon.

Of the parasites encountered in this study, none appeared to be exceedingly pathogenic. Of the alimentary tract forms, only the cestode, Abothrium gadi, appeared to do any damage. Abothrium gadi causes some pathological changes in the tissues of the pyloric caeca, where the scolex becomes completely embedded. Even the tissue inhabiting forms, which sometimes produce unsightly external conditions, did not seem to affect the general condition of the fish to any noticeable extent. The characteristic reaction of the fish is to wall off the parasite by surrounding it with fibrous connective tissue. Of the encountered parasites, the blindness produced by infection of theeye with the copepod Phrixocephalus cincinnatus was probably the most serious pathological condition. However, this parasite seemed to be very rare, and consequently is not of economic importance.

Myxosporidian infections are frequently serious problems in the fishing industry. The one encountered in the salmon appeared to be quite rare and did not affect the quality of the fish as food. However, certain myxosporidian infections of flat-fish have been known to cause serious damage to the flesh, rendering them unfit for market. One such condition in Pacific halibut, known as "wormy halibut" was described by Thompson (1916) and Davis (1924). The causative organism, Unicapsula muscularis Davis, 1924, infects and destroys the muscle fibres. Other infections of the flesh of flat-fish, which at times have been known to attain epizootic proportions, probably have Myxosporidia or Microsporidia as the etiological agent. Such conditions are commonly referred to as "milky", "mushy" or "chalky" flesh. Willis (1949) gave a detailed report of Chloromyxum thyrsites Gilchrist, 1924, the cause of "milky" flesh in Thyrsites atun in Australian and South African marine waters. Several other species of Chloromyxum have been described as producing similar conditions in fish muscle.

In addition to myxosporidian infections, tissue infections by ascaroid nematodes are of the utmost economic importance in the herring, flounder and cod-fish industry. The presence of Anisakis larvae in the body cavity of the herring has practically forced the removal of canned herring from the market. The presence of Anisakis larvae in the muscle of flounders and Porrocaecum larvae in the muscle of cod and sable-fish is presenting a serious threat to the marketability of these fish.

A study of Anisakis sp. infection in flounders was undertaken. The results of this study, summarized in the discussion on Anisakis sp. larva, indicated that a shrimp, Euphausica pacifica possibly plays a role in the life history of the nematode. The adult appears to be found in marine mammals since two species, A. simplex and A. similis are known to occur in whales and sea-lions of the North American Pacific.

As the hosts were not examined in equal numbers, no comparisons can be made as to the degree of parasitic infections in the different species of fish.

Anisakis sp. larva was overwhelmingly the commonest parasite encountered, with respect to host and geographical distribution and number of parasites per individual host.

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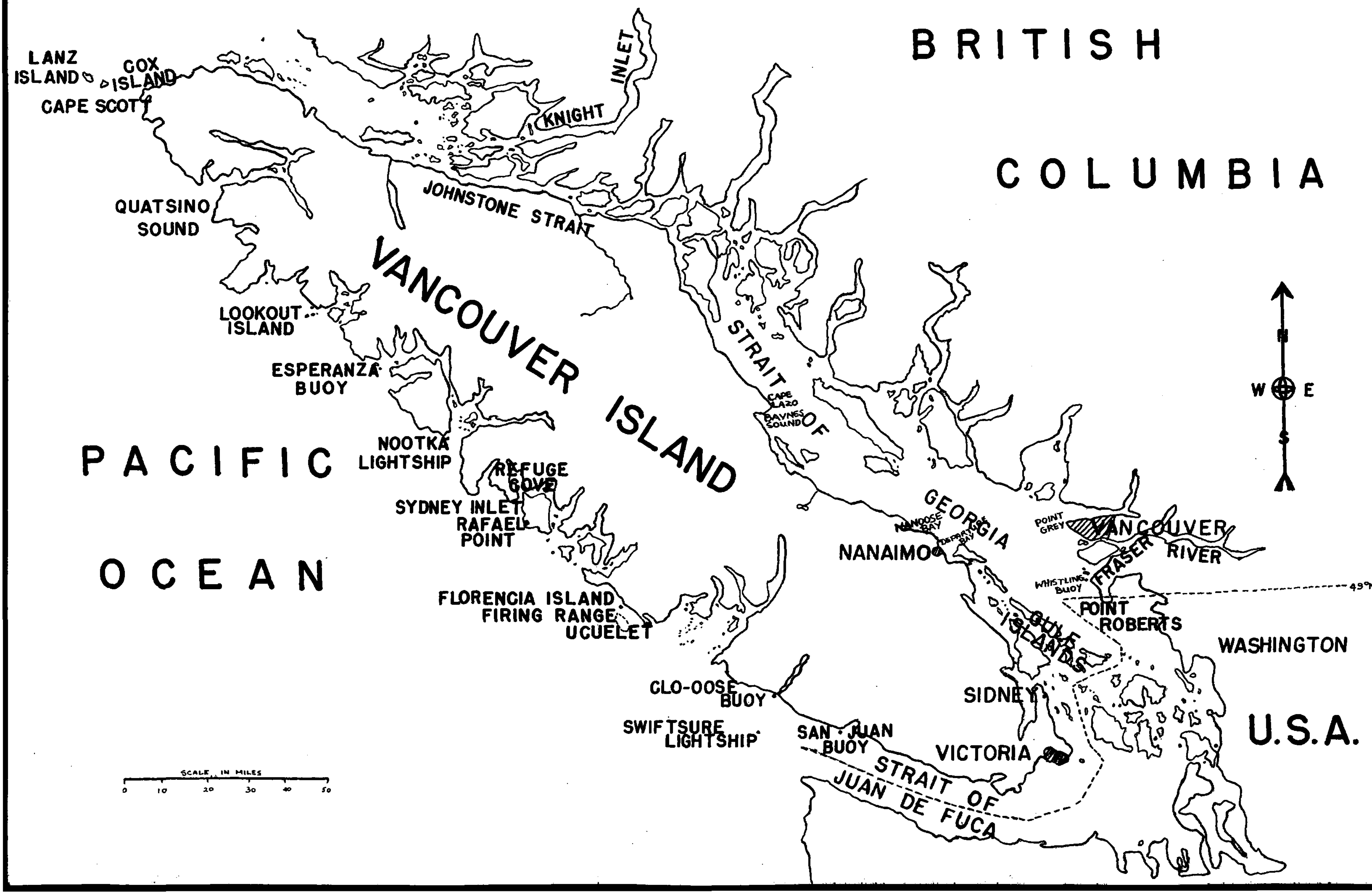
Fig. 1. Map of southern half of the British Columbia coast, including Vancouver Island.



