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STUDIES OF PARASITES OF SALMONOID FISHES OF JAPAN. II.

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Parasites of Salmonoid Fishes (Part II)

By Tamao Fukui

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I Introduction

As was explained in the introduction and in the section of "Material investigated" of Part I, the present report deals with the investigation conducted on the specimens, which had been collected by research vessels, and which had been forwarded by the Fisheries Agency, on frozen fish, which had been sent from the U. S. A., and on specimens, which had been collected by the author in Hokkaido and Aomori-Ken. In comparison to the list of known parasites in salmonoid fishes, which was mentioned in V of Part I, the number of parasites, which the author has been able to observe, is extremely meagre--consisting merely of two species of Trematoda, approximately 5 species of Cestoidea, approximately 6 species of Nematoda, 2 species of Acanthocephala, and 1 specie of Copepoda. Further, they consists solely of known species, and there is no need to specially describe

them. However, the present report is not written for specialists in parasites. The report is written partly to meet the request for a report on the investigations by the Fisheries Agency and partly to aid persons who are not specialists.

The author has had some knowledge concerning Trematoda and Acanthocephala, but had no knowledge concerring other species. During the present investigation, the author had to research; however, he feels that there is a possibility for errors as well as inadequacy. The author appreciates if these can be pointed out to him by other scholars.

There is a considerable duplication in the present article with Part I; further, references are included in the present article. This was done in consideration of the fact that there may be persons who will read only Part II and will not be interested in Part I.

The author takes this opportunity to express his appreciation, in addition to persons mentioned in Part I, to members of the Department of Physiology of Yokohama Civic University, Dr. Takashi Fujii of the Faculty of Science, Tokyo University, Miss Satsuko Hamada and Dr. Takeichiro Yafuku of the Research Station, Fisheries Agency, Prof. Manabu Sasa of the Institute of Epidemiology, and to Mr. Megumu Tsukida of the Department of Medical Physiology, Tokyo University, for assisting the author in the compilation of references.

A report will be made later concerning specimens, which were

obtained at Kanzaki offshore of Hokkaido and sent to the author by Mr. Akio Ishida, and fries, which were sent to the Fisheries Agency from the U. S. A.

II Method of Investigation

No special method of investigation was adopted; the tradigtional methods have been used. Thus, the author feels that there is no need to mention it specially. However, for the benefit of non-specialists, this paragraph is added.

All the specimens of Trematoda were treated by "total preparation". They were stained with DELAFIELD haematoxylin, and sealed with balsum. Some were sealed with "neocygarar1"(?) without staining. There is no difficulty in identification even with the latter procedure.

Some specimens of Cestoda were sealed in "neocygarar1"; others were stained darkly with carmine and cut horizontally to the thickness of approximately 15 μ. Sections were paraffin sections.

Some specimens of Nematoda and Acanthocephala were sealed in "neocygarar1"; others were made transparent with lacto-phenol solution and observed.

Specimens of Copepoda were observed as they were or sealed in "neocygarar1".

III Trematoda

The first reference to Trematoda, which is parasitic on salmonoid fishes, in Japan seems to be the article by

Parahemiurus sp., and Aponurus sp.. The 1956 report by Margolis mentioned, in addition to the above, Tetraonchus alaskensis, Bucephaloides sp., Bacciger sp., Podocotyle shawi, Tetracotyle sp., Genolinea oncorhynchi, and Syncaelium katuwo. Axmepob's report mentioned Bucephalopsis basargini, Crepidostomum farionis, Hemiurus levinseni, Brachyphallus amuriensis, Sterrhurus sp., Hecithaster gibbosus, Derogenes varicus, and Azygia robusta.

As was explained above, species of Trematoda, which had been found in salmonoid fishes, are considerable, and a tentative list of these is as follows:

Monogenea.

Gyrodactylidae

1. Gyrodactyloides strelkowi

Dactylogyridae

2. Tetraonchus alaskensis PRICE, 1937

Discocotylidae

3. Discocotyle salmonis SHAFFER, 1916 (Synonym for D. sagittata (LEUCKART, 1842) DIESING, 1850)

Digenea.

Bucephalidae

4. Bucephaloides sp.

5. Bucephalopsis basargini LAYMAN, 1930.

Fellodistomatidae

6. Bacciger sp. (B. harengulae YAMAGUTI, 1938?) (?, in original manuscript)

Allocreadiidae

7. Allocreadium oncorhynchi EGUCHI, 1933.

8. A. shawi (MCINNTOSH, 1939)

9. Crepidostomum farionis O. F. MÜLLER, 1784 (= C. baicalensis LAYMAN, 1933)

10. C. salmonis FUJITA, 1921.

Tsunenobu Fujita ~~mmmhhd~~, which he ~~hmmb~~ contributed in 1916 to Vol. 28 of Dobutsu-Gaku Zasshi, concerning a specie of Crepidostomum, obtained from ~~fri~~ of Oncorhynchus keta in ~~mmm~~ small stream in the compound of Sapporo University. Next, he has ~~mm~~ article in the same periodical Vol. 30 of in 1918 on a new specie, Azygia perryii which he ~~mmmmmmmm~~ had obtained in Hucho perryi in Hokkaido. A further article by him ~~mmm~~ appears in Vol. 32 of the same periodical concerning a new specie, Crepidostomum uchimii, which ~~hm~~ he had obtained in Salmo ~~mm~~ mocrostoma. Another article by him ~~mmm~~ on a new specie, ~~m~~ Crepidostomum salmonis, appeared in 1921 in Vol. 33 of the same publication. Some ~~hm~~ time elapsed before an article by Sueo Eguchi appeared in Vol. 1 of the Journal of Osaka Medical College on Allocreadium oncorhynchi n. sp. which he had obtained in ~~Salmo miiktschitsch (WALBAUM)~~ Oncorhynchus rhodurus JORDAN et McGREGOR in Nagara river. Beginning in 1934, Sanaka Yamaguchi published expansive reports in several publications concerning Trematoda in fish; he mentioned Brachycephallus crenatus in Oncorhynchus masou, Lecithaster salmonis n. sp. from Oncorhynchus keta. In 1935 Misao Kobayashi mentioned these Trematoda in his book published in 1935. Fish Pathology by Tsunenobu Fujita, published in 1937, mentioned, in addition to the above, Discocotyle salmonis, Crepidostomum farionis, Lecithaster gibbosus, L. bothryophorus, and Derogenes varicus. Publications of the U. S. A. and Canada mentioned, in the text and in tables, Diplostomulum sp., Hemiurus levinseni, Lecithaster gibbosus, Brachyphallus sp., Gyrodactyloides strelkowi, ~~m~~ Derogenes varicus, Tubulovesicula lindbergi,

11. C. uchimii FUJITA, 1921.

12. Podocotyle shawi

Azygiidae

13. Azygia perryii FUJITA, 1918

14. A. robusta ODHNER, 1911.

Hemiuridae

15. Aponurus sp.

16. Brachyphallus amuriensis BABASKIN, 1928.

17. B. crenatus (RUDOLPHI, 1802)

18. Derogenes varicus (MÜLLER, 1784) LOOSS, 1901.

19. Genolinea oncorhynchi

20. Hemiurus levinseni ODHNER, 1905.

21. Lecithaster gibbosus (RUDOLPHI, 1802) LÜHE, 1901 = L. bothryophorus (OLSSON)

22. L. salmonis YAMAGUTI, 1934.

23. Parahemiurus sp. (P. anchoviae VAZ et PEREIRA, 1930?) ? in original manuscript

24. Sterrhurus sp.

25. Tubulovesicula lindbergi (LAYMAN, 1930)

Syncoeliidae

26. Syncoelium katuwo YAMAGUTI, 1938.

Diplostomatidae

27. Diplostomulum sp. larvae.

Strigeidae

28. Tetracotyle sp. larvae

The list consists of 28 species in 22 genera; there will be some changes in the list, since it includes larvae and species not yet identified. An attempt was made at constructing a reference table which is shown below:

Table of reference of eye:

(Development is direct. Mainly parasitic externally on aquatic animals--Monogenea

(Development through transformation. Hosts are changed. Parasitic

(internally on Vertebrata--Digenea.

Table of reference of families of Monogenea.

(4 pairs of specialized anchor device in adhesive disc locate

(in the posterior end of the body ----Discocotylidae

(No such device ------2

2 (pair of cerebral sense organs(?). Pair of large hooks and 15-16 peripheral hooks in adhesive disc. Viviparous--
(
(--Gyrodactylidae.
(
(2 pairs or more of cerebral sense organs; cerebral gland(?) pre-
(
(sent; 1-2 pairs of large hooks in adhesive disc; generally 14
(
(pairs of peripheral hooks. Oviparous-----Dactylogyridae

Table of reference of families of Digenea

1 (Mouth located near the centre of ventral side of the body--
(
(--Bucephalidae.
(
((Gasterostomata)
(
(Mouth located in the anterior end of the body---(Prosostomata) 2

2 (Anterior half of the body widens and forms adhesive disc;
(
(posterior half is cone-shaped, cylindrically-shaped and large.
(
(Genital opening opens in the posterior end of the body-
(
(--------- 3
(
(Body is not as described above. Genital opening located in
(
(the front--------------4

3 (In some, the front half of the body is flat and the sides pro-
(
(truded like ears--------Diplostomatidae
(
(The front half of the body is shaped like a cup or a spoon.
(
(The sucker is extremely poor -----Strigeidae

4 (Testiculus is divided into many parts; or it is tubular with
(
(nodes------Cyncoeliidae
(
(Generally, testiculus is spherical or leaf-like-----5

5 (Body is long and cylindrical; genital opening is near oral
(
(sucker; vitelline gland is located at the back of ovary and
(
(is leaf-shaped or tubular;generally lacks cirrus sac. In some
(
(the posterior portion of the body is telescope-shaped---
(
(Hemiuridae
(
(Not in such condition ---------6

6 (Bristles are found on integument---Fellodistomatidae(=Steringo-
(
(phoridae)
(
(No bristles on integument---------7

7 (Vitelline gland spreads mainly sideways on both sides of the body
(
(--Allocreadiidae . . . . . .
(
(Vitelline gland spreads mainly towards the back of the body---Azygiidae
. . . . . .

The author realizes that ~~the~~ the construction of such a table is almost impossible; he does not believe that the table is too useful after Syncoeliidae. The reason is that it is impossible to find singular characteristics. Simple listing of characteristics of each genus follows:

(1) Gyrodactyloides. It is impossible to list the characteristics of the present genus as the author has no reference books. He believes it to resemble Gyrodactylus NORDMANN, 1832 closely. Therefore, the characteristics of the latter will be listed. The anterior end of the body divides into two leaves with cerebral sense organ in each leaf. The adhesive disc is plate-shaped with a pair of large hooks and 16 small peripheral hooks. It is parasitic on fish and Amphibia.

(2) Tetraonchus. There are ~~the~~ two or several pairs of cerebral sense organs; cerebral glands open to the surfaces. Adhesive organs can be distinguished from the trunk of the body fairly readily. There is a pair of large hooks supported by a rod of cuticle. There are 16 peripheral hooks. Intestine consists of a single tract and does not branch out. There are eyes.

Reproductive gland is located in the centrem of the body. No vagina. There are two known species.

(3) Discocotyle. The body is long. The oral sucker is well developed. There are 4 pairs of specialized anchor devices in the adhesive

parasite parasite parasite

disc. They are located on the periphery of the side. Unguis of cuticle in the anchor devices is uniform and all its parts face inward. The vagina opens on the lateral periphery and is located in the front third of the body. They are parasitic on fishes in sea as well as fresh water.

(4) Bucephaloides. They are found in intestine of Oncorhynchus gorbuscha in sea; the original reference is not available; thus, it is impossible to list its characteristics. The author believes that the genus resembles Bucephalopsis mentioned below.

(5) Bucephalopsis. The body is cone-shaped or cylindrical. The lip is shaped like a sucker. There is no tentacle-like appendage. Intestine is short. Testiculus is located at the back of the body from the centre and located from front to the back or slanted. Ovarium is located to the front or at the same height as the testiculus. Vitelline gland divides itself to right and left on front of the ovarium. The genus is parasitic on salt water or fresh water fishes and occasionally on amphibia. Sanaka Yamaguchi reports that the genus has been obtained in Verasper moseri JORDAN et GILBERT in the Japan Sea.

(6) Bacciger. The body is flat and egg-shaped. Small bristles. The length of the digestive tract is 2-3 times that of pharynx. Intestine is short and reaches testiculus. Ventral sucker is buried under the flesh up to approximately the middle of the body. Testiculus is located immediately behind on both sides of the

Ventral sucker. Reproductive opening is located in the middle in front of the ventral sucker. Ovarium is located immediately behind the ventral sucker and between the testiculus. The vitelline gland is located in front of the ventral sucker on the mmmm outside of the intestine. The genus is parasitic of salt water fish (in the intestine). Margolis reports that the genus resembles B. harengulae; however, the specie is a new one obtained in Harengula zunasi (BLEEKER) in Lake Hamana by Yamaguti.

