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NOTES ON THE BIOLOGY AND PARTIAL LIFE HISTORY OF THE DRACUNCULID, PHILONEMA ONCORHYNCHI KUITUNEN-EKBAUM

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Philonema oncorhynchi was described by the author in 1933 as a new species and a new genus was made to include it (Contr. Canad. Biol. Fisher. 8: 71-75, 1933). It was found parasitic in the abdominal cavity of mature sockeye salmon, Oncorhynchus nerka, caught in English bay, Vancouver, B. C., in August, 1932. Ninety-five per cent of the sockeye examined at one of the canneries in Vancouver were found to be infected. In August, 1934, further examination of maturing sockeye passing up-river to spawn was made at the Steveston cannery on the Fraser river. At this time thirty per cent of the fish examined carried the infection. According to observations made by Dr. W.E. Ricker upon spawning runs of sockeye salmon at Cultus lake, B.C., the infection with this parasite is very heavy in some years and slight in others. In the month of August the parasite was found mainly to be mature, although developing eggs were still present together with ripe embryos, and as the sockeye infected by them had spent generally two years in the sea there seemed no doubt that this dracunculid was a marine fish parasite.

NEW DATA OBTAINED

Through the kindness of Drs. R.E. Foerster and W.E. Ricker in supplying specimens the writer has been able to examine one and two-year-old sockeye from Cultus lake, captured as they were commencing their seaward migration. Samples for April, 1936 and April and May, 1937 were made available.

These fish were found definitely to be infected with Philonema oncorhynchi. Furthermore the older fish, the two-year-olds, showed a greater percentage of infection than the younger, one-year-old. The parasites were not as numerous per host in the sockeye in fresh water as they were found to be in the adult sockeye. Although it is admitted that many of the parasites may easily be over-

looked in even a careful examination, especially in preserved material, the following summarizes the results of the examination:

Date of capture	Age of fish	Number Examined	Number infected	Condition of samples
24.4.36	1 year	50	8	preserved
8 .4.37	1 year	50	0	fresh
30.5.37	1 year	50	2	fresh
16.4.36	2 year	21	12	preserved
1 .4.37	2 year	8	7	preserved

In most cases the parasites found were in young stages of development, apparently not long ago liberated from the intermediate host and had made their way through the intestinal wall into the abdominal cavity of the fish. More advanced stages were found, however, and the largest specimens were females up to 80 mm. long with fertilized eggs in the uteri and males about 20 mm. long, possessing all the adult characters. The youngest stage of the parasite found was slightly larger than the ripe embryo dissected out of the uterus of the female parasite. It measured 0.65 mm. with the oesophagus well defined and long; the long tail, characteristic for the embryos of this species, was much reduced. The following stage found measured 0.95 mm. long, 0.025 mm. wide. A slightly size found apparently belonged to the same stage of development, measured 1.1 mm. long, 0.025 mm. wide. The largest larval stage found was 3 mm. long, 0.075 mm. wide, with oesophagus 1 mm. long and well differentiated into the glandular and muscular parts. No subsequent stages were found between this stage and the well defined male and female individuals. In the females of 60 to 80 mm. long the anus and vulva were already atrophied.

No ripe females of Philonema oncorhynchi were found in the young sockeye at this time of the year but the other characters of the parasites available,

except the embryos, are identical with those from the adult salmon in the sea. The chief differences are that both female and male parasites found in the former are much smaller than the mature parasites from the latter, and a few male parasites found in the sockeye in fresh-water, possess slightly shorter spicules than those in the adult sockeye.

Other species of fish which were found to serve as hosts for Philonema oncorhynchi are the following:- Salmo clarkii (Cultus lake, B.C.), Coregonus clupeaformis and Loucichthys artedi (Lake Nipissing, Ont.), Salvelinus fontinalis (Ship Harbour lake, N.S.), Cristivomer namaycush (Lake Opeongo, Ont.) and Salvelinus alpinus (Somerset Island, N.W.T.). These fish, except S. clarkii, were examined late in the summer and autumn and were found to harbour ripe, or almost ripe, parasites. These parasites found in the above mentioned fish in Eastern Canada and the Arctic Ocean were compared with those taken from the adult sockeye salmon and in all cases they were found to be identical. Specimens of S. clarkii were examined in May and contained young female parasites with developing eggs in the uteri.