BRITISH COLUMBIA
LANZ ISLAND
COX ISLAND
CAPE SCOTT
KNIGHT INLET
QUATSINO SOUND
JOHNSTONE STRAIT
VANCOUVER ISLAND
LOOKOUT ISLAND
ESPERANZA BUOY
STRAIT OF GEORGIA
CAPE LAZO
BAYNES SOUND
NOOTKA LIGHTSHIP
PACIFIC OCEAN
REFUGE COVE
SYDNEY INLET
RAFAEL POINT
NANOOSE BAY
DEPARTURE BAY
NANAIMO
POINT GREY
VANCOUVER
FRASER RIVER
WHISTLING BUOY
49°N
FLORENCIA ISLAND FIRING RANGE
UCUELET
GULF ISLANDS
POINT ROBERTS
WASHINGTON
CLO-OOSE BUOY
SIDNEY
SWIFTSURE LIGHTSHIP
SAN JUAN BUOY
VICTORIA
U.S.A.
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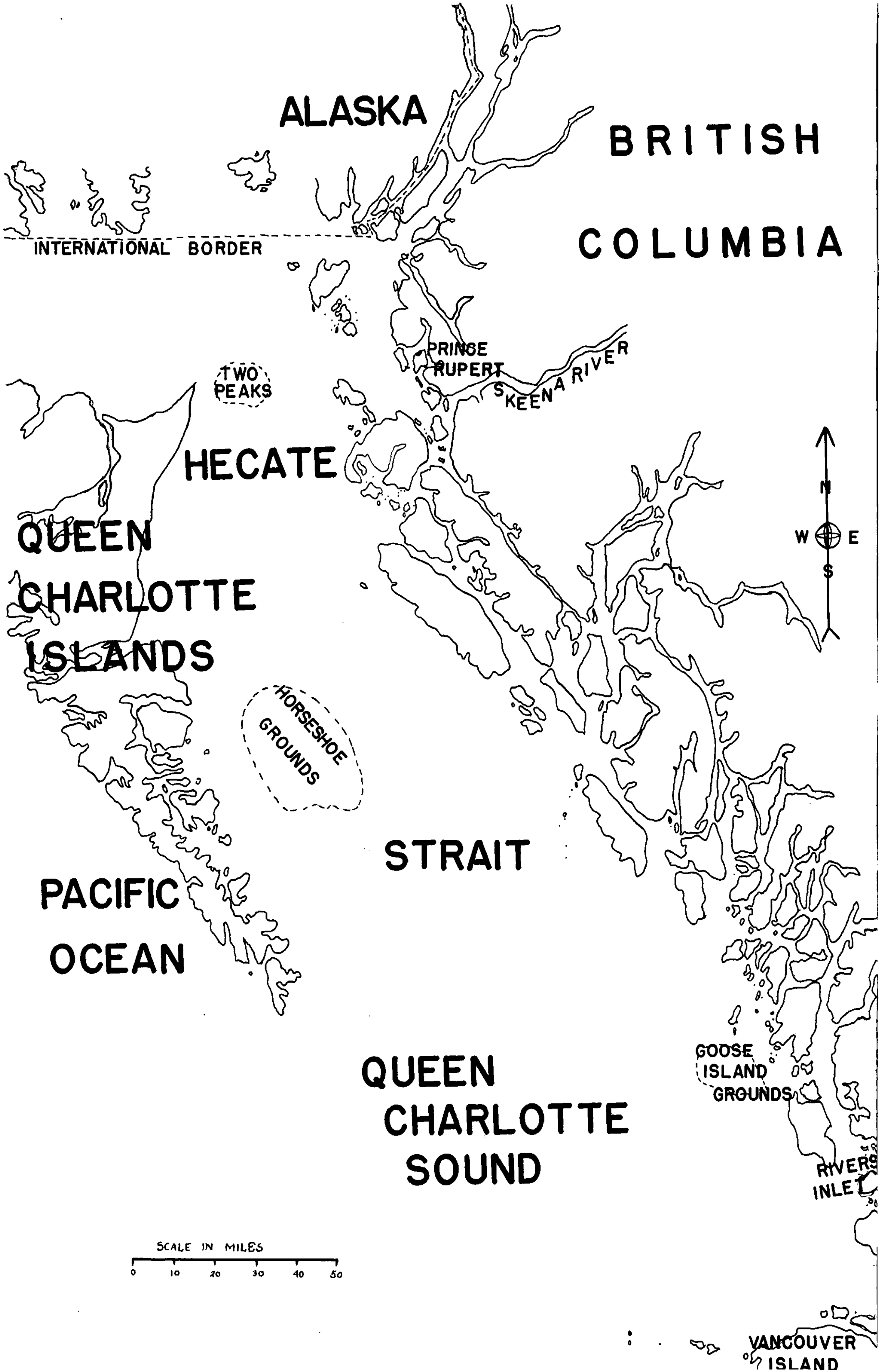
Fig. 2. Map of northern half of British Columbia coast, including Queen Charlotte Islands.



ALASKA
BRITISH
COLUMBIA
INTERNATIONAL BORDER
PRINCE
RUPERT
SKEENA RIVER
TWO
PEAKS
HECATE
QUEEN
CHARLOTTE
ISLANDS
HORSESHOE
GROUNDS
STRAIT
PACIFIC
OCEAN
N
W
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GOOSE
ISLAND
GROUNDS
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VANCOUVER
ISLAND

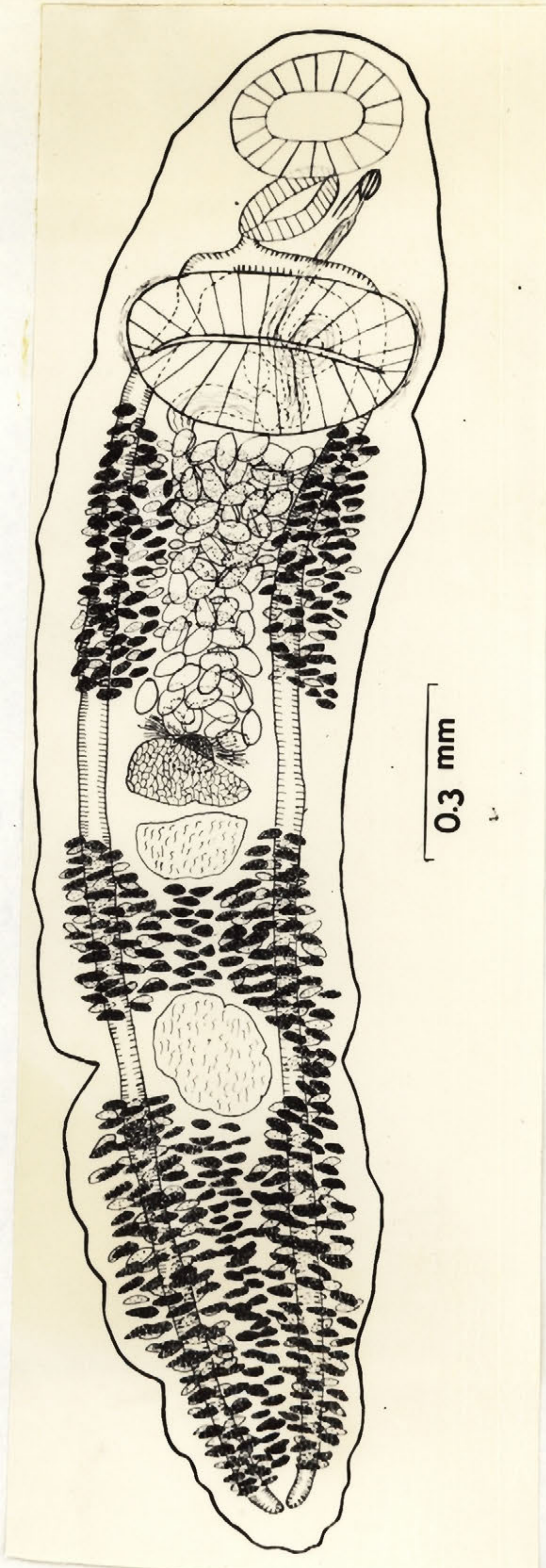


Fig. 3. Pseudopecoelus vancouveri, n. sp. - ventral view.