(7) Allocreadium. The body is long; two ends are not pointed. No bristles. Sucker and pharynx are well developed. The intestine mmmmm is long and reaches the posterior end of the body. The ventral sucker is located in the anterior half of the body. The testiculus is mm located in the middle of the posterior half of the body and runs front to back. The cirrus sac is well developed and contains winding seminal vesicle ~~vaicula seminalis~~, prostate gland, and penis and is located in front of the ventral sucker mm and on the dorsal side, and occasionally at the back. The reproductive opening is located at the dividing point of the intestine. The ovarium is located between the ventral sucker and the mmmm anterior testiculus somewhat on the side. The mmmm seminal receptable and the Laurer's tube are present. The vitelline gland is located mainly in the posterior half of the body. The genus is parasitic in the intestine of sea or fresh water fishes. As parasitic on salmonoid fishes, A. oncorhynchi EGUCHI, 1933 and A. shawi(MCINTOSH, 1939) are recorded.

(8) Crepidostomum. The body is elongated egg shape or cylindrical; there are no bristles. There are 6 protrusions in at the back of frontal periphery of the oral sucker. Frontal pharynx is present. The digestive tract is short; the intestine nearly reaches the posterior end of the body. The ventral sucker is located in the anterior half of the body. The testiculus is located in the posterior half of the body and aligned from front to back. The cirrus sac is long-stick shape and reaches the ventral sucker. The reproductive opening is located in the centre in front of the ventral sucker. The ovarium is located approximately in the middle between the ventral sucker and the frontal testiculus. The seminal receptable and the Laurer's tube are present. The vitelline gland spreads on practically on the whole side of the body. The genus is parasitic on the intestine of fresh water fish and Mammalia. Three species of the present genus have been recorded as having been found in salmonoid fish -- C. farionis (O. F. MULLER, 1984), C. salmonis FUJITA, 1921, and C. uchimii FUJITA, 1921. The differences are shown in tabular form:

Headings of the table shown on page 8.

Second column - heading Entries — Length of body
2 - 6 x 1.5 mm
1.42 x 0.41
1 x 0.5

Third columnar heading - Testiculus

Entries - Front to back
A little slanted;front to back
Front to back

Fourth columnar heading - Reproductive opening

Entries - At the height of pharynx
Division point of intestine
At the height of pharynx

Fifth columnar heading - Sucker

Entries - Ventral sucker large
Both somewhat intermediate
Both large

Sixth columnar heading - Egg

Entries - 65 - 85 x 40---44
80 x 70
80 x 40

---

(9) Podocotyle. The body is long; no ~~bristle~~ spine. The ventral sucker is located in the front in the anterior half of the ~~mmm~~ body and is occasionally equipped with a short ~~handle~~ stalk. Further, there may be folds in the ~~handle.~~ stalk Both the oral sucker and the pharynx are well developed. The intestine reaches near the posterior end of the body. The testiculus is located in the posterior ~~mm~~ portion of the posterior half of the body and is aligned from front to back. The cirrus sac is long, or thin and long, and is rod-shaped. It extends ~~mmmmmm~~ in some from the ventral sucker ~~m~~ backwards. The reproductive opening is at the height of the digestive tract or the division point of the intestine and opens to the left of the central line. The ovarium is ~~mm~~ located ~~mmmmmmmmmmmm~~ in the front of the testiculus on the right side of the central line. The seminal receptacle and the Laurer's tube are present. The vitelline gland spreads

from both sides of the body backwards. The genus is parasitic in the intestine of fresh or salt water fish. Only one specie, P. shawi, of the present genus is recorded in Oncorhynchus nerka from the Columbia River.

(10) Azygia. The body is very long and muscular; there are no bristles. The pharynx is somewhat elongated. The esophagus is very short. The intestine winds somewhat and reaches the posterior end of the body. The ventral sucker is not large, and is located in the middl of the anterior third of the body. The testiculus is located near the anterior end of the posterior third of the body and aligned either front to back or obliquely. The cirrus sac is spherical or pear shaped and located immediately to the front of the ventral sucker or lies on top of it. The reproductive opening is in front of the ventral sucker. The ovarium is located immediately in front of the cirrus sac. The vitelline glands are located on both sides of the body in the back and reaches the posterior end of the body. The genus is parasitic on the stomach or intestine of fresh or salt water fish. In the present genus, A. perryii FUJITA, 1918 and A. robusta ODHNER, 1911 are recorded. The comparison of the description of the two makes one wonder if they are identical; however, there is a considerable difference in the size of eggs. It is 58 x 33 μ in A. perryii and 45 x 23 μ in A. robusta. Further, The Trematoda (page 251) by B. DAWES treats A. robusta as being synonymous with A. lucii(MÜLLER,1776) LÜHE, 1909.

(11) Aponurus. The body is either stick- or cone-shaped. There is no tail portion. Occasionally prostomium is found in oral sucker. The pharynx is round. The esophagus is short. The intestine reaches near the posterior end of the body. The ventral sucker is larger than the oral sucker. It is located at the posterior end of the anterior third of the body. The testiculus is located at the centre of the body and aligned obliquely from front to back.. The seminal vesicle is spherical or elongated egg shape, and is located in front of the ventral sucker or lies on top of it. The prostate gland is tubular. The hermaphroditic tube is tubular, and enclosed by hermaphroditic sac which is elongated pear shape or egg shape. The reproductive opening is located at the height of oral sucker, pharynx, or intestinal division point. The ovarium is located at the back of the testiculus approximately in the centre. The vitelline gland is located at the back of the ovarium and consists of 7 round leaves. The seminal receptacle at times is quite large. The genus is parasitic in the stomach of salt water fish. The only record of the present genus is in Margolis' report in which it is recorded as A. sp.

(12) Brachyphallus. The body is long. The tail portion is present. At times there is a depression between the ventral sucker and the reproductive opening. The oral sucker is relatively large; the pharynx is spherical; the esophagus is short; and the intestine reaches near the posterior end of the body. The ventral sucker is located

near the centre in the anterior third of the body. The testiculus is located at the back of the ventral sucker aligned obliquely. The seminal vesicle is constricted(?), is divided into two portions, and is located in the front of the ventral sucker. The prostate gland is short and poor. The hermaphroditic tube is short. The reproductive opening is located at the height of pharynx or esophagus. The ovarium is separate from the testiculus and is located near the centre in the posterior portion of the body. The vitelline gland is divided into two parts with lobation into two leaf-like parts. The genus is parasitic on fresh or salt water fish. Two species of the present genus, B. amuriensis BABASKIN, 1928 and B. crenatus (RUDOLPHI, 1802), are known. They are somewhat similar. However, in B. amuriensis, horizontal folds are found only in ~~around~~ the central portion of the body, the tail is approximately one quarter of the body, the vitelline gland is large and occupies a wide area in the centre of the body. Among the material, which the author had collected, a few specimens were found in Oncorhynchus gorbuscha, and identified as B. crenatus.

(13) Derogenes. The body is small with no tail portion. The oral sucker is equipped with prostomium. The pharynx is spherical; the esophagus is short; and the intestine reaches the posterior end of the body. The ventral sucker is larger than the oral sucker, and is located near the centre of the body. The testiculus

is at the back and is aligned to left right or obliquely. The seminal vesicle is a single sac-like structure or tubular, and is located in front of the ventral sucker. The prostate gland is tubular and long. The hermaphroditic gland is wrapped in a muscular sac and protrudes into the genital atrium in cone-shaped prominence. The reproductive opening opens at the height of the pharynx. The ovarium is located near the centre at the back of the testiculus; the seminal receptacle is present. The Laurer's tube is absent. The vitelline gland is divided into two leaves and is located on both sides of the body at the back of the ovarium. The genus is parasitic in the esophagus, stomach, and the gall bladder of salt water fish. Only D. varicus (MULLER, 1784) LOOSS, 1901 has been recorded in the present genus. The afore-mentioned parasite is parasitic on various salt water fishes; approximately 25 genera of fish have been mentioned as hosts.

(14) Genolinea. The size ranges from small to ~~large~~ medium and is approximately scale, cylindrical. There is no tail portion. The pharynx is spherical. The esophagus is short. The width of the intestine is wide; its wall is somewhat crooked and reaches the posterior end of the body. The ventral sucker is larger than the oral sucker, and is located at the posterior end of the anterior third of the body. The testiculus is located a little to the back of the centre of the body and is aligned obliquely from front to back. The seminal vesicle is tubular, crooked, and located on the dorsal side in front of the

ventral sucker. The prostate gland is short. The hermaphraditic tube is crooked and ends in a pear shaped hermaphraditic sac. The reproductive opening opens at the height of intestinal division point. The ovarium is located in the posterior half of the body. The seminal receptacle is at times large. The vitelline gland consists of two dense leaves, is aligned obliquely from front to back, and is located at the back of the ovarium. The genus is parasitic in the stomach of salt water fish. Only a single specie of the present genus, C. oncorhynchi has been reported by Margolis; it has been reported that the specie was rare and had been observed only twice.

(15) Hemiurus. The size range from small to medium; there is a tail portion. There are tooth-like protrusions on the cuticle. The esophagus is short. The intestine gets into the tail portion. The ventral sucker is located near the anterior end of the body; it is larger or smaller than the oral sucker. The testiculus is located considerably behind the ventral sucker and is aligned obliquely. The seminal vesicle is located in front of the testiculus, is constricted into two parts: its frontal portion is covered by a somewhat thick muscle layer. The prostate gland is long and crooked. The hermaphraditic tube is thin. The reproductive opening is located at the height of the oral sucker or the pharynx. The ovarium is located at the back of the testiculus behind the ovary. The vetilline gland is divided into two dense leaves and

is located immediately behind the ovarium. Eggs are small; there is no polar filament. The genus is parasitic in the stomach of salt water fish. Only one specie of the present genus, H. levinseni, appears in the reports by ODHNER, 1905 or MARGOLIS or AXMEROP. It appears that in Oncorhynchus nerka they are prevalent in the western part of the Pacific.

(16) Lecithaster. The size of the body is small. The body is cone-shaped, smooth; there is no tail portion. The esophagus is short. The intestine does not reach the posterior end of the body. The ventral sucker is larger than the oral sucker, and is located at the posterior end of the front third of the body. The testiculus is located near the back of the ventral sucker, and is aligned obliquely from front to back or from left to right. The seminal vesicle is in the shape of a sac, and is located in the dorsal side of the ventral sucker or at its back. The prostate gland is tubular. The hermaphroditic tube is egg-shaped or oval located in the hermaphroditic sac. The reproductive opening is located at the height of pharynx or the intestinal division point. The ovarium is divided into 4-5 leaves, and is located in the posterior half of the body. The seminal vesicle is at times remarkable. The vetilline glands number seven, and form flower-crest-like or rod-like leaves. The genus is parasitic in the intestine of salt water fish. Two species of the present genus, L. gibbosus (RUDOLPHI, 1802) LÜHE, 1901 and L. salmonis YAMAGUTI, 1934 have

been recorded. Examination of the report by Yamaguti on L. salmonis (Dobutsu-Gaku Shu ~~Kuiho~~, Vol. 5, page 486, 1934) shows that the egg is remarkably large; in this respect the specie resembles closely L. gibbosus. However, according to ODHNER, the size of egg in this specie is 25-27x 13 μ and the seminal vesicle does not reach the back of the ventral sucker. However, in L. salmonis of Yamaguti the size of egg is 23.7x 15.8 μ or 22-24x 14-16 μ (Dobutsu-Gaku Shu ~~Kuiho~~, Vol. 9, page 97, 1940), and there is hardly any difference in comparison to that of L. gibbosus. The distinguishing feature seems to be how whether the seminal vesicle reaches the back of the ventral sucker. It is not possible now for the author to see the original manuscript of ODHNER. However, a comparison of the description of L. gibbosus on page 269 of the Trematoda by B. DAWES and the original description of L. salmonis by Yamaguti does not enable one to distinguish the two. Even with respect to the position of the seminal vesicle, Yamaguti himself writes, at the point where he mentions variations, that it is located at times on the dorsal side in front of the ventral sucker. Thus, it appears as though the two species are identical and that L. salmonis and L. gibbosus are synonymous. The author observed many in Oncorhynchus keta in Hokkaido.

(17) Parahemiurus. The body is long and has a tail portion. There are tooth-like protrusions of cuticle. The esophagus is short. There are specimens in which the intestine enters into the tail

portion. The ventral sucker is located near the anterior end of the body. The testiculus is located somewhat at the back of the ventral sucker near the posterior end of the front third of the body, and is aligned front to back a little obliquely. The seminal vesicle is a single-sac-like structure with a considerably thick wall, and is located in front of the testiculus. The prostate gland is long, and spreads and winds between the seminal vesicle and the ventral sucker. The hermaphroditic tube is thin; the reproductive opening is located at the height of the oral sucker. The ovarium is located near the centre of the body; the space between the testiculus is occupied by part of the uterus ~~the ovary~~. The genus is parasitic in the stomach and the intestine of salt water fish. Only one specie of the present genus appears in MARGOLIS' report as P. sp.; it was observed only once in Oncorhynchus nerka in the coast. It is said that it is believed to be P. anchoviae.

(18) Sterrhurus. The body is cone shaped. There is a tail portion which is wholly or partially depressed. There is prostomium in the oral sucker. The esophagus is short. At times the intestine enters into the tail portion. The ventral sucker is located near approximately the posterior end in the front third of the body; it is larger than the oral sucker. The testiculus is located immediately behind the ventral sucker, and is aligned from left to right somewhat obliquely. The seminal vesicle is twisted, and is located on the dorsal side in front of the ventral sucker. The anterior end of

the prostate gland enters into the hermaphroditic sac. The hermaphroditic sac contains the hermaphroditic tube, the anterior end of the vagina, and the ejaculatory sac. The reproductive opening opens in the ventral side of the pharynx or at its back. The ovarium is located near the centre of the body. The vitelline gland consists of seven round or finger-like leaves. The genus is parasitic in the stomach of salt water fish. Only one specie of the present genus appears in AXMEPOB's report as S. sp.