The above findings show that Philonema oncorhynchi has a circumpolar range and is, as far as known at present, restricted to salmonoid fishes.

Simon and Simon (1936) added another species to the gen. Philonema, P. agubernaculum, which was distinguished from P. oncorhynchi by the slightly smaller size only. They found the parasite in the abdominal cavity of Prosopium williamsoni, Salvelinus fontinalis and Salmo shasta in the United States.

Further study of ripe specimens of Philonema oncorhynchi from the fresh-water hosts in Cultus lake, British Columbia, will definitely show whether or not P. oncorhynchi and P. agubernaculum are distinct species.

DISCUSSION

Origin of parasite. As intimated above, the occurrence of specimens of Philonema oncorhynchi in adult sockeye returning from the sea led to the opinion that the parasite was definitely a marine one. The discovery of this parasite, however, in young sockeye which have resided wholly in fresh-water and not yet reached the sea, raises the question as to whether Philonema oncorhynchi is definitely a marine parasite, a fresh-water one, or one which was originally marine but secondarily carried into fresh-water, or vice versa.

Because of the occurrence of young stages of development of the parasite in fresh-water and the transfer of larvae from intermediate to final host during the fresh-water period of the life cycle of the sockeye salmon, Philonema oncorhynchi is definitely not a wholly marine parasite. The occurrence of the parasite in several fresh-water and anadromous fishes gives suggestive evidence that the parasite may be a fresh-water one. To be such it would have to lengthen out its period of development or lie dormant over a certain period, for generally two years, as this is the normal duration of residence of sockeye salmon in the ocean. The normal life cycle, when known for dracunculid parasites, is completed, however, in approximately one year.

The number of parasite found in the sockeye salmon in fresh-water was much smaller than that in the adult fish. No definite conclusions, however, can be made from this observation, as the number of parasites in adult sockeye may vary from year to vary.

Another suggestion is that Philonema oncorhynchi is capable of existing in both marine and fresh-water habitats. It may develop and mature in the sea as well as in fresh-water. Under such circumstances it would appear that the parasites carried to the ocean by the seaward migrating sockeye infected during the

fresh-water phase of their life history are set free in the sea and subsequently the sockeye may become reinfected by the same parasite in the sea and carry it in mature form into fresh-water again when returning to spawn.

It is unfortunate that the collections of fish submitted from Cultus lake have contained only specimens obtained during the spring months. At this time of year Philonema oncorhynchi is in the immature stages. Further collections of fish in late summer and autumn months will be made to determine whether in the sockeye remaining over in the lake from the first to second year or from the second to the third and in the lake-dwelling trout mature stages are present and whether the ripe parasites of both sexes reach the same size as they do in the sea-running sockeye. It may be possible that in the sea-run fish Philonema oncorhynchi reaches a larger size than in the fresh-water hosts.

Intermediate host. The intermediate host for Philonema oncorhynchi is as yet unknown. It is expected that the early stage of the parasite becomes completed and the infective stage reached in only one intermediate host, as occurs in those other dracunculids for which the development is known. This intermediate host is believed to be a plankter in the lake and there is some evidence that the cladoceran, Bosmina obtusirostris, may be the species but feeding experiments have not yet been undertaken to determine this point.

If infection can occur also in the sea, as is surmised above, there must be an intermediate host among the marine plankton also but this phase of the problem has not yet been touched.

Expulsion of the parasites. Philonema oncorhynchi inhabits the abdominal cavity of the fish and has not been found elsewhere though Simon and Simon (Parasitol, 28: 440 - 442, 1936) in describing their new species, Philonema agubernaculum, report that their species was also present in the abdominal

wall of the body cavity.