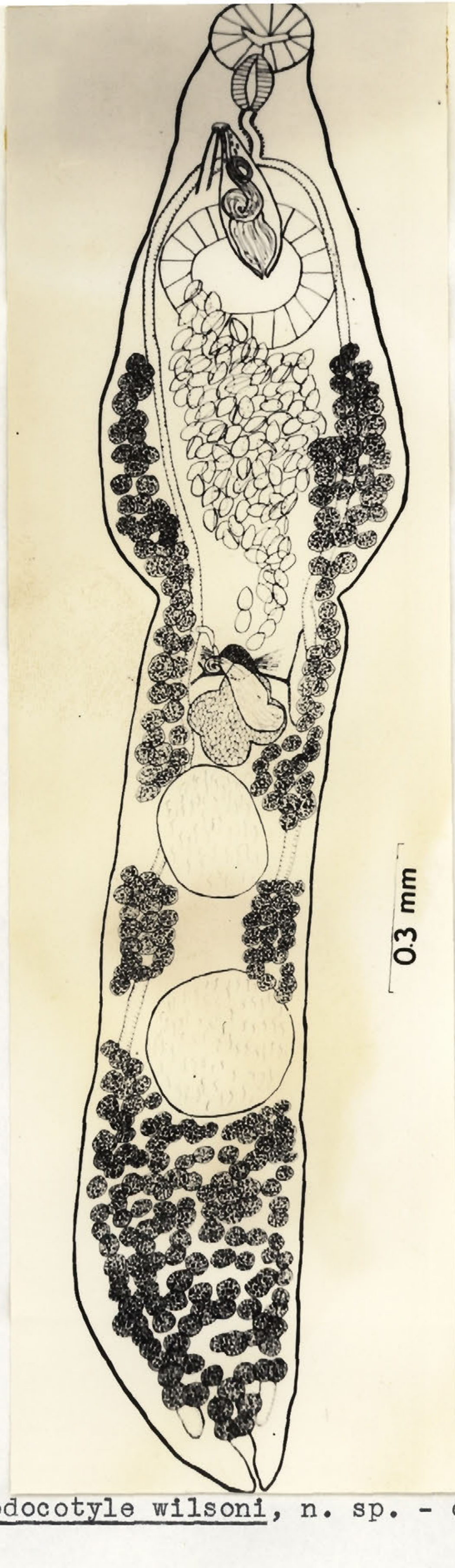
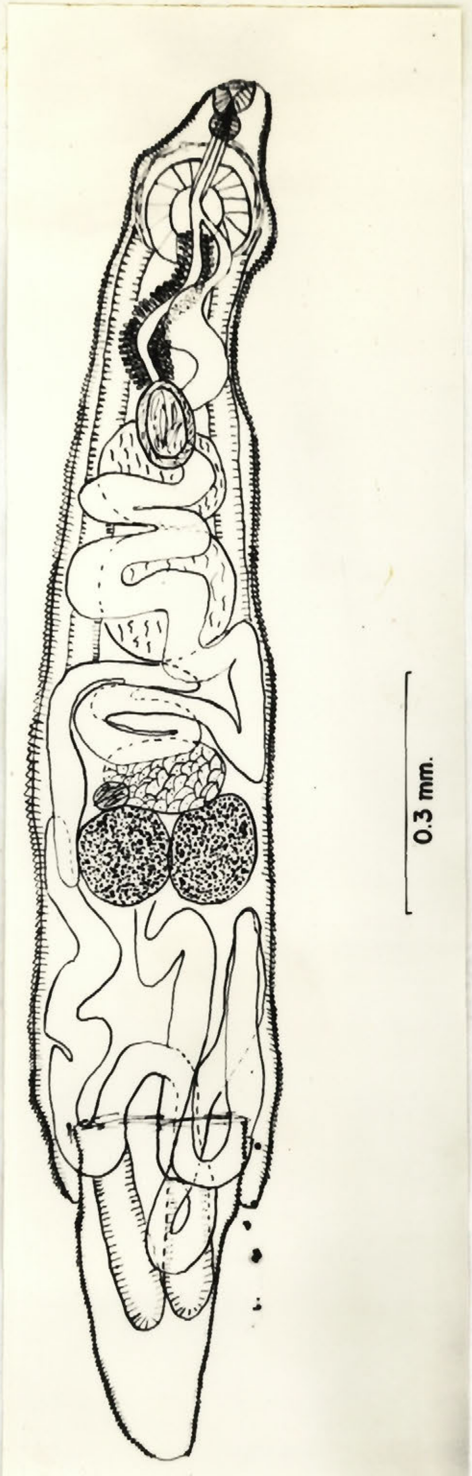


Fig. 4. Podocotyle wilsoni, n. sp. - dorsal view.



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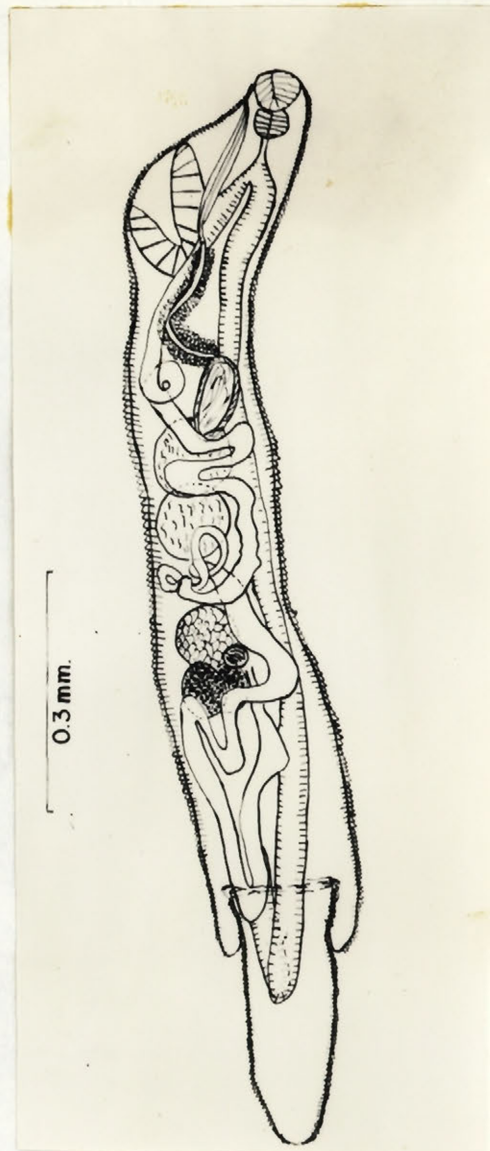

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Fig. 5. Parahemiurus oncorhynchi, n. sp. - dorsal view.
Fig. 6. Parahemiurus oncorhynchi, n. sp. - lateral view.