(19) Tubulovesicula. The body is cone shaped. There is a tail portion. There is prostomium in the oral sucker. The esophagus is extremely short. The intestine reaches the posterior end of the body. The ventral sucker is larger than the oral sucker and is located near the anterior end of the body. The testiculus is located at the back of the ventral sucker somewhat obliquely from left to right. The seminal vesicle is located in front of the testiculus, is tubular and somewhat crooked. The prostate gland is long. The base of the hermaphroditic tube fills out, and is enclosed in a muscular sac. The reproductive opening is located at the height of the pharynx. The ovarium is located immediately behind the testiculus near the centre of the body. The seminal vesicle is present. The Laurer's tube is absent. The vitelline gland consists of seven tubular leaves. The genus is parasitic in the stomach of salt water fish. Only one specie of the present genus, T. lindbergi (LAYMAN, 1930) is mentioned in MARGOLIS's report.

It is also known in the Japan Sea.

(20) Syncoelium. The body is considerably large. The anterior portion is thin; the posterior portion is either tubular or flat and cone shaped. The cuticle is either smooth or uneven with protrusions. The esophagus is short. At times the intestine is observed to be crooked and meets near the posterior end of the body. The ventral sucker has a handle and is located approximately near the centre of the body. The testiculus is vesicular and divides into many parts. In many cases, it is found in two vertical rows between the handle of the ventral sucker and the ovarium. The seminal vesicle is tubular, long, and somewhat crooked. In some the prostate gland is seen well developed behind the division point of the intestine. The hermaphroditic tube is found inside or outside of a sac. The reproductive opening is located at the height of the oral sucker. The ovarium is located immediately behind the testiculus and is divided into few round or somewhat long leaves. The vitelline gland consists of few dense small leaves, and is located between the posterior ends of the ovarium and the intestine. The genus is parasitic in the branchial chamber of salt water fish. With respect to the present genus, Margolis's report mentioned the collection of S. katuwo YAMAGUTI, 1938 once in Oncorhynchus nerka. In 1936, L. C. LYOYD and J. E. GUBERLET obtained Syncoelium filiferum (SARS) and reported findings(trans. Amer. Micr.

Vol. 55, p. 44-48). According to Yamaguti (Dobutsu-Gaku Shu Ho, Vol. 8, page 70), they resemble each other but differ in the size of eggs.

(21) Diplostomulum. This generic name refers to the late stage larvae of so-called Strigeata LA RUE, as does the Tetracotyle mentioned next, whose front half of the body is flat, and which has a type of sucker near the centre. The adult parasite is parasitic on birds and Mammalia. The parasites of the present genus are parasitic in eyes, brain, or spinal cord of fish or Amphibia; there is no tunica; the parasites move freely through the structures of the host. With respect to salmonoid fish, MARGOLIS states in his report that they are prevalent in eyes of Oncorhynchus nerka.

(22) Tetracotyle. As is the case with the previous genus, the present genus is the larvae of Strigeata LA RUE; unlike the former, the genus is in tunica, and is parasitic on Hirudinea, Mollusca, or Vertebrata. There is a reference to this genus also in MARGOLIS' report in which he states that it is observed sporadically in pericardial cavity or mesentery in fry of Oncorhynchus nerka.

The data on Trematoda, which the author possesses are extremely meagre. They consist of two species, Lecithaster gibbosus and Oncorhynchus keta and Brachyphallus crenatus in Oncorhynchus gorbuscha, which the author collected in Hokkaido.

IV Cestoda

As was noted on page 73 (617) of Part I, Cestoda, which are found in salmonoid fishes number 17 species in 11 genera; however, there are species in which the adult parasite has not been recognized, or species, which have been defined later as synonym. Thus, the actual number will be less.

So far as the author has been able to ascertain, the first reference to the genus appears in the thesis entitled "The source of Bothriocephalus latus in Japan", by Takashi Iiyama, which he published in 1889 in Vol. 2 pp. 49-56 of Tokyo Teikoku Daigaku Rika Daigaku Kiyô (Tokyo Imperial University Science Bulletin). In the thesis he established experimentally using his own body that Dibothriocephallus latus, which was parasitic on humans was communicated from Oncorhynchus masou. In 1922, Tsunenobu Fujita contributed a thesis, entitled "Parasites in Fish", to Dobutsu-Gaku Zasshi; on p. 579, Vol. 34, in this thesis, he makes reference to two species, Phyllobothrium salmoni n. sp. and Plerocercoide sp. Both are larvae. The former is parasitic in the digestive tract, the latter in the gall bladder. In the same year, Sueo Eguchi published an article on Dibothriocephalus latus, which was parasitic on Oncorhynchus keta in Jintsu River, in Vol. 29 of Aichi Igaku Senmon Gakko Zasshi (Aichi Medical College Publication); later in 1924, 1926 and 1929 he published his studies on the cestoda on p. 518, vol. 14, p. 563, Vol. 15, p. 253, Vol. 16, and p. 567,

parasite parasite parasite 25.25.25.25.25.

Vol. 19 of Byorigaku Kiyo (Pathological Bulletin) Nihon Byorigaku-Kai Shi (Journal of Japan Pathological Society), on p. 1, Vol. 3 of Byorigaku Kiyo (Pathological Bulletin). During 1934-1935, Sanaka Yamaguti published a series of articles, Studies on the Helminth Fauna of Japan, in Dobutsugaku Shuho (Zoological Bulletin); in these articles, he made reference to larvae of Pelichnibothrium, which he had obtained from Oncorhynchus keta and Oncorhynchus masou. The book by Hisao Yobayashi, Fresh water fish and their parasites in Japan, which was published in 1935, mentioned Diphyllobothrium latum (larvae); in 1936, he added Pelichnibothrium (larvae) in Vol. 8 of Sake.Masu Ruiho(Salmon. Trout Bulletin). Fish Pathology, by Tsunenobu Fujita which was published in 1937, mentioned Diphyllobothrium latum (larvae) in muscle, Schistocephalus gasterostei (Europe), S. solidus (Europe), and Tetrarhynchus quadrirostris (Atlantic) in the abdominal cavity, Triaenophorus tricuspidatus (Europe, Canada), Diplocotyle olrikii (U. S. A.), Cyathocephalus truncatus (Europe, U. S. A.,Canada), Eubothrium crassum (Europe, U. S. A.), E. oncorhynchi (U. S. A.), E. salvelini (Europe, U. S. A.), Phyllobothrium salmonis (Japan), Proteocephalus longicollis (Europe), P. torulosa (U. S. A.), P. salvelini (U. S. A.), P. arcticus (U. S. A.), P. coregoni (U. S. A.), and P. laruei (U. S. A.) in the digestive tract, and Taenia longicollis (Europe) in the liver. Reports by U. S. A. and Canada mention Diphyllobothrium sp., Phyllobothrium caudatum, Triaenophorus crassus, Proteocephalus, Eubothrium salvelini, E. oncorhynchi, E. sp., Diplocolyle sp.,

and Nybelinia surmenicola; АХМЕРОВ's report mentioned Eubothrium crassum, E. salvelini, Nybelinia sp., Calliobothrium filicolle(larvae), Proteocephalus exiguus, and Diphyllobothrium sp. (larvae).

Mmm "s a reference, the author attempted a construction of a Table of Reference of eye of species of Cestoda mentioned above:

1. There are four thin "hook-lips" with retrorse bristles, which freely go in and out, at the tip of the head. Trypanorhyncha(= Tetrahynchidea).
   No "hook-lip" at the tip of the head ----------2
2. There are four phyllidia at the tip of the head. Tetraphyllidea.
   No phyllidium ----------3
3. There are 4 single-cup-like suckersat the tip of the head. Proteocephala.
   No sucker ----------4
4. There are sucking grooves at the tip of the head, or the back and the abdomen. Pseudophyllidea
   No true sucking groove or sucker. Spathebothridea.

Mmm Notes on the above-mentioned genera, which belong to each Amd order will be given next:

Trypanorhyncha. Nybelinia surmenicola OKADA, 1929, whose specific name was mentioned in Part I, was mentioned by MARGOLIS in his 1956 report; the one mentioned as N. sp. was mentioned by АХМЕРОВ in his 1957 report; the one mentioned as Tetrarhynchus quadrirostris (GOEZE) is quoted on page 84 of Fish Pathology by Tsunenobu Fujita as having been found by ZSCHOKKE MM and HEITZE in Oncorhynchus tschawytscha in

parasite parasite

Kamchatka. The generic name, Tetrarhynchus is used for larvae of different genera; thus, it is not recognized today as an independent genus.

Tetraphyllidea. Of the above-mentioned genera, ones belonging to the present order are the following two:

{ Possesses only four phyllidium. Phyllotothriidae

A pair of hooks each on the tips of four phyllidium. Onchobothriidae

Phyllobothrium caudatum is mentioned in AXMEPOB's report; it is reported as the late stage larvae of Calliobothrium filicolle ZSCHOKKE. It also appears in MARGOLIS' report as larvae under the same name. Ph. salmonis FUJITA is mentioned on page 168 of Fish Pathology. Pelichnibothrium, which belongs to the same order, is mentioned in AXEMPOB's report as the larval name of the above-mentioned Calliobothrium filicolle. Calliobothrium licole ZSCHOKKE, which should be included in Onchobothriidae, is in AXMEPOB's report. There is some confusion here.

Proteocephala. Proteocephalus is the only one which belongs to this order. It is mentioned as P. spp. in MARGOLIS' report; it is reported that the adult is P. salmonicida. P. exiguus LA LUE is in AXMEPOB's report.

PSEUDOPHYLLIDEA. Two genera, Diphyllobothrium and Triaenophorus, can be mentioned as belonging to this order. It is a well known fact that plerocercoid, the larvae of Diphyllobothrium latum, lurks in muscle of fishes of this family and infect human beings. The parasite is

lives upon mainly fishes caught in fresh water. This fact is mentioned in reports by MARGOLIS and AXMEPOB referred to in Part I. Plerocercoid, which was obtained by AXMEPOB, is reported not to be parasitic on humans but to be the larvae of L. strictum, which is parasitic on sea gulls in Lake Baikal. The specimens obtained by MARGOLIS are reported to be the larvae of D. ursi, which is parasitic on bears. There seems to be considerable confusion between this genus and the traditional genus Dibothriocephalus. It appears that there are a few adult types of plerocercoid which is parasitic on salmonoid fishes. Three species of Eubothrium, E. crassum BLOCH, E. oncorhynchi WARDLE, and E. salvelini SCHRANK, are mentioned. The three species are all mentioned on page 168 of Fish Pathology by Tsuhenobu Fujita; the distinguishing features are given as follows:

E. crassum	Length 300 mm:	width	3.5 mm.	Size of egg	54x41 μ
E. oncorhynchi	600 mm:		5 mm.		40x30 "
E. salvelini	150 mm				60x30 "

MARGOLIS' report mentions E. salvelini, E. oncorhynchi, and E. sp.: AXMEPOB's report mentions E. crassum and E. salvelini. According to The Zoology of Tapeworms by R. A. WARDLE and J. A. MCLEOD, there are eight species of Eubothrium; of these, the species parasitic on salmonoid fishes are the above-mentioned three. The comparison of descriptions of each species brings about differences noted below:

Table of comparison on page 19.

Second columnar heading - Length mm

Entries - 120 - 600

Reaches 600

Up to 280

Third columnar heading - Width mm

Entries - 2.5 - 5.6

5

2.25

Fourth columnar heading - Sucker

Entries - Large

Small, less than 1 mm

Considerably large

Fifth columnar heading - Sucking groove

Entries - Shallow

Deep

Considerably deep

Sixth columnar heading - Apical ~~plate~~ disc

Entries - Distinct

Divides markedly into two

Weak and small

Seventh columnar heading - Ovarium

Entries - Divides markedly into leaves

Dense and measures 1/4 - 1/5 of width

Kidney-shaped

Eighth columnar heading - Vitelline gland

Entries - Many

Many

Many and large

Ninth columnar heading - Position of vitelline gland

Entries - Mainly outside vertical muscle layer.

Mainly outside vertical muscle layer.

Mainly inside vertical muscle layer.

parasite parasite parasite 30/30.30.30.30.30.

The examination of the above table shows that E. crassum (parasitic on Salmo salar in the Atlantic and Salmo trutta in Europe and Canada) and E. oncorhynchi (parasitic on Oncorhynchus in the Pacific) are very closely related. The specimen, which the author has, is identified as E. crassum mentioned above. In Triaenophorus, T. tricuspidatus, T. nodulosus , and T. robustus are mentioned on page 169 of Fish Pathology by Tsunenobu Fujita; it is stated that they were recognized as identical specie. In MARGOLIS' report, it is stated that larvae of T. crassus had been obtained from fry of Oncorhynchus nerka. The above-mentioned book by WARDLE and MCLEOD mentions three species, T. nodulosus, T. crassus, and T. stizostedionis, and states that T. tricuspidatus and T. robustus are synonymous to T. crassus. Larvae infect salmonoid fishes.

Spathebothridea. The genus, Diplocotyle, belongs to this order. D. olrikii is shown on page 166 of Fish Pathology by Tsunenobu Fujita. MARGOLIS reports D. sp. and D. olriki? (? in original manuscript) as common among Oncorhynchus gorbuscha near Attu Island. Only one specie, D. olrikii KRABBE, 1874 is mentioned in the book by WARDLE and MCLEOD.