Nybelin (Zbl. Bact. Jena, 121: 58 - 64, 1931) states that the dracunculids inhabiting the abdominal cavity never leave the latter, though no explanation is given of how the ripe female parasites reach the exterior. Several authorities, however, infer that all dracunculids, whether abdominal cavity or sibcutaneous forms, make their way through the skin of the host to liberate the embryos. Willemoes-Suhm (Z. wiss. Zool., 21: 175 - 203, 1871) was of the opinion that the ripe female parasite bursts within the fish and the liberated young actively make their way out. Another suggestion was made by Linstow (Arch. Naturgesh., 40: 122 - 134, 1874) that the ripe female parasite makes its way through the intestinal wall of the fish, thus reaching the exterior with feces. He based his statement upon the fact that a ripe female dracunculid was found which had, with its anterior end, pierced the intestinal wall of the fish. The parasite found was dead when observed.

In the opinion of the writer neither of these can be considered as a normal event in the life of the parasite. In the case of the first suggestion the remains of the parasites should be found in the abdominal cavity of the fish, but such were never found. It also was observed that a dracunculid parasite does not normally burst in the tissues of its host. If it cannot make its way out it dies in the host tissues with all its embryos in the uterus.

Linstow's observation can in all probability be considered as an accidental case. The ripe female dracunculid is very fragile and can hardly make its way out through the intestinal wall of the three to five year old sockeye.

In the case of sockeye salmon and also the other species of fish which serve as hosts for Philonema oncorhynchi (except Salmo clarkii) the time of maturation of the host coincides with that of the parasite and the parasite may thus reach the exterior during the spawning activities. According to

Kendall (Bull. Bureau Fish. 37: 183 - 208, 1921) the ovaries of salmonoid fishes are suspended from a membrane originating in the dorsal peritoneum. This membrane envelopes the entire surface of an immature ovary. As development proceeds, however, the edge of the membrane of the outer surface parts from the membrane of the inner surface leaving a narrow area of the ovary without membranous covering. The surface of the ovary thus uncovered gradually widens and extends forward as the ovary increases in size. There would thus be opportunity for the ripe parasites to be expelled with the genital products of the host.

On the other hand there remains the possibility that the ripe individuals of Philonema oncorhynchi, lying in the abdominal cavity of the fish, await the decomposition and gradual breakup of the body of the host after the spawning activity has ceased and thus eventually become liberated into the waters of the lake or stream. Such could, of course, apply only to those parasites infecting adult sockeye and could not be used to explain the means of liberation of ripe parasites from the trout, Salmo clarkii, and young sockeye either in fresh-water or subsequently in the ocean.

It may be of interest to note that in most dracunculids known the male parasites perish or are rare when the females are ripe. In the case of Philonema oncorhynchi the male parasites are quite numerous when the females contain fully ripe embryos.

CONCLUSIONS

The present data do not by any means complete the picture of the life cycle of Philonema oncorhynchi and are not so intended. They do, however, serve to extend the existing knowledge of this species. As for its original discovery in the adult sockeye salmon returning from the sea and the consequent belief that

it is a marine parasite, the most recent discovery of specimens in young sockeye salmon still resident in fresh-water indicates that it is in all probability a fresh-water species. It would appear that infection by this parasite may take place either in fresh-water or both in fresh-water and in the sea.

Much further investigation and experiment is required before the complete life history can be made known. Further collection of young sockeye and of trout will be required in order to determine whether ripe specimens occur in these fish inhabiting fresh-water and also to provide information as to the size of mature parasites. Close study of the food organisms of the fish will be necessary in order to find the intermediate host and to follow the development of the larval parasite within it. It is hoped that the information here reported will assist in the further investigation of these important phases.

Note. After completing these notes it was learned that Richardson (Amer. Fisher. Soc., 66 (1936): 343 - 356, 1937) recorded a cracuncalid nematode from the speckled trout, Salvelinus fontinalis, which he found to belong to the genus Philonema and which he tentatively named P. salvelini. No description of the parasite was given.