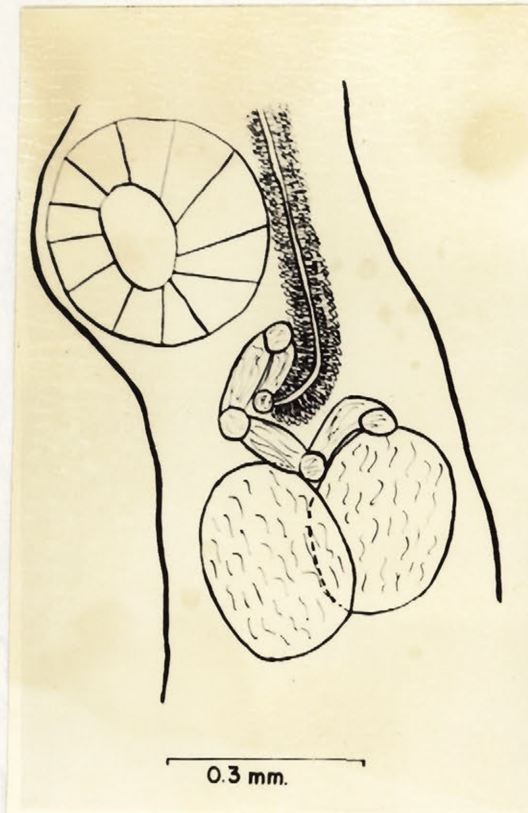


Fig. 7. Tubulovesicula nanaimoensis (McFarlane, 1936) Manter, 1947, semi-ventral view, showing seminal vesicle, prostatic duct and cells, testes and acetabulum.

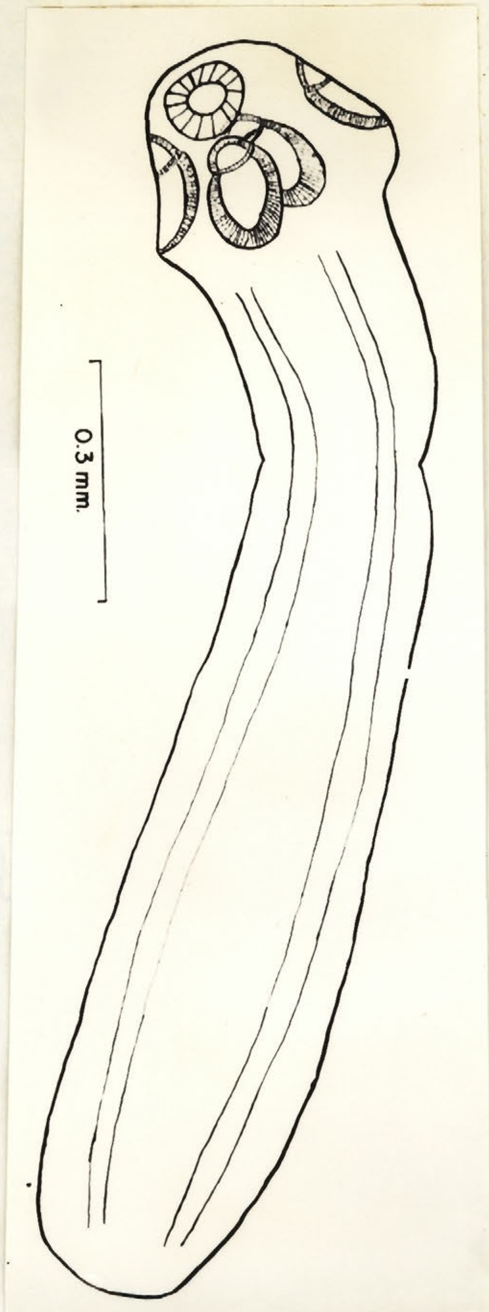


Fig. 8. Phyllobothrium sp. larva (Scolex pleuronectis Müller, 1788).

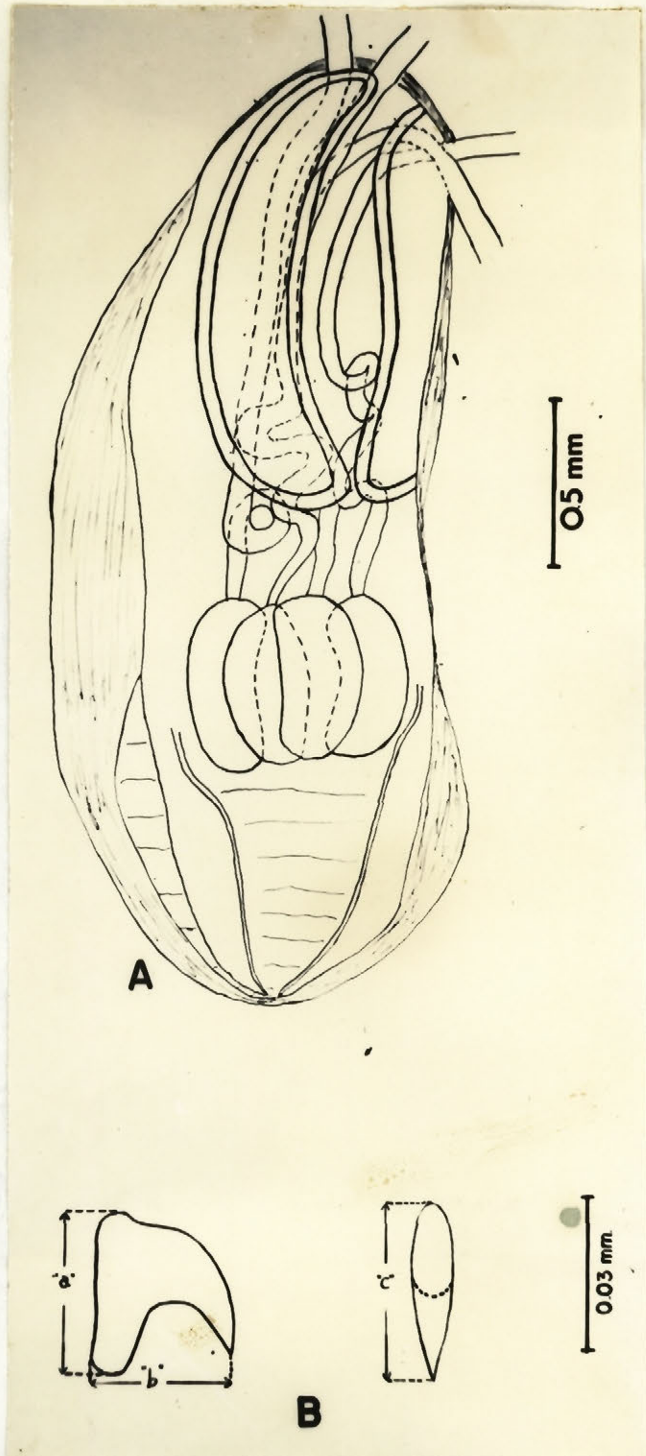


Fig. 9. Nybelinia surmenicola Okada, 1929, postlarva.
A -- encysted form.
B -- hooks. "a" = length of base
"b" = height
"c" = length