The above sections were written as a reference concerning Cestoda which is parasitic on salmonoid fishes.

As was explained in Part I, the specimens, which the first author obtained, were collected from Oncorhynchus nerka, Oncorhynchus keta, and Oncorhynchus gorbuscha, which had been caught in the North Pacific and Bering Sea by the research ships of the Fisheries Agency; further they were

had been damaged heavily. However, the author was able to distinguish and report four species --Diphyllobothrium sp. (larvae), Phyllobothrium salmonis (larvae), Proteocephalus sp. (larvae), and Schistocephalus solidus?. (? in original manuscript)

Of these, the last was erroneously identified by the author. At the request of MARGOLIS, the author sent the specimen to him. It was identified as Eubothrium sp. There was only one specie S. solidus of Schistocephalus. The adult is found in water fowls, procercoid in small crustaceans such as Cyclops, and plerocercoid in the coeloma of fresh water fishes. In the fresh water fishes, Salvelinus fontinalis is included. The reasons for the misidentification on the part of the author were lack of knowledge concerning Cestoda and the lack of references.

The collection on board a ship is inconvenient. Further, there is a possibility that small species will be missed. Thus, the author has visited on two occasions fisheries in Hokkaido and related operations in Aomori-Ken, and collected parasites from fresh fish, and was able to collect several species from Oncorhynchus keta and Oncorhynchus gorbuscha. Not too many fishes were dissected. However, the author was surprised to find in the intestines of each fish larvae of Cestoda thickly as pile on carpet. Further, the author observed a large number of Eubothrium although they were not as large as those collected on board the ship. A report on these will follow.

(1) Diphyllobothrium larva

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The specimens, which were collected on board Daiichi Tsukiyama-Maru, the research vessel of the Fisheries Agency in the North Pacific and the Bering Sea in 1955 and forwarded to the author, were very poorly preserved as has already been described. Cestoda consisted solely of Eubothrium sp. The specimens, which were collected in 1956 by the research vessels, Takuyo-Maru, Etsuyama-Maru, and Eiko-Maru in the same areas and forwarded to the author, were much better preserved in comparison to the former specimens. In one Oncorhynchus nerka and four Oncorhynchus keta, the author found specimens which appeared to be larvae of Diphyllobothrium: this was so reported. Plerocercoid of D. latum has been discovered in muscle of Oncorhynchus masou in fresh water; Margolis collected many larvae of this specie from fish which had been caught in salt water. However, the majority is from fresh water. Again, the specimens, which AXMEPOB obtained from Kamchatka River, is stated to be larvae of Diphyllobothrium. However, both ~~interpret~~ presume it not to be parasitic on humans and to become adult in bears and sea gulls. As was stated in Part I, the author made visits to Hokkaido in Nov. 1957 and Sept. 1958. The first visit was to Hatano, Abashiri, Gosen and Juyonsen of Nakahyotsu, Horouchi of Tokachi, and Makubetsu [illegible]. Mainly parasites from stomach and intestine of Oncorhynchus keta were collected. The second visit was to Wakubetsu and Shari. Again, parasites in stomach and intestine from Oncorhynchus gorbuscha and Oncorhynchus masou were collected. The purpose was to collect small species, which were missed ~~during~~ being coll-

ected on board ship, and to supplement the collection by research vessels. In this collection, the author found specimens which appeared to be larvae of Diphyllobothrium; however, later examination cast doubt on this conclusion. These larvae, i. e., plerocercoid, are known to lie dormant in a muscle; however, this was also found in the digestive tract. Those, that the author recognized as this included larvae of other Cestoda, which had been cut. When a larva is cut, the central portion contracts and the end becomes Y-shaped. There were occasions when this was mistaken for plerocercoid. Further, in these cases, there are specimens in which the injury can be recognized; however, in others the tip becomes round, and the injury cannot be observed and the specimens appears at a glance to be plerocercoid. However, it is clearly different from the plerocercoid of D. latum.

(2) Phyllobothrium larva and Pelichnibothrium larva.

As has already been explained, salmonoid fishes, which the author examined, consisted of a small number of Oncorhynchus keta, Oncorhynchus gorbuscha, and Oncorhynchus masou. However, the author observed that these were very heavily infected by larvae of genus Phyllobothrium. If the author may exaggerate, in extreme cases, they looked like pile on a carpet. The locale of infection was that part of the intestine which extends to the stomach. Tsunenobu Fujita, in his series of articles, entitled "Parasites in Fish", which he contributed to Vol. 34 of Dobutsugaku Zasshi, published on p.577 Phyllobothrium salmonis nov. sp.

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and Plerocercoid sp. among Cestoda. It is reported that the latter is extremely young larvae, which he found in the gall bladder of Oncorhynchus keta, and that the former he found in large numbers in the intestine and appendix pylorica of Oncorhynchus keta and Oncorhynchus masou, which were going up-stream in Tone, Jintsu, Sanmen, Ishikari, and Nijibetsu Rivers. There is no doubt that the author's specimens are this speciem. The author realized that the parasites were larvae and that the reproductive organs had not been formed. He felt that there had not been previous mention of such a specimen and that the specimens were unique for Japan. Thus, he published them as a new species on the basis of the stalk in phyllidium, the presence of auxiliary sucker, and the presence of neck portion.

However, Sanaka Yamaguti reported on larvae, which he had obtained in Oncorhynchus keta, as Pelichnibothrium larvae on page 84 of the article, "Studies on the Helminth Fauna of Japan, Part 4. Cestodes of Fishes", which appeared in Vol. 6 No. 1 of the Japanese Journal of Zoology in 1934. There he wrote that the new species of Tsunenobu Fujita along with Pelichnibothrium caudatum of ZCHOKKE and Heitz should be considered as a synonym for Pelichnibothrium speciosum MONTICELLI, 1889. However, Tsunenobu Fujita wrote Phyllobothrium salmonis FUJITA in his Fish Pathology (page 168) published in 1937. In investigations of U. S. A. and Canada since 1955, MARGOLIS and others wrote as Phyllobothrium caudatum and added it to be late stage larvae. They stated the rate of infection to be high reaching 100% in many places. The maximum average number

AXMEPOB regards Phyllobothrium caudatum of parasites quoted was 408.

to be the late stage larvae of Calliobothrium filicolle ZSCHOYKE.

There is no doubt that this Phyllobothrium caudatum is identical with the specimen which the author obtained. The author examined the specimen, which had been brought back by the research vessels of the Fisheries Agency on its second expedition, identified it as Phyllobothrium salmonis of Tsunenobu Fujita, and so reported. The reference to the afore-mentioned The Zoology of Tapeworms (1952) of WARDLE and MCLEOD shows: that phyllidium of Phyllotothrium BENEDEN, 1849 is with or without stalk; that the adhesive surface is simple, wind in a complicated fashion, or is bent; that its line is smooth, forms complicated folds, or has minute sucker-like objects; that the auxiliary sucker is generally present in each phyllidium; that it is lacking in some; and that the neck portion is either present or absent.

Pelichnibothrium MONTICELLI, 1889. There are a single top sucker and four auxiliary suckers which are located on the anterior periphery of each phyllidium. Each phyllidium has a wide base. There is a pair on the dorsal side and a pair on the ventral side. The proglottid forms from immediately behind the sucker. The space between the proglottids is strongly constricted and is euapolytic. (Euapolytic means that a mature proglotted separates itself from the parent body, continues growth, has power of locomotion, and in some cases, forms pseudo-sucker, and undergoes transformation).

The "internal vertical muscle bundle" is well developed in the first proglottid and the tail portion; however, this is not present in a mature proglottid. The neural tube is located on both sides inside the vitteline gland zone. The testiculus is extremely numerous, and is located inside the marrow on the side. The deference duct is found coiled up in front of the uterus; the cirrus sac is long with a thin wall, located obliquely with respect to the longitudinal axis of the body, and opens into outside immediately at the back of the vagina. The genital atrium is present on the right or the left side irregularly. The ovarium consists of two leaves and is dense. The uterine tube opens into the uterus in the anterior end. The uterus is of a long oval shape and is located in the centre of the body. The seminal receptacle is present. The vitelline glands are numerous, and located between the cortex and the marrow layer. It is present on both sides in mature proglottids; however, in those in which eggs are present, it is absent starting with its anterior end. The author reports in detail that the adult parasites live on Elasmobranchii, and that the larvae have a tail and live on Teleostei or on Cephalopoda. Further, the author mentions the fact of Sagana Yamaguti's identification and of his creating a new sub-family. However, it does not appear that the author recognizes the new sub-family, Pelichnibothriinae. Judging from the description above, the points of difference between Phyllobothrium and Pelichnibothrium in the case of the specimens of the author of this

article become the presence or absence of the top sucker and of the tail portion: however, they both seem to be present.

(3) Proteocephalus larva.

There is no report on this genus in the literature at the headquarter; the only reference made is in Fish Pathology by Tsunenobu Fujita to the effect that P. longicollis was found in Oncorhynchus masou and Niphon spinosus in Europe, and P. torulosa, P. salvelini, P. arcticus, P. coregoni, and P. laruei in Oncorhynchus keta, Oncorhynchus masou, Salvelinus pluvius, and Niphon spinosus in U. S. A. In MARGOLIS' report, the rate of infection is not high but the generic name is mentioned. Further, it is noted that each specie is the fry of Oncorhynchus nerka, that it is found in fresh water, and that the adult is P. salmonicida. In AXMEPOB's report, it is noted as P. exiguus, and is reported to be found in Oncorhynchus nerka, Salvelinus malma, and Oncorhynchus tschawytscha in the Kamchatka River. The author found what appears to be larvae of this genus in Oncorhynchus nerka and Oncorhynchus keta among the second group of data which had been sent to him from the Fisheries Agency, and so reported. According to WARDLE and MCLECD,

Proteocephalus WEINLAND, 1858 has, as adhesive mechanism, four suckers of ordinary type and a single top sucker. The top sucker, however, may be, in some, vestigial. There is no bristle nor hook, nor folds on the adhesive mechanism. The vitelline gland is located on both sides of the body in a belt fashion. The testiculus is scattered over a wide area and terminates at

parasite parasite parasite

the place where the uterus is located. It is noted that the adult infects fresh water fish and at times amphibia. Over 62 species are mentioned. Of these, five species, all mature parasites, P. arcticus, P. salmonis-umblae, P. pusillus, P. longicollis, and P. salvelini, are parasitic on salmonoid fish. The specimens, which the authorm had, were larvae; thus, the identification was impossible. The specimens, which had been collected in Hokkaido later, also included similar material.

(4) Eubothrium.

This is a considerably large tapeworm. Since this is most noticeable, in the collection on board the research ships of th· Fisheries Agency, a large number was obtained from Oncorhynchus keta in the first expedition. An overwhelmingly large number of this parasites was also collected in the second expedition from oncorhynchus keta. Reference to the past literature in Japan finds three species mentioned as parasitic on salmonoid fishes in Fish Pathology (page 168) of Tsunenobu Fujita--Eubothrium crassum (BLOCH) (parasitic on Oncorhynchus keta and Salvelinus pluvius in Europe and U. S. A.; reaches 300 mm in lenth), E. oncorhynchus WARDLE (parasitic on Oncorhynchus masou, Oncorhynchus keta, and Oncorhynchus kisutch in the west coast of U. S. A.; reaches 600 mm in length), and E. salvelini (SCHRANK) (parasitic on Salvelinus pluvius and Oncorhynchus nerka in Europe and U. S. A.). Reports published in U. S. A. and Canada since 1955 often mention Eubothrium; MARGOLIS' report mentions three species--

parasite parasite parasite

E. salvelini (fry of Oncorhynchus nerka; fresh water; few), E. oncorhynchi(Oncorhynchus nerka, Oncorhynchus gorbuscha; salt water; rare in the western Pacific, observed twice in Oncorhynchus nerka; seen in Oncorhynchus gorbuscha in the east), E. sp. (fry of Oncorhynchus nerka; fresh water; E. salvelini?). (? in original manuscript) In his investigations in the Kamchatka River, AXMEPOB reports finding E. crassum in the intestine of Oncorhynchus keta, Oncorhynchus tschawytscha, and Oncorhynchus kisutch, which were caught in salt water; E. salvelini in Salvelinus leucomaenis, Salvelinus malma, Salmo mykiss, and E. thymallus which were also caught in salt water.

As was mentioned above, in the specimens of the author, the genus is included in a large number both in the material collected on the research vessels and the ones collected by the author in Hokkaido. The specimens collected in the high sea are markedly larger.

According to WARDLE and MCLEOD,

> Eubothrium Nybelin, 1922: phyllidium is simple, the proglottid is generally distinct. Vertical grooves are observed in the centre surface of the dorsal and the ventral sides of the body. The testiculus is located completely between the two neural tubes. The cirrus sac is not remarkably large; it is not muscular. The vagina is S-shaped and opens outside into the genital atrium, which is narrow and deep, in front of the cirrus sac. The seminal receptacle is not present; however, the vagina widens at this point. The "mature-egg-cavity" is located on the dorsal side. The vitelline

gland is located as a half-moon shaped side zone in the cortex. The uterus opening is located on the ventral side.

Species mentioned are eight which are all parasitic on fish. Of these, those parasitic on salmonoid fishes are E. crassum BLOCH, 1779(length 120-699 mm), E. salvelini SCHRANK, 1790 (reaches 280 mm in length), and E. oncorhynchi WARDLE (reaches 600 mm in length). The differences are points mentioned above; however, E. crassum and E. oncorhynchi are very closely related; the author wonders if they should be regarded as identical.

The author investigated the above-mentioned material as a section, and identified it as E. crassum on the basis of the condition of the vitelline gland and other factors. The specimens, which the author had collected in Hokkaido, were larvae, in which the reproductive organ had not been formed, when they were examined as a section.

V. Nematoda

In part I of the present report 33 species of parasites in 11 genera of Nematoda are reported as those which are known to be parasitic in salmonoid fishes; however, there may be some, which cannot be identified because the specimens are larvae, and there may be others which are synonymous. Thus, as in the cases of Trematoda and Cestoda, the number will decrease. The classification of the above mentioned parasites shows that they belong to the following 4 superfamilies--Ascaroidea, Spiruroidea, Trichuroidea, and Dracunculoidea.

parasite parasite parasite 41.41.41.41.41.

For convenience, a table of reference, which is based on the most readily distinguishable features of the four super families, is given:

1 { The anterior part of the body is generally thin and long --------Trichuroidea
  { Not as above. ----------2

2 { Lips absent ----------Dracunculoidea
  { Lips present ----------3

3 { 3 lips, and no oral cavity ----------Ascaroidea
  { 2 lips, or 4-6 small lips. Oral cavity present. At times, teeth present ----------Spiruroidea

Of the above, the one, which belongs to Trichuroidea, is Capillaria of Trichuridae; 6 species of Philometridae belongs to Dracunculoidea; Anisakidae and Goeziidae to Ascaroidea; to the former belongs 3 species of Anisakis(?) (? in original manuscript), 8 species of Contracaecum, and 2 species (?) of Terranova (=Porrocaecum) (? in original manuscript); to the latter belong one specie of Goezia. 3 families, Cucullanidae, Rhabdochonidae, and Thelaziidae belong to Spiruroidea; of these one specie, Dacnitis, belongs to the first family, 5 species of Cystidicola, 2 species of Metabronema, and 5 species of Rhabdochona belong to the second family; and 2 species of Ascarophis belong to the third family.

Tabular representation is as follows:

Trichuroidea	Trichuridae	Capillaria	1	specie
Dracunculoidea	Philometridae	Philometra	1	"
		Philonema	6	"
Ascaroidea	Anisakidae	Anisakis	3	" (? in original)
		Contracaecum	8	"
		Terranova (Porrocaecum)	2	" (? in original)
	Goeziidae	Goezia	1	"

Spiruroidea	Cucullanidae	Dacnitis	1 specie
	Rhabdochonidae	Cystidicola	5 "
		Metabronema	2 "
		Rhabdochona	5 "
	Thelaziidae	Ascarophis	2 "

(1) Capillaria.

The one, which belongs to this genus, appears only once in MARGOLIS' report (1956) as C. sp. It is noted that they were obtained from the intestine of fry of Oncorhynchus nerka and that they are rare. The ones belonging to this genus are parasitic mainly on birds and mammalia. They are not known to be parasitic on amphibia and fish. There was none in the author's specimens.

(2) Philonema.

The first mention of parasites belonging to this genus seems to be two simple diagrams and explanations on Ph. oncorhynchi KUITUNEN-EKBAUM, 1933 and Ph. ochotense FUJITA on page 87 of Fish Pathology by Tsunenobu Fujita in 1937. Next, he published in 1939 three species, Ph. kondai n. sp., Ph. salvelini and Ph. tenuicauda n. sp. on pages 260 et seq. of Vol. 42 of Hokkaido Teikoku Daigaku Nogaku-Bu Kiyo (Hokkaido Imperial University, Faculty of Agriculture Bulletin); further in 1940, he published Ph. elongata n. sp. on page 390 of Vol. 8 of Dobutsugaku Zasshi. Reference is made to MARGOLIS' Ph. oncorhynchi in U. S. and Canadian reports; found many of these in the coeloma of Oncorhynchus nerka in fresh water; further, he found many specimens, which appeared to be the larvae, in fry of

Oncorhynchus nerka. AXMEPOB obtained the genus from the protrusions in the pylorus of Oncorhynchus nerka, Oncorhynchus keta, and Salvelinus leucomaenis, which had been caught in salt water, and identified it as Ph. oncorhynchi; he stated Ph. gubernaculum SIMON E et Simon as synonymous with Ph. elongata FUJITA. Be that as it may, the above-mentioned species when listed become the following six species:

Ph. Oncorhynchi KUITUNEN-EKBAUM, 1933

Ph. ochotense, FUJITA

Ph. kondai FUJITA, 1939

Ph. salvelini FUJITA, 1939

Ph. tenuicauda FUJITA, 1939

Ph. elongata FUJITA, 1940

The main points of difference between the species are tabulated below. In the lack of original literature, information on the first two species was taken from Fish Pathology; information on others was taken from the original works.

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page 30

first columnar heading - Specific Name

Entries - Ph. Oncorhynchi

Ph. Ochotense

Ph. Kondai

Ph. salvelini

Ph. tenuicauda

Ph. elongata

second columnar heading - Size mm

Third " " - Esophagus

Entries - Front < Back

? (in original manuscript)

Front > Back

(Third column con'd.)

Entries - Front < back

Front < Back

Front < Back

Fourth columnar heading - Copulatory Wing

Entries - Present ? (in original manuscript)

Absent

Absent

In front of anus; 0.12 mm
Back of anus; 0.1 mm

Absent

Not distinct

Fifth columnar heading - Length of copulatory needle

Sixth " " - Genital ~~Prominence~~ papillae

Entries - In front of anus: none
Back of anus: 6

In front of anus: @ 3
Back of anus: 3

In front of anus: 9
Back of anus: 6-8

In front of anus: 9
Back of anus: 8

In front of anus: 3
Back of anus: 3

In front of anus: 4
Back of anus: 6

Seventh columnar heading - Head papillae? (question mark by the translator.)

Entries - ?
?
? (? in original manuscript)

Ventral, dorsal, side distinct

Few, indistinct

Indistinct

The examination of the above table shows that there is a difference in size; however, since this depends on the development of parasites, it cannot be relied on too much. The other charac

teristics are similar. However, the difference in the length of anterior and posterior portion of esophagus, and the position and the number of the genital protrusions, though there are variations, seem to supply fairly distinct bases for the identification of species.

The parasites of this genus are extremely thin and thread-like; thus, they are easily observed when the host is opened up. Hence, a fairly large number of parasites was included in the collection of the first and the second expeditions. However, perhaps because the body is soft, they were very badly damaged. Thus, though they could be recognized as belonging to this genus on the basis of eggs, further identification was difficult. In his 1956 report to the Fisheries Agency, the author identified them as Ph. ochotense and Ph. oncorhynchi on the basis of size and so reported. However, he has his doubts.

(3) Anisakis.

The parasites of this genus, which are found in salmonoid fishes, are all larvae. The rate of infection is extremely high. The fact probably is known; but, among the Japanese references quoted in Part I, the author feels that the mention of Anisakis salaris (GMELIN, 1790) by Sanaka Yamaguti (1935) on page 338 of Vol. 6 of Dobutsugaku Shu ho is the first. The larva of this specie has been know as Ascaris capsularia RUDOLPHI, 1802. Before this, the name, Capsularia salaris (GMERIN, 1790) ZEDER, 1800, was given. however, the generic name Capsularia was first a genus of

Hydrozoa by CUVIER in 1798. Since Anisakis of DUJARDIN resembled this closely, Yamaguti proposed the name Anisakis salaris, a combination of the two. Since there is no doubt that Ascaris simplex RUDOLPHI, 1804, is a mature form of this larvae, Yamaguti states this specie synonymous with Anisakis salaris. Without commenting on the propriety of this argument, the author for the time being at any rate reported as Anisakis salaris. The larvae are parasitic mainly on species of fish in the ocean; Yamaguti mentions 33 species of fish.

Anisakis sp. larva is mentioned in 1956 reports of U. S. A. and Canada; the rate of infection is shown as 95-100%, and the average number per fish is reported as 5 - 28. On the basis of the rate of infection of Anisakis and others, J. R. UZMANN of U. S. A. argues that the distribution border of salmon between the eastern and the western portion of the Pacific is between 170° E to 180°. The larvae of this specie are found in tunica in a circinate such places as tunica in muscle, mesentery, surface of the internal organs, and the methothelium, and easily detected. Later, Uzmann and others used protein-digestive-enzyme to decompose the fish body in order not to miss them. AXMEPOB's report adopted the name, Anisakis simplex RUDOLPHI, 1819, and regards A. salaris of Yamaguti as synonym, and states that they are parasitic on Oncorhynchus nerka, Salvelinus malma, Salvelinus leucomaenis, Oncorhynchus keta, Oncorhynchus gorbuscha, Oncorhynchus tschawytscha, and Oncorhynchus kisutch, Salmo mykiss.

The material of the author includes the ones which ~~appeared~~

~~to have been~~ were parasitic on Oncorhynchus nerka in the second collection, which was sent to him from the Fisheries Agency. He also found them, though in a small number, in the frozen fish which was sent from the U. S. A. On his trip to Hokkaido, he did not pay any particular attention to them; thus, his collection of the specie is few. It appears as though it is prevalent as stated in Uzmann's report in the Pacific. The material of the author includes specimens, in which the back of the esophagus is clearly seen, and those in which this is not distinct; however, since the structure of the head and the tail is identical, it probably is not a different specie. The size, measurements of nine parasites, is 23-38 x 0,3-0.6 mm.

(4) Contracaecum.

The number of species of this genus, which are parasitic in salmonoid fishes, are considerable. Tsunenobu Fujita mentions in his Fish Pathology, C. ochotense Fujita, C. benimusu Fujita as being parasitic in the ventral cavity, C. aduncа (RUDOLPHI) and C. clavata (RUDOLPHI) as being parasitic in the digestive tract. Next, he published C. hypomesi FUJITA, C. crassicaudatum n. sp., C. elongatum n. sp., C. unidentatum n. sp. (illustrative diagram refers to C. monodentatum), and C. robustum on pages 248 - 252 of ~~the~~ Vol. 42 of 1939 Hokkaido Teikoku Daigaku Nogakubu Kiyo; further, in his article entitled "Further notes on nematodes of salmonoid fishes in Japan" in ~~the~~ Vol. 8 (1940) of Dobutsugaku Shu~~ri~~ho, he published four new species, C. okadai, C. salvelini, C. longicapiculum and C. oshorocensis.

In reports of U. S. A. and Canada, the genus is found as Contracaecum sp. in a considerable number. Larvae are obtained in the coeloma. The rate of infection seems to be higher in the eastern Pacific. AXMEPOB notes one specie, C. adunca; he reports finding mature parasites in Salvelinus leucomaenis, Oncorhynchus nerka, Oncorhynchus gorbuscha, Salmo mykiss, Salmo thymallus, and immature parasites in Oncorhynchus keta and Salvelinus malma. Locales of infection are shown as the esophagus, the stomach, the intestine, and the coeloma.

Both the first and the second material, which were sent to the author by the Fisheries Agency, included specimens belonging to this genus; however, a complete identification was not made. The specimens from the first collection was reported as merely Contracaecum sp., and those from the second collection as C. adunca? (? in original manuscript) and C. benimasu. ~~(translator's note--the question mark is in the original manuscript).~~ The material from Hokkaido also included a few specimens.

On the basis of the literature, the species of this genus, which have been found in salmonoid fishes, are the following 13:

Contracaecum adunca (RUDOLPHI), 1809
C. benimasu FUJITA, 1932(?) (? in original manuscript)
C. crassicaudatum FUJITA, 1939
C. elongatum FUJITA, 1938
C. hypomesi FUJITA, 1932(?) (? in original manuscript)
C. longispiculum FUJITA, 1940
C. ochotense FUJITA, 1922(?) (? in original manuscript)

parasite parasite parasite 49.49.49.49.49.49.

C. okadai FUJITA , 1940

C. oshoroensis FUJITA, 1940

C. robustum FUJITA, 1939

C. salvelini FUJITA, 1940

C. tridentatum FUJITA, 1939

C. unidentatum FUJITA, 1939 (=C. monodentatum FUJITA).

The author made a comparison of the characteristics of these species making a table with respect to several parts; he is doubtful if there are this many different species. Those, which were published by Fujita as new species, contained a considerable number of larvae. In some, genital organs could not be recognized. In some specimens consisted of a single sex. It is doubtful if their characteristics remain the same until after maturity. There was a specimen with no lip (C. robustum), vagina There are considerable degrees of differences between those, whose vagina open in the centre or in front of the centre of the body, and those , in which the vagina opens at the rectum. It is doubtful whether the specie with the genital nipples should be included in the same Contracaecum with the specie without one. Since the esophageal "closed sac" and the intestinal "closed-sac" are present in every specie, it is recognized to be the most marked characteristics of the present genus. However, the author feels that ~~this~~ further examination is necessary. Fujita used the expression, C. unidentatum, in his report, and used the designation, C. monodentatum in the explanation of the diagram. The author adopted C. unidentatum and treated the latter as a synonym.