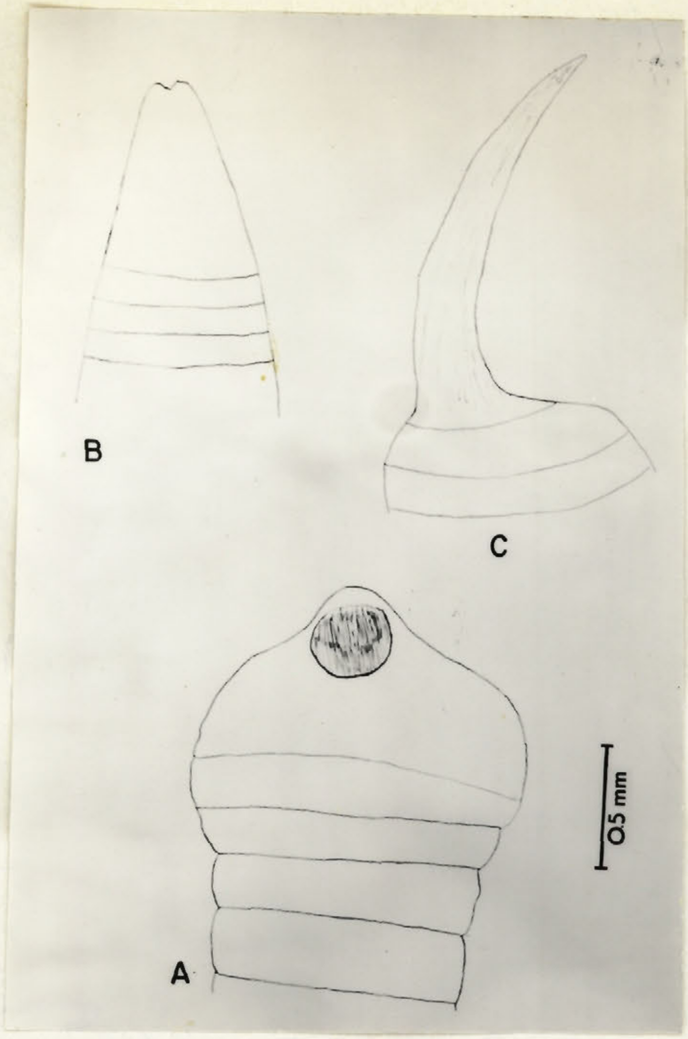


Fig. 10. Abothrium gadi (van Beneden, 1871).
A -- true scolex.
B -- advanced stage in degeneration of scolex.
C -- pseudoscolex.

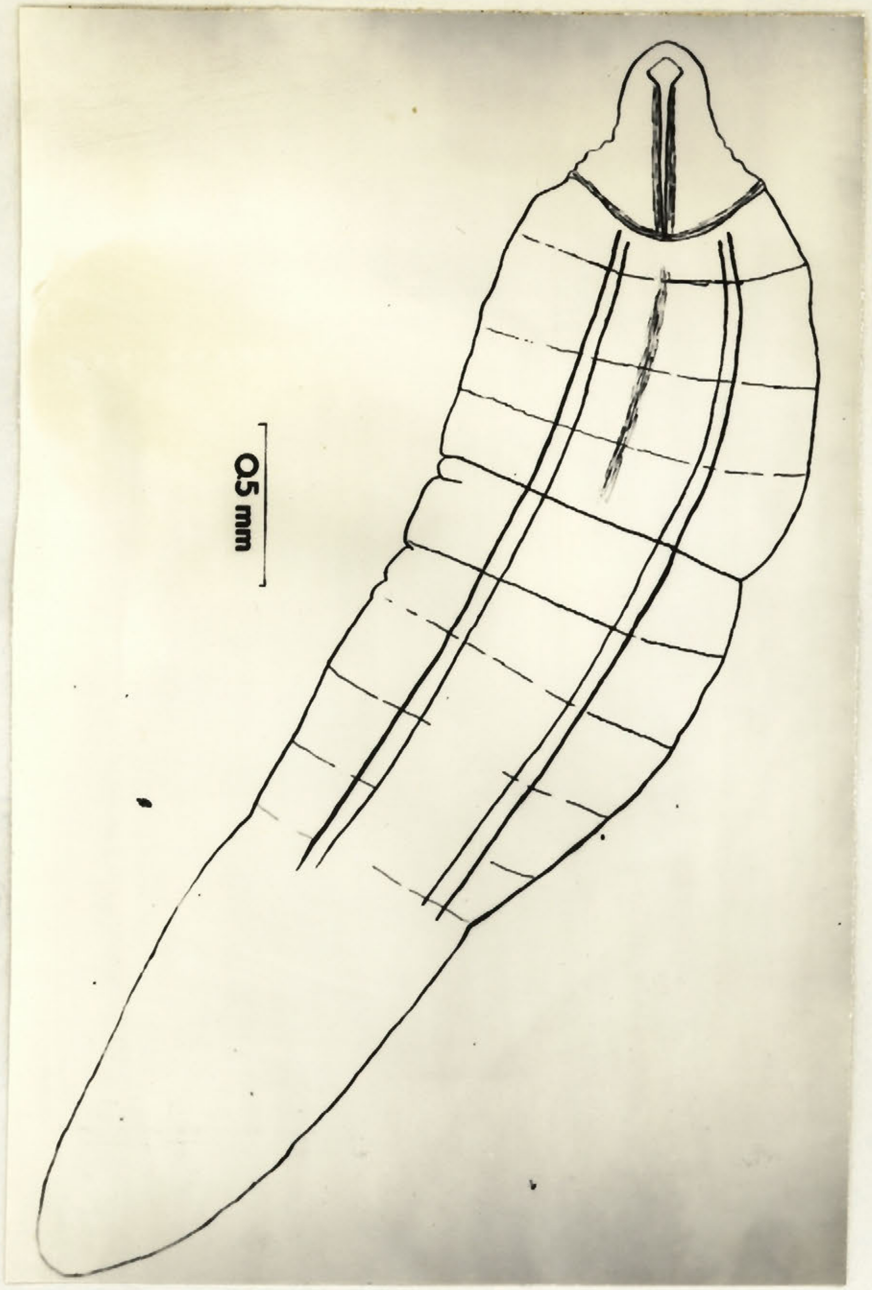
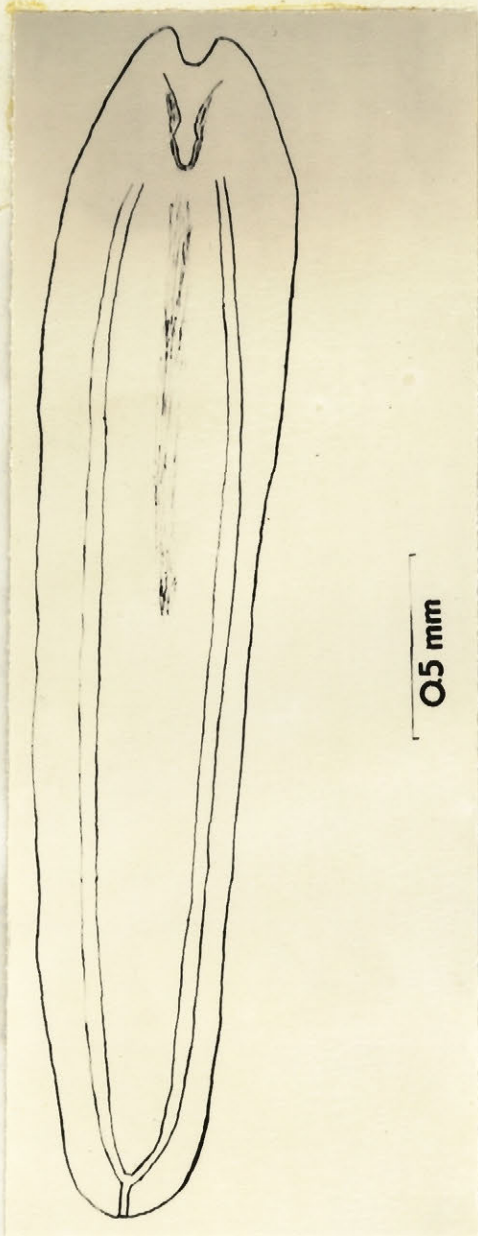


Fig. 11. Pseudophyllidea plerocercoid I - from Oncorhynchus tshawytscha surficial view.