The following table of reference on the basis of characteristics, which are most easily recognized by anyone, is shown below:

1 { Lips absent ----------C. robustum
  { Lips present ----------2

2 { Protrusion facing forward in front of lips ----------3
  { No such protrusion ----------4

3 { Only one protrusion on dorsal lip ---------C. unidentatum
  { Three protrusions in each lip ----------C. tridentatum

4 { Genital nipples present----------5
  { Genital nipples absent----------9

5 { Genital nipples located only in front of the anus -------6
  { Genital nipples located both in the front and the back of anus ----------8

6 { Genital nipples consist of 20-25 pairs --- 7
  { Genital nipples consist of 28-34 pairs --- C. salvolini

7 { The vagina opens at the base of the rectum -C. okadai
  { The vagina opens in the centre of the front 1/3 of the body----------C. hypomesi

8 { Genital nipples - 30 pairs in front of the anus and 3 pairs at the back. Length of the body 12.5-21 mm ---------- C. longipiculum
  { Genital nipples - 27 pairs in the front of anus and 3 pairs at the back. Length of body 30-65 mm ---------- C. adunca

9 { The vagina opens near the centre of the body ---------10
  { The vagina opens into the rectum ----------11

10 { The esophageal "closed-sac" is longer than the intestinal "closed-sac" ----------C. crassicaudatum
   { The esophageal "closed-sac" is shorter than the intestinal "closed-sac".-----C. elongatum

11 { Single protrusion at the end of the tail -------C. oshoroensis
Many small bristles at the end of the tail ----------12

12 { The esophageal "closed-sac" is longer than the intestinal "closed-sac"----------C. benimasu
The esophageal "closed-sac" is shorter than the intestinal "closed-sacs" ----------C. ochotense

This table of reference is merely for convenience; there are species in which only the male or the female is known. Further, if the specimens to be examined consists only of one sex, there are cases when the search cannot be made. Further, as was explained previously, there are cases, in which the original report deals only with larvae. Further examination may introduce a change. AXMEPOB stated (1955) that C. okadai, C. longispiculum, C. salvelini, and C. oshoroensis should be regarded as synonymous with C. adunca.

The specimens, which the author has, consists of those which were sent by the Fisheries Agency, and those which the author collected from Oncorhynchus gorbuscha caught at Ajigazawa in Aomori-Ken. However, since they appear to be of the same specie, they were identified as C. adunca.

(5) Terranova (=Porrocaecum?). (? in original manuscript) The present genus appears in MARGOLIS's report and is referred to as (=Porrocaecum). It is stated that it is found in the inner part of muscles of Oncorhynchus nerka and Oncorhynchus gorbuscha in salt water in a small number. It is said that the genus is larvae of T. (=P.) decipiens. According to MARGOLIS' report, "Parasitic Helminths and Arthropods from Pinnipedia of the Canadian

Pacific Coast, 1956", this genus, Terranova, which we are not accustomed to hear, was established by ATKINSON and LEIPER in 1914 with T. antarctica, which had been obtained from sharks in New Zealand, as a specimen and specie; the point of difference from Porrocaecum is the lack of interlabia. Porrocaecum is parasitic on birds with interlabia; Terranova is parasitic on Elasmobranchii, Teleostei, and Mammalia and has no interlabia.

It is reported that T. decipiens is parasitic on Pinnipedia. This is also lacking in the author's material.

(6) Goezia. In the literature of Japan the genus seems to have been mentioned first by Tsunenobu Fujita when he published a new specie, Goezia onchorhynchi, on page 384 in Vol. 8 of Dobutsugaku Shuho. The genus is the only one which belongs to Goeziidae. The characteristics of the genus is the presence of a thorny ring, of ventricular caecum, which faces the back, and the presence of the intestinal caecum, which faces the front. However, in the description by Fujita horizontal folds are present but the thorny rings are absent. What appears to correspond to the ventricular caecum, he defines as the esophageal gland. Further, the genital organs are not well developed. Thus, the specimen appear to be larvae. Although no mention was made in Part I, R. PH. DOLLFUS obtained G. ascaroides (GOEZE) from Salmo irideus var shasta and reported (Bulletin de la Société Zoologique de France, Tome LX, 1935). This was also absent from the material of the author.

(7) Dacnitis. MARGOLIS' report states that D. truttae of the present

genus was obtained from the intestine of Oncorhynchus ~~m~~ nerka in fresh water and that the parasites are not numerous. AXMEPOB'S report states that D. truttae DUJARDIN was obtained in a large number from Salvelinus leucomaenis and Salmo mykiss in fresh water, that only one Oncorhynchus nerka harboured the specie, and that this could have been accidental. It is further reported that the specie is found in Salmo leveratus, Salmo nelma, and Salmo taimen in the Lena River(?), the Enisei River(?), The Anadowill River (?) and the Obi(?) and Iltwish(?) water basins. (question mraks by the translator). The genus was absent in the author's material.

(8)Cystidicola. With respect to the present genus, in 1911 Shigeyoshi Ishii published Ancyracanthus salmonicola, which is parasitic in the air bladder of Oncorhynchus masou, as a new specie; this was later transferred to the present genus. In the article, "Parasites in Fish", which Tsunenobu Fujita published during 1920-1922, references are made to C. oncorhynchi (later transferred to Rhabdochona), which was obtained from the intestine of fry of Oncorhynchus keta, C. fujii (same as above), which was obtained from the intestine of Oncorhynchus adonis JORDAN et MCGREGOR and Oncorhynchus rhodurus JORDAN et MCGREGOR, and Spiroptera salvelini, which was obtained from the intestine of the same hosts, as new species. The last-mentioned specie was later included in the present genus. These are all parasitic in the intestine. Again, the same author published articles entitled "Vermes Parasitic in Fishes in the Lake Biwa" during 1926-

parasite parasite parasite ..... 54.54.54.54.54.

1928; he obtained C. salvelini from Salvelinus pluvius; at the same time he obtained C. iwana from the coeloma and identified this as a new specie. During 1934 - 1935 Sanaka Yamaguchi published additional observations concerning C. salvelini, and obtained C. salmonicola from Oncorhynchus rhodurus JORDAN et MCGREGOR. In 1935 Isamu Okada reported on ecology and pathology of C. salmonicola in an article entitled "On Nematodes Parasitic in Air-Bladders of Salmonoid Fishes". Hisao Kobayashi refers to the above-mentioned three species in his article "Species of Fresh water Fish in Japan and Its Parasites". Tsunenobu Fujita mentions C. salvelini, C. salmonicola, C. farionis, and C. impar in his Fish Pathology. Further, he reported on a new specie, C. brevicauda, which he obtained from Salvelinus malma, in Vol. 42 on page 259 of 1939 Hokkaido Teikoku Daigaku Nogakubu Kiyo; and in 1940, he published C. chitosensis as a new specie , which he had obtained in the air-bladder of Oncorhynchus keta, in Vol. 8 of Dobutsugaku Shu Ruiho. In his 1955 report AXMEPOB reports of finding C. farionis in the air-bladder, the intestine, and the esophagus of Salvelinus leucomaenis and Salmo mykiss. Thus, the parasites, which belong to the present genus, number nine:

Cystidicola brevicauda FUJITA, 1939

C. chitosensis FUJITA, 1940

C. farionis FISCHER

C. Fujiii FUJITA. 1921 → Rhabdochona fujiii

(Dobutsugaku Zasshi - 1926-1928, p. 309)

C. impar SCHNEIDER

C. iwana FUJITA, 1928 → Metabronema iwana

(Fish Pathology, p. 86)

C. oncorhynchi FUJITA, 1921 → Rhabdochona

parasite parasite parasite 55.55.55.55.55.55.

Oncorhynchi (Dobutsugaku Zasshi, 1926-1928, p. 309)

C. salmonicola (ISHII, 1911)

C. salvelini (FUJITA, 1922)

The table of reference, which excludes Rhabdochona and the three species, which were transferred to Metabronema, and C. brevicauda, in which male is not known, is as follows:

1 { Genital nipples not present behind anus -----C. chitosensis
  { Genital nipples present behind anus ----------2

2 { Four pairs of single genital nipple in front of anus;
  { four or five pairs behind anus ----------C. salvelini
  { Even number of genital nipples in front of anus ------3

3 { Seven pairs in front of anus; five pairs behind anus--C. impar
  { Ten pairs in front of anus; four pairs behind anus---C. farionis
  { 10-11 pairs in front of anus; 3-4 pairs behind anus--C. salmonicola

The above table is based only on the genital nipple; ~~thus~~ therefore, it cannot be used in the case of female only. The last two species can hardly be distinguished by other points; however, since there is no original description, the author leaves the table as it is.

The author obtained many specimens from the air-bladder and the coeloma of fry of Oncorhynchus keta, which he had collected in Aomori-Ken. Some differences were observed in the number of the genital nipples; however, the author felt that the differences were variation between specimens. Thus, they were identified as C. salmonicola.

(9) Metabronema (= Cystidicoloides). The first appearance of the present genus in the literature of this country probably is M. iwana on page 86 of Fish Pathology by Tsunenobu Fujita. The specie was first

published by the same author as Cystidicola iwana n. sp. in Dobutsugaku Zasshi; here the specie is transferred to the present genus. Further, he published five new species in 1939 in Vol. 42 of Hokkaido Teikoku Daigaku Nogaku-Bu Kiyo --M. oncorhynchi from Oncorhynchus masou, M. kosugii from Salvelinus leucomaenis, M. amemasu from Salvelinus leucomaenis, M. salvelini from Oncorhynchus keta and Salvelinus leucomaenis, and M. laticauda from Oncorhynchus nerka. Further, in 1935 BAYLIS contributed an article entitled "Four new species of nematodes" in Vol. 16, Ser. 10 of Ann. Mag. Nat. Hist.; in this article he published M. truttae as a new specie. However, in his opinion Cystidicola = Metabronema and he states C. salvelini to be M. salvelini. However, this salvelini is different from the above-mentioned M. Salvelini. The name of the present genus does not appear in U. S., Canadian, or Soviet reports.

Among the specimens of the author, which had been sent to him by the Fisheries Agency, what appears to belong to the present genus was found in Oncorhynchus nerka. However, the specimens consisted solely of females and the author was unable to identify them. He reported them as M. sp. The size was approximately 29-36 x 0.7-0.8 mm ; there were two or three very long strands of thread-like-object coming out of one end of the egg. The size of the egg was approximately 40 x 20 μ; the egg contained larva. Thus, in the end six species can be counted to belong to this genus. They are, M. iwana, M. oncorhynchi, M. kosugii, M. amemasu, M. salvelini, and M. laticauda. The table of reference

parasite parasite parasite. 57.57.57.57.57.

is shown below. It appears as though the distinctions are somewhat clearer in comparison with Contracaecum or Cystidicola. However, there are species in which only female is known. Variations must also be considered. Thus, the table is not sufficient.

1 { Width of tail is wide and is approximately equal to the length and is rectangular in shape ---------M. laticauda
  { The tail becomes smaller towards the end ----------2

2 { Eggs are large: 90 x 40 μ ----------M. amemasu
  { Eggs are smaller ----------3

3 { Genital nipples are single ----------4
  { Genital nipples in front of anus are in groups of two -----5

4 { Genital nipples: 8 pairs in front of anus and 2 pairs at the back of anus ----------M. kosugii
  { Genital nipples: 10 pairs in front of anus and 3 pairs at the back of anus ----------M. salvelini

5 { Genital nipples: in front of anus in one part groups of two; however, counting singly 16 pairs: 2 pairs at the back of anus ----------M. iwana
  { Genital nipples: 13 pairs in front of anus, 3 pairs at the back of anus ----------M. oncorhynchi

(10) Rhabdochona. There are 10 - 12 high ridges running longitudinally along the inner wall of the oral cavity in the present genus. The ends of the ridges become teeth. The first reference to this genus in the literature in this country appears to be the publication of a specie as Cystidicola oncorhynchi and C. fujii by Tsunenobu Fujita in 1922; these were later transferred to the present genus. Next, he published a specimen as Rh. salvelini sp. on page 172 Vol. 1 of 1927 Dobutsugaku Zasshi; the same item was also

parasite parasite parasite 58.58.58.58.58.58.58.

published in Dobutsugaku Zasshi. Following this, Sanaka Yamaguti published Rh. amago n. sp. on page 372 Vol. 6 of Dobutsugaku Shu ho. The above-mentioned three species are mentioned in "Fresh Water Fish of Japan and Their Parasites " by Hisao Kobayashi; Fish Pathology by Tsunenobu Fujita also mentions these. In 1940 the same author published Rh. oncorhynchi n. sp. on page 388 , Vol. 8 of Dobutsugaku Shu ho. MARGOLIS states in his report that he obtained Rh. sp.(?) (translator's note: question mark is in the original manuscript) in the intestine of fry of Oncorhynchus nerka and that they are rare. The above accounts indicate that the species of the present genus found in salmonoid fishes are two in Rh. oncorhynchi--Rh. fujii and Rh. salvelini-- and Rh. amago. A comparison was made of these by tabulating distinguishable characteristics. However, Rh. oncorhynchi, which was published by Fujita in 1940 Dobutsugaku Shu ho, was described in terms of female only, and can hardly be distinguished from the specie, which was published as Cyssidicola (translator's note: Cystidicola?) oncorhynchi and later transferred to the present genus. The description of high ridges in the oral cavity is not sufficient and the identification is difficult. However, the author feels that they are identical. The table of reference, constructed with this excluded, is as follows:

1 { No high ridges of chitinous substance in the oral cavity ----------Rh. amago
  { Six high ridges consisting of 2 closely located ridges in the oral cavity----------2

parasite parasite parasite 59.59.59.59.59.59.