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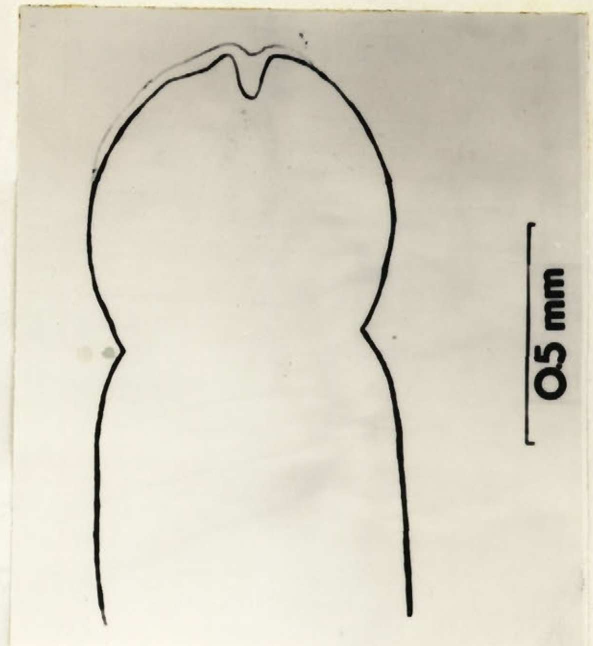

13

Fig. 12. Pseudophyllidea plerocercoid II from *Oncorhynchus tshawytscha* - surficial view.
Fig. 13. Pseudophyllidea plerocercoid II from *Oncorhynchus tshawytscha* - lateral view.

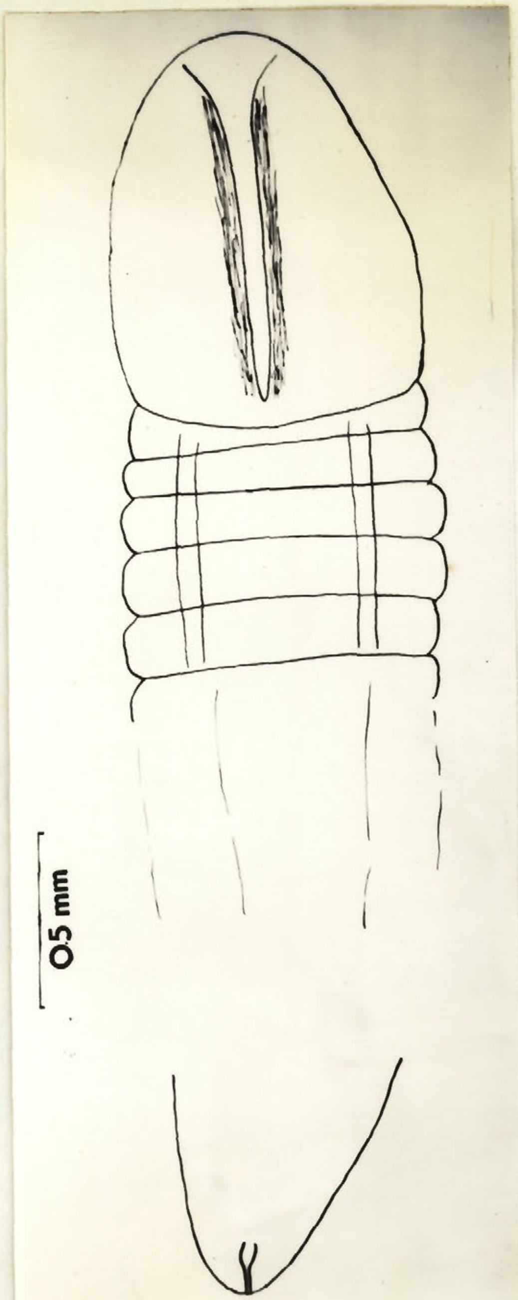

Fig. 14. Pseudophyllidea plerocercoid III from Lepidopsetta bilineata -surficial view of anterior and posterior extremities.

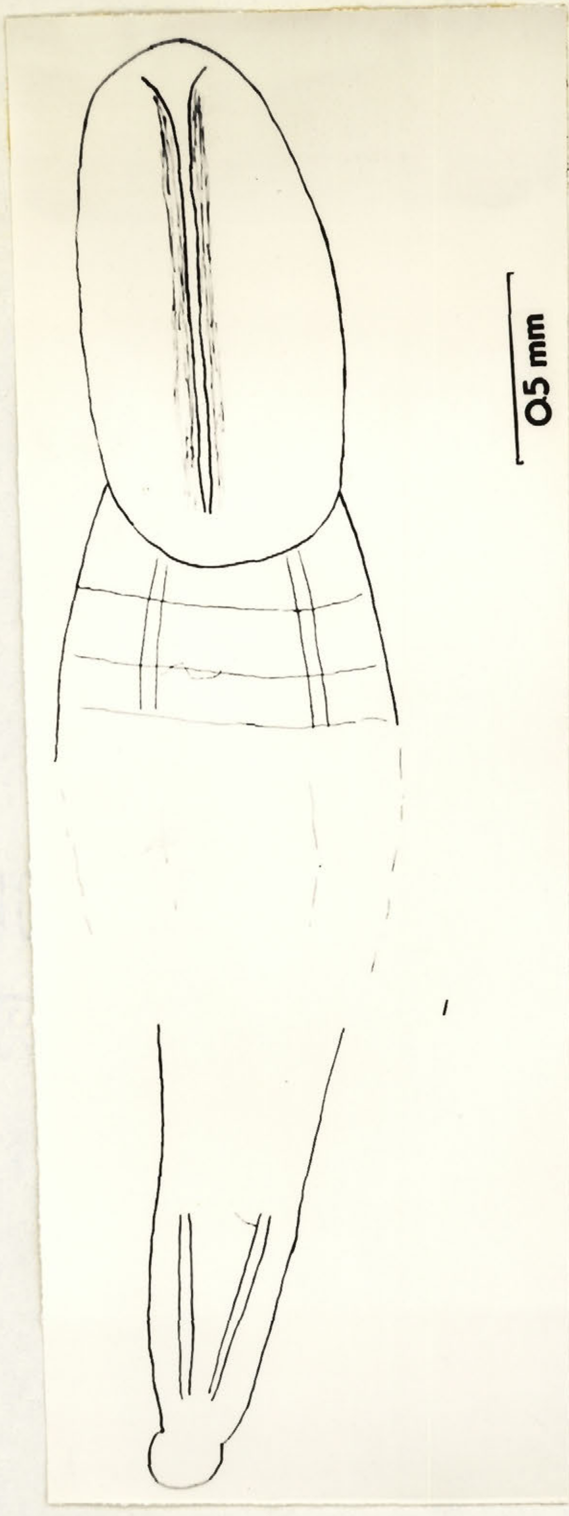

Fig. 15. Pseudophyllidea plerocercoid IV from Lepidopsetta bilineata - surficial view of anterior and posterior extremities.