2 { Copulatory wing is distinct and well developed ---Rh. fujiii
Copulatory wing is absent or can hardly be recognized -------3

3 { Genital nipples: 8-9 pairs in front of anus, and 5 pairs at the back of anus. Egg size: 43 x 24 μ ------Rh. oncorhynchi
Genital nipples: 10-12 pairs in front of anus, and 5 pairs at the back of anus. Egg size: 58 x 32 ------Rh. salvelini

Among the specimens of the author, what appears to be of the present genus was included in the first collection which had been forwarded to the author by the Fisheries Agency; he reported them as Rh. sp. Later, he obtained Rh. oncorhynchi from the intestine of fry of Oncorhynchus keta 54 mm which he had obtained from the Prefectural Hatchery in Aisaka, Towada-Shi, Aomori-Ken. There was a small variation in the number of mm genital nipples; however, they appear to be of the present specie.

(11) Ascarophis. There does not appear to be any mention of the present genus in the literature in this country. MARGOLIS' report mentions that a small number of A. skrjabini was collected from the stomach and the intestine of Oncorhynchus gorbuscha in salt water. AKMEPOB's report also mentions that A. malmae ACHMEROW was obtained from the intestine of fry of Salvelinus malma in fresh water. It was not seen in the author's material.

VI ACANTHOCEPHALA

The known parasites of Acanthocephala, which is parasitic on salmonoid fishes, as was noted on page 81 (page 624) of Part I, number 15 species in 7 genera. However, there are cases where the

parasite parasite parasite parasite 60.60.60.60.60.60.60.

specific names are not known. There are cases which were taken as synonyms for others. Thus, the actual number probably is less. For convenience, the following table of reference is constructed:

Table of reference of eye

1 cement glands. The oral hooks are collectively located. Hosts are land animals -------1. Archiacanthocephala

6 cement glands in general. Oral hooks aligned in radial fashion alternately. Hosts are mainly aquatic animals ----------2. Palaeacanthocephala

Cement glands are multinuclear cells; the "storage-sac" is present. Oral hooks are aligned in radial fashion. Hosts are aquatic animals----------3. Eoacanthocephala.

The first order is not related. The above-mentioned parasites belong to the second and the third order.

Palaeacanthocephala. Those belonging to this order have the oral hooks drawn up in small cubes; main "groove-tubes" are on the side; in a female, the single "ligament sac" breaks. In a male, there are usually six cement glands; there is no protonephridium. The main families are Rhadinorhynchidae, Gorgorhynchidae, Polymorphidae, and Echinorhynchidae. The species mentioned above belong to the three families excluding the second. Eoacanthocephala. In this order the oral hooks are aligned in a radial fashion ; there is no protonephridium; the cement glands are multinuclear cells with a large nucleus; the secretion pours into the "storage-sac". The main families are Pallisentidae, Quadrigyridae, Neoechinorhynchidae, and Rebesomidae, and others. The one related here is Neoechinorhynchidae only.

parasites of this genus, which

The first record of [illegible]

is parasitic on salmonoid fishes (In the literature of Japan) was [illegible] the article by Tsunenobu Fujita on Acanthocephalus entitled "Vermes Parasitic On Fry of [illegible] Salmonoid Fishes" in 1916 in Vol. 28 of Dobutsugaku Zasshi; the specie was not identified. The same author wrote on Echinorhynchus gadi MÜLL (= E. acus RUD.) and a new specie Acanthocephalus echigoensis in Vol. 32 of Dobutsugaku Zasshi in 1920: the next year, in 1921, he reported on A. oncorhynchi n. sp. in Vol. 33 of Dobutsugaku Zasshi. In 1931 VAN CLEAVE published Acanthocephalus aculeatus n. sp. which is parasitic on Oncorhynchus nerka, and A. acerbus n. sp., which is parasitic on Salmo irideus Gibbons, in Vol. 13 of Dobutsugaku Ruiho. In 1935 Isokichi Harada discussed marked variations in the number of hooks, the number of rows of hooks, or the size of eggs in Vol. 14 of Taihoku Teikoku Daigaku Rinogaku-Bu Kiyo (Taihoku Imperial University Science and Agriculture Faculty Bulletin), and stated that the above four species of Acanthocephalus should be all identified as A. echigoensis. In 1936 the author and [illegible] Tetsuo Morishita made a report on one male and one female specimens of Acanthocephalus echigoensis, which had been obtained by Mifusa Kurozawa in Salmo mocrostoma from Sano River in Yamanashi-Ken, [illegible] on page 761 of Vol. 48 of Dobutsugaku Zasshi. Fish Pathology [illegible] (1937) by Tsunenobu Fujita mentions, in addition to the above-mentioned species, Acanthocephalus angullae (MÜLL), which is parasitic on Oncorhynchus masou: of Echinorhynchus, the publication mentions E. salmonis

and E. truttae SCHRANK
MÜLLER, which is parasitic on Oncorhynchus keta and Niphon spinosus in Europe, Bolbosoma caenoforme (HEITZE), which is parasitic on Oncorhynchus nerka in Kamchatka, and B. heteracanthe (HEITZE) in Oncorhynchus keta in Europe. In 1937 the author and Tetsuo Morishita published Rhadinorhynchoides miyagawai n. g., n. sp., which had been obtained from Salvelinus pluvius from Taguchi River in Niigata-Ken, in Vol. 21 of Jikken Igaku Zasshi (Journal of Experimental Medicine). Further, in the same year in the same publication, Tetsuo Morishita published Neoechinorhynchus tsintaoensis n. sp., which he had obtained from Oncorhynchus masou in Tsingtao.

Reports of U. S. A. and Canada mention at the beginning Echinorhynchus sp. and Bolbosoma sp.; however, the former is E. gadi and among the collection, which was made in rivers and lakes during Apr. - May, 1955, the name of Neoechinorhynchus rutili appears. In the collection, which was made in July-Sept., 1955, Echinorhynchus and Bolbosoma are noted; the fact that the former may be useful in determining the borderline of fish distribution is also indicated. MARGOLIS's 1956 report shows Echinorhynchus gadi, Nipporhynchus sp., Corynosoma strumosum later period larvae, Corynosoma spp. late period larvae, Bolbosoma sp. late period larvae, and Neoechinorhynchus rutili. Of these, the genus, Nipporhynchus, was established by A. C. CHANDLER in 1934 in his theses, "A revision of the genus Rhadinorhynchus with the descriptions of new genera and species", which was published on p. 355 of PARASITOLOGY, Vol. 26 No. 3. However, in 1935 Sanaka Yamaguti in at

the end of his supplementary article on a new specie, Rhadinorhynchus katsuwonis, of Harada mmà notes that there is not sufficient evidence to regard it as a new genus. AXMEPOB's report mentions six species--Echinorhynchus gadi, E. salmonis, Corynosoma strumosum, Bolbosoma caenoforme, Neoechinorhynchus crassus, and N. cristatus. The listing of the above is as follows:

Palaeacanthocephala order

Echinorhynchidae family

Acanthocephalus acerbus VANCLEAVE, 1931
A. aculeatus VANCLEAVE, 1931
A. echigoensis FUJITA, 1920
A. oncorhynchi FUJITA, 1921
Echinorhynchus gadi ZOEGA in MÜLLER, 1776
E. salmonis MÜLLER
E. sp.
E. truttae SCHRANK

Rhadinorhynchidae family

Nipporhynchus sp.
Rhadinorhyncoides miyagawai FUKUI et MORISHITA, 1937

Polymorphidae family

Bolbosoma caenoforme (HEITZE)
B. sp.
Corynosoma strumosum HEITZE
C. spp.

Eoacanthocephala order

Neoechinorhynchidae family

Neoechinorhynchus crassus VANCLEAVE
N. cristatus LYNCH
N. rutili (MÜLLER)
N. tsintaoensis MORISHITA, 1937

Of the above Acanthocephalus becomes a specie of A. echigoensis, if we agree with Harada's theory. For reference, the

characteristic of several parts are listed from the original publication.

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headings ~~to~~ of table on page 48.

2nd column - Size

3rd " - Size of ~~lip~~ proboscis

4th " - "~~lip~~ proboscis-sheath"

first entry - A little longer than lip proboscis

second " - A little shorter

5th " - "~~Acanthel~~ Lemniscus" (?) (~~translator's note; question mark by the translator~~)

1st entry - a little longer than ~~lip~~ proboscis

6th " - Number of hooks

1st entry - vertical 8-10 x horizontal 7-8

7th column - Length of hook

8th " - size of embryo

3rd entry - none

Consideration of such factors as the ~~dmmdmpm~~ growth of the specimens, the state of preservation of the material, original variations leads one to the belief that these four species are identical as was shown by Harada. The author examined and compared the reproductive organs with ~~mmm~~ respect to ~~mh~~ the original description and the diagram; he failed to find differences sufficient to identify them as ~~to dm~~ separate species. The comparisons were not made with type specimens; therefore, nothing definite can be ~~mmm~~ stated. However, the author is inclined to accept Harada's theory.

(2) Echinorhynchus. E. gadi is found parasitic on many salt water fishes; Sanaka Yamaguti reports, in his 1935 report, finding it in

"kinguchi" (golden mouth), Cyclogaster owstoni (JORDAN et SNYDER), Stereolepis ishinagi (HILGENDORF), Hapalogenys nigripimis TEMMINCK (et SCHLEGEL), Arctoscopus japonicus (STEINDACHNER), Hexagrammos otakii JORDAN et STARKS, and Linanda punctatissima (STEINDACHNER), and others. As the specific name indicates, it is prevalent in cod. The author has obtained it in a red snapper in Hokuriku. E. salmonis cannot be compared since the author has not seen the original description. Numerical information in Fish Pathology by Fujita differs considerably from E. gadi; thus, it appears that it is a different specie.

(3) Nipporhynchus. This genus was published as a new specie by A. C. CHANDLER in his article, "A revision of the genus Rhadinorhynchus with descriptions of new genera and species", on page 355 of Vol. 26, Parasitology in 1934. The name was given the parasite, which Isokichi Harada published as Rhadinorhynchus katsuwonis, which is parasitic on bonito, in his article, "A new species of Acanthocephala from the Japanese Bonito, Euthynnus", published on p. 10 Vol. 2 of Dobutsugaku Shu ho. Its marked characteristics are four long and thin cement glands. However, even the reference to Chandler's original article, as Yamaguti states, does not reveal sufficient differences to define as a new specie. MARGOLIS' report mentions Nipporhynchus sp.; however, it probably is Rhadinorhynchus katsuwonis. The author collected specimens which appears to belong to the present species. However, there are some points of difference; therefore, the report on it will be made later

(4) Rhadinorhyncoides. This genus was defined as a new genus by the author and Tetsuo Morishita in 1937 as was stated above. A brief outline of its characteristics are as follows: the proboscis is cylindrical; the oral hooks in the front are smaller than those at the back and those on the ventral side are larger than those on the dorsal side; there are no hooks on the body, which is cylinderical in shape, and on the head; the "lip-sheath" is cylindrical; the walls are double; the brain is located in the middle of the "lip-sheath"; the lemniscus is a little shorter than the "lip-sheath" and is "finger-shaped"; the testiculus is aligned vertically adjacent to one another and is located in the anterior portion of the posterior half of the body; there are four cement glands which are arranged parallel to one another in a group of two; the ovarium is circular; the uterus and the uterine bell are short; mature eggs fill the coeloma; the "middle shell" has elongated terminals; the inner shell is distinct. The present genus resembles Leptorhyncoides KOSTYLEV, 1914 or Tenuisentis VANCLEAVE. However, it differs completely in the number of cement glands, shape, or "proboscis-sheath". The author feels that one Rhadinorhynchus aspinosus FUKUI et MORISHITA (Jikken Igaku Zasshi Vol. 21, No. 1, p. 39), which has been obtained in Teutis fuscescens (HAUTTUYN), should be classified as belonging to the present genus.

(5) Bolbosoma. The species belonging to the present genus can be easily recognized by its extraordinary shape, i. e., there is an extremely swollen portion following the neck, followed by a markedly

parasite parasite parasite ... 67.67.67.67.67.67.

thin portion, which forms the main trunk of the body. There are many spines in this swollen portion. The bristles form roughly two bands. The mature ♀♂ parasite of this genus is parasitic on salt water mammals; those, which infect salmonoid fishes, are larvae. As has been mentioned above, MARGOLIS' and AXMEPOB's reports mention B. caenoforme. However, Fujita (Fish Pathology) states that the identification was made on immature specimens. The author obtained many larvae from Oncorhynchus gorbuscha in Hokkaido; however, since the reproductive organs were not developed sufficiently, the identification was impossible.

(6) Corynosoma. The mature parasite of this genus is also parasitic on sea birds and marine animals. The anterior portion of the body is extremely thick. The body spines are found to the posterior portion of the body. Thus the genus can be recognized easily. There are species which have spines around the genital opening located at the posterior end of the body. The species of this genus are not in the author's material.

(7) Neoechinorhynchus. The characteristics of this genus are that it is small in size generally, and that it has a large cell nucleus in the epidermis. The proboscis is short and circular; it has few hooks of which the ones located in the anterior end are extremely large. Reports mention N. crassus, N. cristatus, N. rutili and N. tsintaoensis; however, they were caught (all) in fresh water. There are no specimens in the author's possession which belong to the present genus.

Copopoda

With reference to Copopoda, which is parasitic on salmonoid

among the Japanese literature
fishes, one can cite the reference to 6 species -- Caligus rapax, Lepeophtheirus salmonis, L. stromii, Lernaeopoda carpionis, L. salmonea, and L. edwardsii-- in Fish Pathology by Tsunenobu Fujita in 1937. In each case, it is the introduction of the specie found in Europe. Following this in 1939, Sanaka Yamaguti published a new specie, Lepeophtheirus uenoi, on page 451 of Dr. Sadao Yoshida Shukuga Kinen-Shi, Obun-Hen, 2-Kan (Dr. Sadao Yoshida Congratulatory Commemorative Publication, European Language Volume, Vol. 2). U. S. and Canadian reports mention Lepeophtheirus salmonis, Ergasilus sp., and Salmincola falculata; AXMEPOB's report mentions four species, Salmonicola thymalli, Salminicola edwardsi, S. bicauliculata, and Lepeophtheirus salmonis. (Note: the references in the author's possession spell Salminicola, Salmonicola, and Salmincola. The author feels that these were errors in printing. Since the author cannot confirm it, they were copied as they appear). In 1954 Riichi Hoshina and Takeshi Suenaga published Salmincola yamame n. sp., which he obtained from Salvelinus pluvius on page 75 of No. 1, Vol. 41 of Jour. Tokyo Univ. Fisheries. The listing of these species are as follows:

Caligidae

1. Caligus rapax (M. EDWARDS)
2. Lepeophtheirus salmonis KRÖYER
3. L. stromii (BAIRD)
4. L. uenoi YAMAGUTI, 1939

Ergasilidae

5. Ergasilus spp.

Lernaeopodidae

6. Lernaeopoda carpionis KRÖYER

7. L. salmonea KRÖYER
8. L. edwardsii OLSSON
9. Salmincola bicauliculata
10. S. edwardsi OLSSON
11. S. falculata (WILSON, 1908) WILSON, 1915
12. S. thymalli KESSLER
13. S. Yamame HOSHINA et SUENAGA, 1954

The author found many specimens of this genus in the two collections, which had been forwarded to him from the Fisheries Agency. The listing was shown on pages 628 to 632 of Part I. However, these agreed completely with Lepeophtheirus uenoi. Thus, the author reported them under this name. However, in U. S., Canadian, and Soviet reports they are identified as L. salmonis. Thus, the author felt that, if these were an entirely different specie, they would be useful in establishing a distribution border of fishes. However, the author came to have doubt on reading MARGOLIS' thesis, "The identity of the Species of Lepeophtheirus (Copepoda) parasitic on Pacific Salmon (Genus Oncorhynchus) and Atlantic Salmon (Salmo Solar)", on p. 889-892 of Can. J. Zool. 36 (1958). He made extensive investigations of this genus in salmonoid fishes both in the Pacific and Atlantic, consulted literatures extensively, and wrote that the identification as a new specie by Yamaguti was the result of inadequate description by C. B. Wilson and T. and A. Scott whose reports he had used as references. The author agrees with this view. Thus, he feels that L. uenoi and L. salmonis should be regarded as synonymous. The is all the material which the author has on this genus.

VIII Protozoa

The author made almost no consideration of Protozoa which are parasitic on salmonoid fishes. However, since the present volumes are not for specialists, he will give a general outline as a reference. The first reference in the literature of this country seems to be the report on Myxidium oncorhynchi n. sp. (Oncorhynchus masou), Chloromyxum salvelini n. sp. (Salvelinus leucomaenis), Ch. chitosense n. sp. (Oncorhynchus keta), Ch. giganteum n. sp. (Oncorhynchus gorbuscha) and Ch. quadriforme n. sp. (Oncorhynchus keta, Oncorhynchus gorbuscha, and Oncorhynchus masou) by Tsunenobu Fujita in his article "Studies on Myxosporidia of Japan" in 1923. In 1935 Muneo Watanabe reported on Ichthyophthirius multifiliis; there are other reports on "white spot" disease. Books and reports by Hisao Kobayashi in 1935 and 1936 and Fish Pathology by Tsunenobu Fujita in 1937 mention this. Further, the book by Fujita mentions Costia sp. (fry of Oncorhynchus masou), Cyclochaeta domerqueri (fry of Oncorhynchus masou), Lymphosporidium truttae (Salvelinus fontinalis, U. S. A.), Lentospora cerebralis (HOFFER)(Salmo irideus GIBBONS? , Europe; Oncorhynchus masou, the Atlantic Ocean; Salvelinus Fontinalis), Octomitus intestinalis truttae (MOROFF)(Salmo irideus GIBBONS, Europe), O. salmonis MOORE (U. S. A.), Myxidium oviforme PARISI (Oncorhynchus masou, Europe; Salmo irideus GIBBONS, U. S. A.), Chloromyxum truttae LÉGAR (Oncorhynchus masou, France), and Thelohania ovicola (AUERBACH) (Niphon spinosus, Switzerland). Although there is no mention of it in U. S. and Canadian reports, АХМЕРОВ's report mentions Hennoguya

salminicola WARD (Oncorhynchus keta, Oncorhynchus nerka, Oncorhynchus kisutch, Salmo thymallus). The list of these is as follows:

Flagellata (=Mastigophora)

Tetramitidae

1. Costia sp. (Author's note: C. pyriformis DAVIS, 1943?) (? in original manuscript)

Hexamitidae

2. Octomitus intestinalis truttae (MOROFF)

3. O. salmonis MOORE

(Author's note: This genus is now Hexamita).

Sporozoa

Chloromyxidae

4. Chloromyxum chitosense FUJITA, 1923

5. Ch. giganteum FUJITA, 1923

6. Ch. quadriforme FUJITA, 1923

7. Ch. salvelini FUJITA, 1923

Myxidiidae

8. Myxidium oncorhynchi FUJITA, 1923

9. M. Oviforme PARISI

Myxosomatidae

10. Lentospora cerebralis (HOFFER)

(Author's note) This genus is now Myxosoma)

Myxobolidae

11. Henneguya salminicola WARD

Nosematidae

12. Thelohania ovicola (AUERBACH)

Family unknown

13. Lymphosporidium truttae

Ciliata

Holophryidae

14. Ichthyophthirius multifiliis FOUQUET

Urceolariidae

15. Cyclochaeta domerquei WALLENGREN

The author examined the gall-bladders and the bile of material which he had collected in Hokkaido. He found nothing which

resembled a spore. Since this had not much relation to the present investigation, the examination was not carried further.

Annelida. Hirudinea.

As one, which is parasitic on salmonoid fishes, Fish Pathology by Fujita on page 47 mentions Pontobdella moorei OKA only. There is no other record. It appears that it infects fresh water fish; however, there is no other record.

Acarina.

Some ticks were found in a bottle, which contained Anisakis salaris, which is parasitic on Oncorhynchus keta, in the collection forwarded to the author from the Fisheries Agency, and in a bottle, which contained Philonema, which is parasitic in Oncorhynchus nerka, and in a bottle, which contained parasite from Oncorhynchus keta. The latter two were sent from the U. S. A. It is not known whether these ticks had happened to be in the bottles, whether these entered the bottle during collection, or whether these were in the internal organs of live fishes. The attempt at an identification is now being made; when it is completed, on the basis of the ecology of the genus will be answered these questions.

IX Results of the Investigation and Discussion

As the reading of Part I and Part II of the present report will reveal, what the author has done is to identify a very small number of species among the parasites which are parasitic on a few main salmonoid fishes. Further, they are all known species. Nothing new

has been gained.

As was stated in Part I, there have been many reports concerning parasite on salmonoid fishes in this county; Tsunenobu Fujita especially published many new species. However, many of these deal with material which was obtained in fresh water. Only a few reports by Fujita are available concerning material from the sea. The present investigations by the author were conducted mainly on material which had been obtained in the ocean. The author is grateful for having been given this opportunity. Some of the reasons for the lack of worthwhile results are as follows:

(1) The collection of parasites was made by amateurs on board a ship where the working was difficult.

(2) The number of fish investigated was few.

(3) The work was carried by the author in his spare time between his main work and many other work.

(4) Number of days was few on account of conferences and other reasons.

(5) In sufficient literature.

When the author was first asked by the Fisheries Agency, he understood the work to be a mere identification of parasites collected. On this basis he accepted the work. However, the work developed into the area related to fisheries problems between Japan, U. S. A. and Canada, into the problem of distinguishing the American and the Asiatic strains on the basis of parasites, or into the problem of border with respect to the distribution of fish

in the north Pacific Ocean. With respect to this situation the author has already made several recommendations to the Fisheries Agency. In order to solve the problems of the nature mentioned above, it will be necessary to fullfill at least the following conditions:

(1) It will be necessary to have a specialist in parasites who will devote full time to the investigation.

(2) It will be necessary to establish a place and employ a number of people to investigate many fishes.

(3) It will be necessary to continue the investigations for at least five or six years.

(4) Thus, a large expenditure will be necessary.

LEO MARGOLIS made important contributions. The author feels that the reasons for his success are that the work was done in a specialized research institute, that he is a young, and able, and full time worker, and that the work was carried with sufficient funds and with a well-equipped library.

The problem of the investigation of parasites in fish will occur in future in connection with fisheries problems with U. S. A., Canada, Soviet Union as well as with China and other countries in the south. I would suggest that the Fisheries Agency set up a specialized agency to carry on research and investigation with able and young parasitologists to accumulate knowledge.

Finally the author apologizes that the investigations, which were undertaken with so much effort, did not yield much useful results on important points. At the same time he would express his deepest appreciation for assistance and co-operation to officials of concerns both public and private.

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Note:

Osaka Koto Igaku Senmon Gakko Zasshi = Osaka Medical College Journal

Do Zatsu = Zoological Magazine

Suisan Kenkyu Rui-Ho = Fisheries Research Bulletin

Hoku Teidai No Ki = Hokkaido Imperial University Agricultural Bulletin

Do Shu = Zoology Bulletin

Jikken Igaku Zasshi = Experimental Medicine Journal

Yokohama Daigaku Ronso = Yokohama University Theses Collection

Taihoku Tei Dai Ri No Ki = Taipei Imperial University Science and Agricultural Bulletin

To Suisan Dai Ki = Tokyo(?) Fisheries College Bulletin

Nihon Dobutsu Bunrui = Japanese Animals Classification

Sake Masu Rui-Ho = Salmon Trout Bulletin

Shokubutsu oyobi Dobutsu = Plants and Animals.

Do Rui = Misprint for Do Shu(?)

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Fig. 1. A. Lecithaster gibbosus. Found at Hatano Hokkaido. Host -- Oncorhynchus keta. Locale of infection --Intestine. Collected on Nov. 22, 1957.

B. Brachyphallus crenatus. Found at Shari, Hokkaido. Host -- Oncorhynchus gorbuscha. Locale of infection -- Stomach. Collected on Sept. 3, 1958.

1. Oral sucker 2. Pharynx 3. Cirrus sac. 4. Depression in front of ventral sucker. 5. Ventral sucker 6. Intestine 7. Testiculus 8. Seminal receptacle 9. Ovarium 10. Vitelline gland 11. Place where intestine bends 12. Excretory bladder 13. Excretory pore 14. Seminal vesicle 15. Folds on body wall

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Fig. 2. A. Proteocephalus sp. Larva. Found at Wakubetsu, Hokkaido. Host - Oncorhynchus gorbuscha Locale of infection - Intestine. Collected on Sept. 2, 1958. Total length - 1.5 mm

B. Phyllobothrium sp. Young larva. As above. Total length 4 mm.

(Original drawing)

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Fig. 3.

A. Eubothrium crassum: head portion. Found at Abashiri, Hokkaido. Host - Oncorhynchus keta. Locale - Appendix pylorica. Collected: Nov. 23, 1957.

B. As above. Undergone transformation. Found at Hatano, Hokkaido. Host: Oncorhynchus keta. Locale of infection: Appendix pylorica. Collected: Nov. 23, 1957.

C. As above. Horizontal section. Found in the North Pacific. Host: Oncorhynchus keta. Locale of infection: Appendix pylorica. Collected by the Fisheries Agency Research vessel.

(Original drawing)

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Fig. 4

A. Philonema sp. ♀ 93x1.2 mm. Head end. North Pacific. W. 165° N. 51°. Host: Oncorhynchus nerka. Locale of infection: Coeloma Found: From a frozen fish sent from the U. S.

B. As above ♀ Tail end.

C. As above. ♀ Head end.

D. As above. ♂ Tail end.

(Original drawing)

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Fig. 5

A. Anisakis salaris. Head end of larva. Host: Oncorhynchus nerka. Locale of infection: Coeloma. 24x0.5 mm. Found: North Pacific W 136° - ' 39° N 56° - 58°. From frozen fish from U. S. A.

B. As above. Head end.

C. As above. Tail end.

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Fig. 6

A. Contracaecum aduncа ♀ Head end. 38x0.8 mm.

B. As above. Tail end.

C. As above. ♂ Head end. 30x0.65 mm

D. As above. Tail end.

Host: Oncorhynchus gorbuscha. Locale of infection: duodenum and coeloma. Found: Ajigazawa, Aomori-Ken. Collected: Mar. 28, 1958.

(Original drawing)

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Fig. 7

A. Cystidicola salmonicola. ♂ Head portion. 10x0.2 mm. Host: Oncorhynchus keta, fry, length 54 mm. Locale of infection: coeloma. Aisaka Hatchery, Mimotoki, Aomori-Ken. Collected: Mar. 29, 1958.

B. As above. Tail end.

C. As above. Tail end of another individual.

D. As above. ♀ Near genital opening.