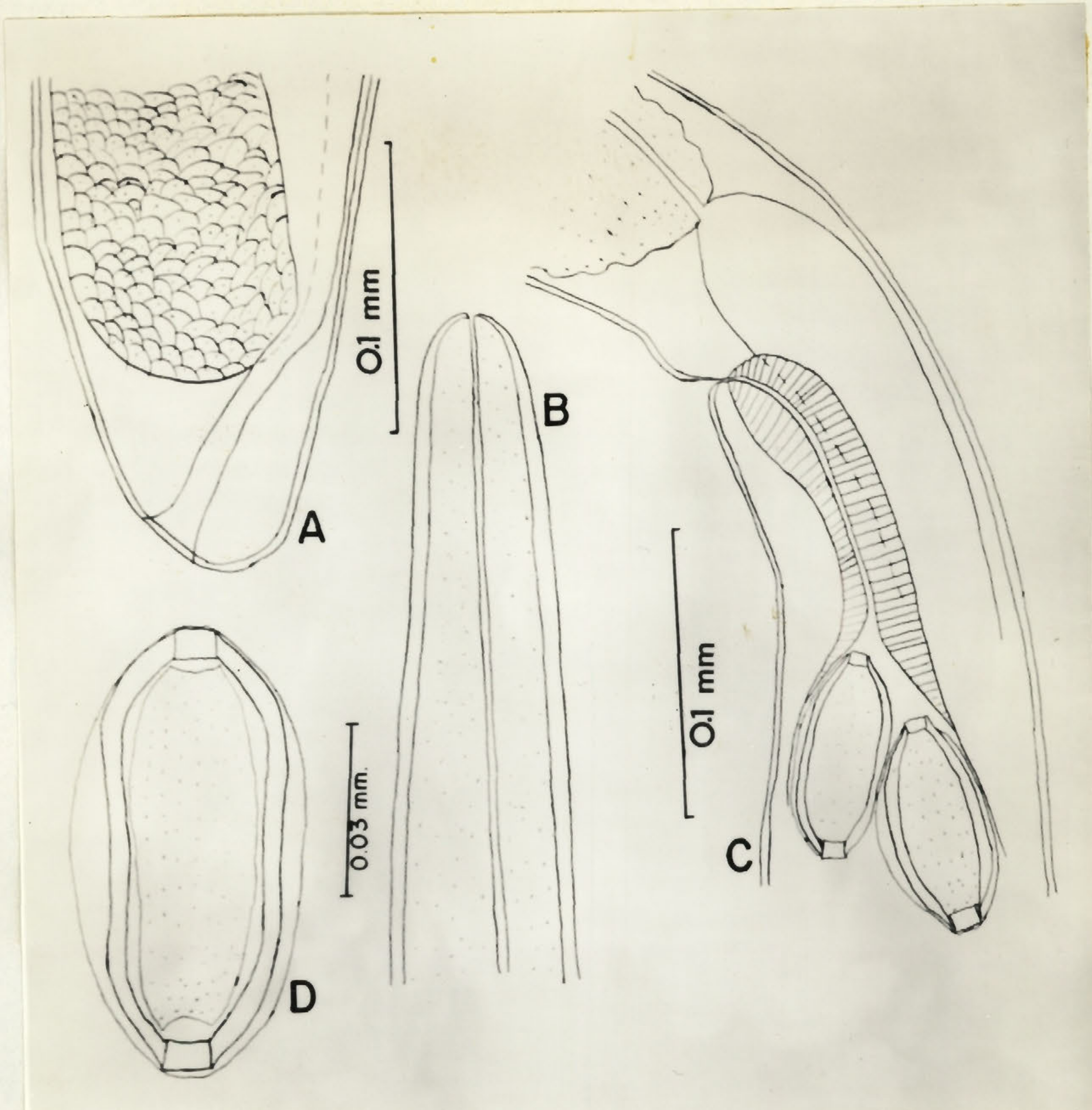

Fig. 16. Capillaria lepidopsettae n. sp., female.
A -- posterior extremity.
B -- anterior extremity.
C -- vulvar region.
D -- egg.

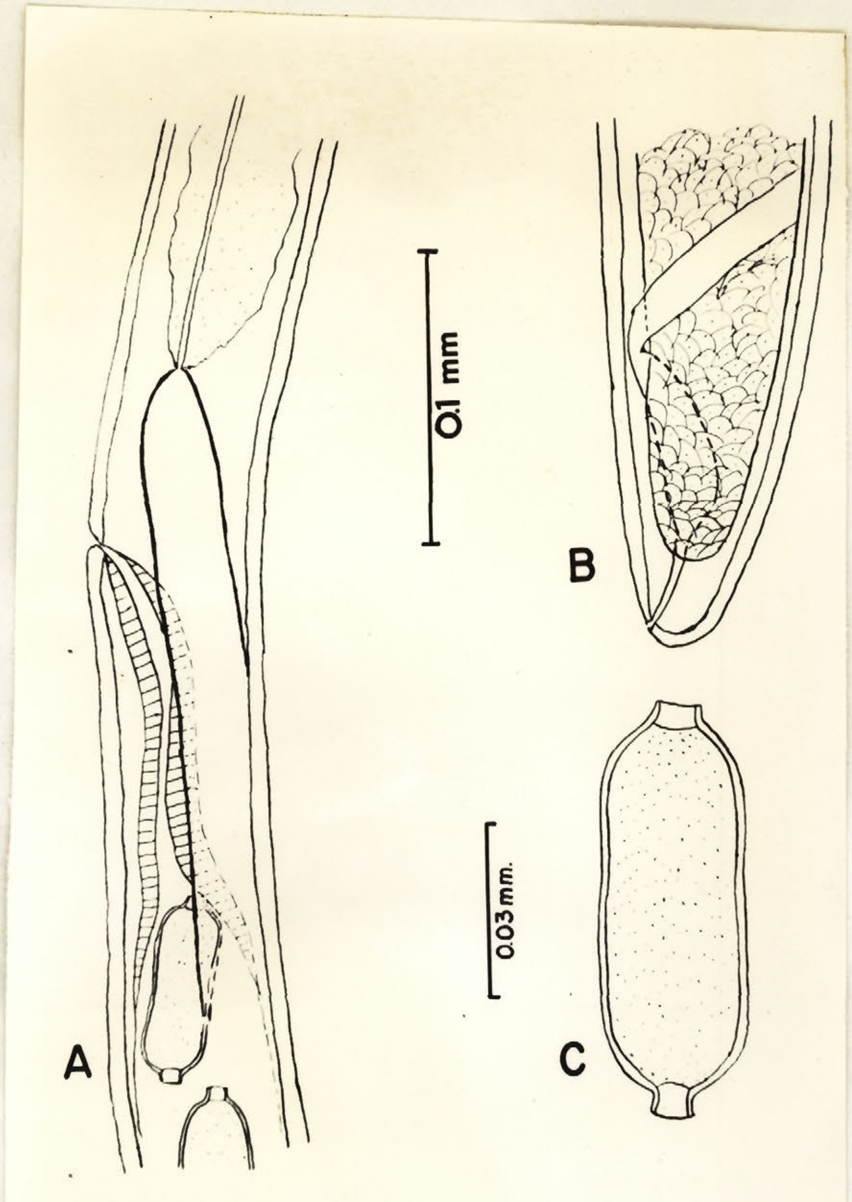

Fig. 17. Capillaria parophrysi, n. sp., female.
A -- vulvar region.
B -- posterior extremity.
C -- egg.

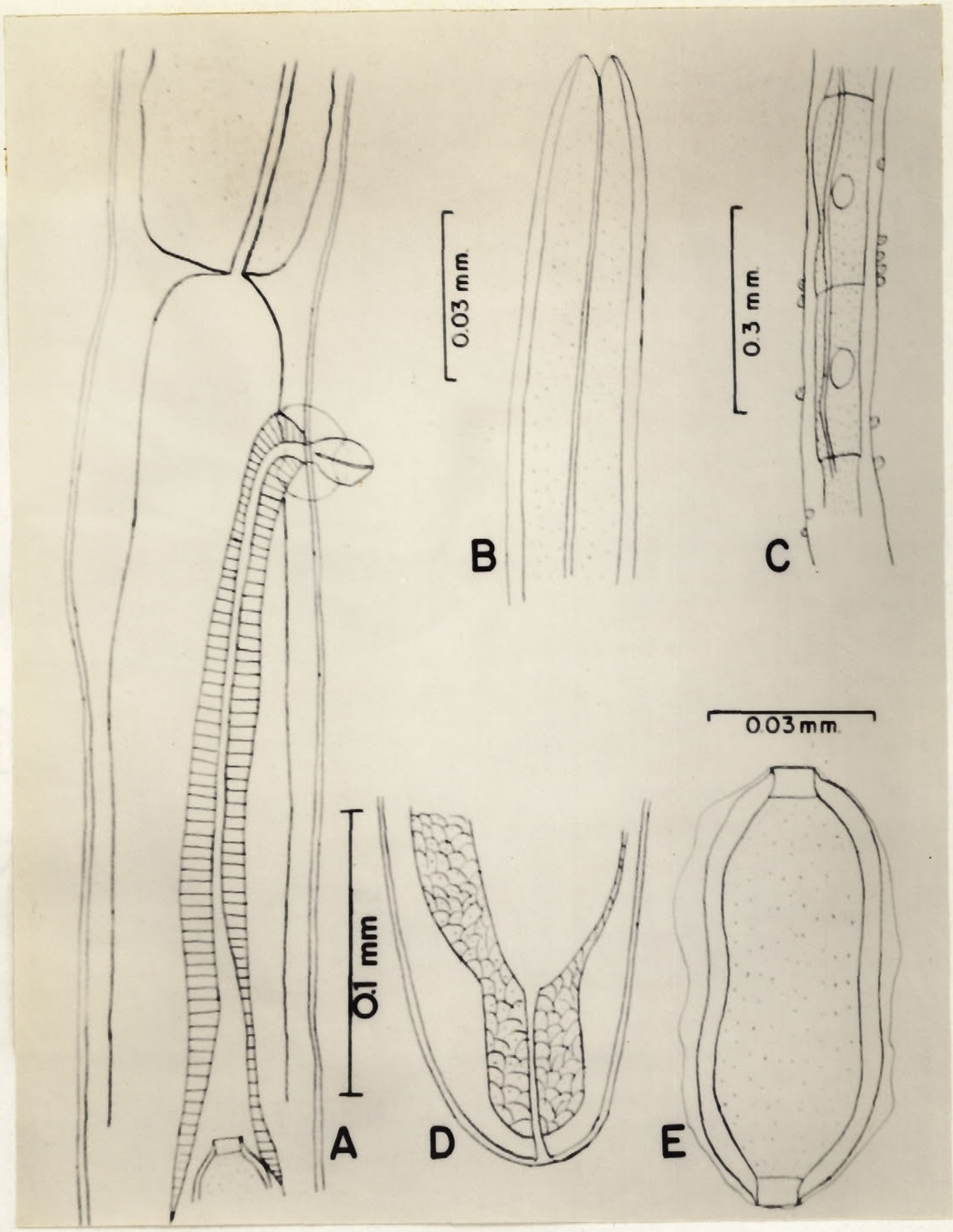

Fig. 18. Capillaria lycodi, n. sp., female.
A -- vulvar region.
B -- anterior extremity.
C -- oesophageal region, showing cuticular tubercles.
D -- posterior extremity.
E -- egg.

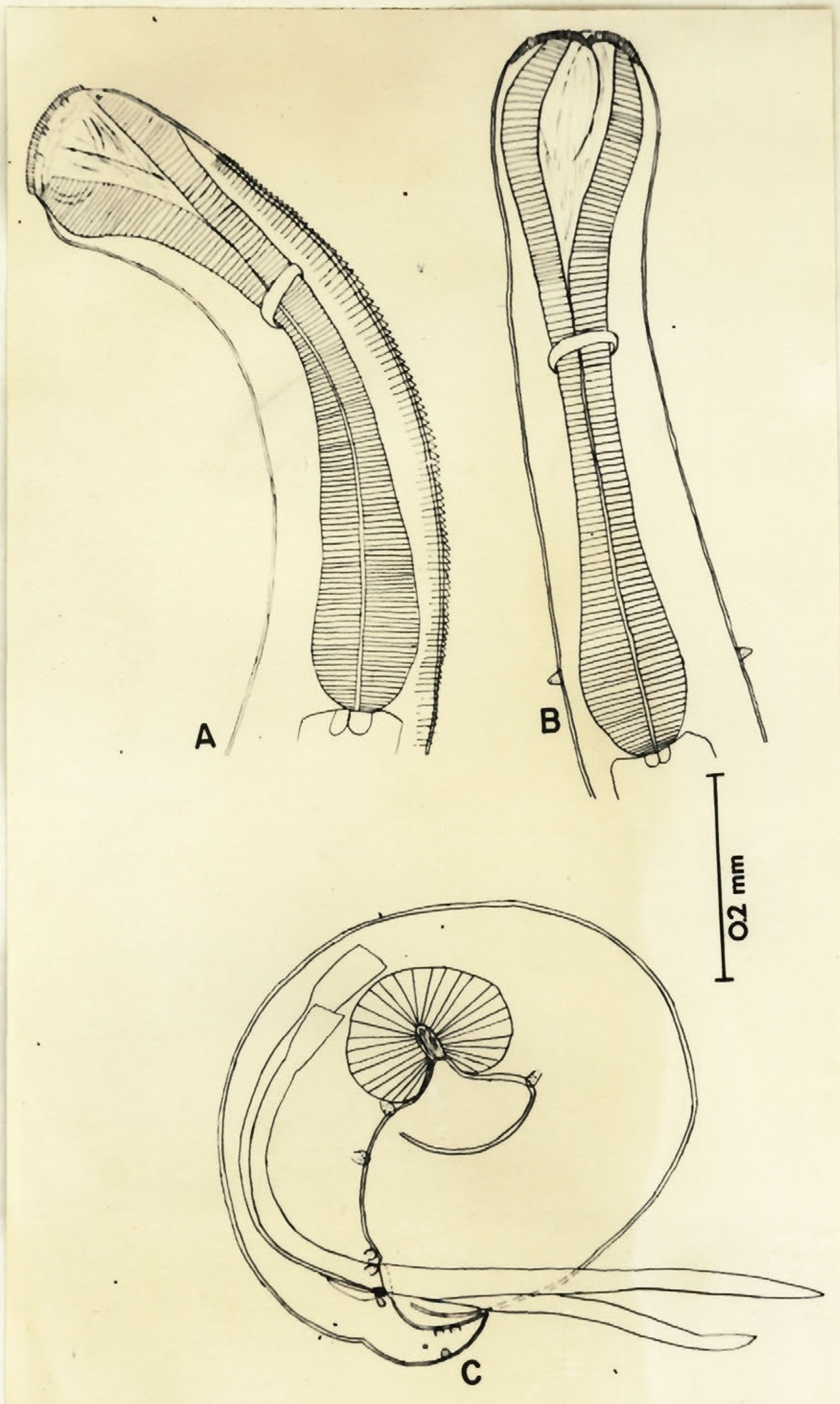

Fig. 19. Dacnitis plicata, n. sp., male.
A -- anterior extremity -- lateral view.
B -- anterior extremity -- dorsal view.
C -- tail, lateral view.