pigment and their hydrophilic integument, which traps the animal at the water surface, are characteristic of subterranean and deep water forms respectively, neither of which are ever exposed normally to the problem of contacting the air-water interface.

The most perplexing feature of the Momonidae is how they use their peculiarly modified fore legs. Since both sexes and all the genera have similarly modified legs the function is probably one that requires a very specific device. After observing specimens Angelier (1953) was convinced that the function was tactile and *S. letipes*, with a leg similar to that in figure 4 does have hairs that are obviously sensory. *S. moodyi* lacks the long fine hairs, however, but still retains the essential morphology of leg segment I–6 (Fig. 2). This example of variation in tactile structures but with uniform mechanical relationships suggests an additional function for the leg.

Mechanically, the claw of the first leg, may anchor the animal or it may be used for feeding. The lack of any muscle development in the coxae and basal segments is good evidence that the first leg has not taken over a major part of the locomotor functions, for it has been shown that coxal apodemes are generally reliable indicators of the strength of leg action. It thus appears probable that both sensory and mechanical functions are carried out by leg I.

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# NEW PARASITE RECORDS FROM STICKLEBACK AND SALMON IN AN ALASKA STREAM


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Some new fish parasite records were made during the course of fishery investigations in Alaska in the summer of 1947. The host fish, three-spine stickleback (*Gasterosteus aculeatus* Linn), king salmon (*Oncorhynchus tshawytscha* (Walbaum) ), and red salmon (*Oncorhynchus nerka* (Walbaum) ), were found in Otter Creek on the military reservation at Fort Richardson, Anchorage, Alaska. Otter Creek is tributary to Eagle Bay, an arm of Cook Inlet. Additional host and parasite material was collected for the author by Mr. David Sleeper in the summer of 1948.

Three parasites were found in abundance on Otter Creek fish, each

representing new host or distributional records. One parasite, a fr water mussel glochidium of *Anodonta beringiana* Middendorf, infested three fish species named above. A copepod, *Ergasilus turgidus* Fra was found on the stickleback and the red salmon. A microsporic *Nosema anomela* Moniez, infested only the stickleback.

Adult mussels collected in Otter Creek and Otter Lake were ki identified by Dr. Myra Keen, Curator, Conchology Museum, Stan University. Parasitic females of the copepods were identified by Thomas E. Bowman, Associate Curator, Division of Marine Invertebr U. S. National Museum. Dr. Datus Hammond, Zoology Departm Utah State University, examined the microsporidians.

TABLE I

Incidence of *Glugea* cysts on 56 sticklebacks in Otter Creek, 1948.

| Date | Number of fish | Average size of fish (mm.) | Average number of cysts per fish | Percentage of cysts | | |
|---|---|---|---|---|---|---|
| | | | | Skin | Gills | F |
| May 22 | 33 | 40 | 0.52 | 35 | 65 | |
| Jun. 5 | 20 | 48 | 0.55 | 60 | 40 | |
| Jun. 15 | 2 | 50 | 1 | 100 | 0 | |
| Aug. 23 | 1 | 40 | 5 | 60 | 20 | |

### *Nosema anomela Moniez*

This microsporidian parasite has been known from the three- stickleback in Europe for many years (Weissenberg, 1921). Alth Kudo (1946) named *Nosema anomela* as a parasite of stickleback present author has not found infections which specifically show its exis in North America. Markley (1940) did not name it in his paper on st back parasites in California. The present record is, therefore, judg be the first from the new world.

*Glugea* cysts may be found in many fish tissues, Stempell (1904) h reported infestation in the skin, the ovarium, the peritoneum, an intestine. The morphology and development of the cysts have described in detail by Debaisieau (1920).

Microtome sections of infested sticklebacks from Otter Creek sh that most *Glugea* cysts were located in the large body muscles, just the skin. The presence of cysts was apparent from outside the because the lesions took the form of whitish swellings which often dist large portions of the body surface. The head, thorax, and abdom harbored cysts. Few were found on fins, but many were located i gill chambers. Table I contains a summary of counts of *Glugea* cy Otter Creek sticklebacks to show the distribution on the body, an abundance, in samples collected randomly in four days in 1948.

Sticklebacks were not abundant in the stream after the mid June, and it was difficult to secure specimens for examination. Alt the data in the later collections are scanty, they suggest an incre numbers of cysts per fish as the season progresses. Of the 56 fish col and examined, 16 had *Glugea* cysts. There appeared to be no re

between the size of fish and the amount of infestation. Most of the cysts were located on the skin and gills, the fins having little importance as sites for cysts. No cysts were found on the red salmon or king salmon.

*Anodonta beringiana* Middendorf

The glochidium of this fresh-water mussel has not been reported previously from any host. In Otter Creek the author found it on sticklebacks and fingerlings of king salmon and red salmon. The identity of the glochidia was established by comparison of newly-attached individuals with advanced glochidia from the marsupia of adult mussels near the outlet of Otter Lake and the sections of Otter Creek in which parasitized fish were collected. Only the one species of adult mussel was found in Otter Creek, so the identity of the attached glochidia is open to little question.

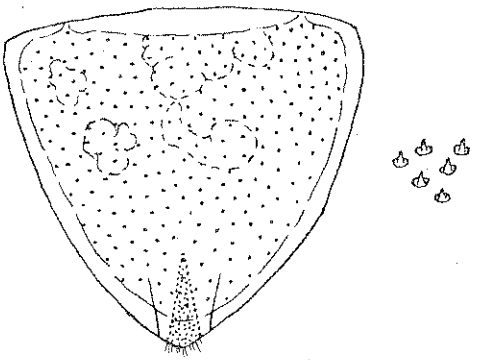

FIG. 1. Newly-attached glochidium of *Anodonta beringiana*. Inset shows setae covering the outer surface of the glochidium.

The glochidium of *Anodonta beringiana* is of the typical *Anodonta* type, as defined by Surber (1913). It is relatively large and subtriangular, and has a spine at the tip of each valve (figure 1). The hinge line is long and slightly curved. The length is slightly greater than the depth, the newly attached glochidia averaging 0.275 by 0.300 mm. The surface of each valve is covered with setae, each developing from a pit, as shown in the inset in figure 1.

Glochidia were found on the fins, gills, and skin, and in the mouths of sticklebacks. Infestations on red and king salmon were lighter, and were found on the skin and fins and in the mouth. None were found on the gills of salmon. Table II shows the distribution of glochidia on sticklebacks.

These data suggest an increase to the middle of the season, and a decrease in numbers of glochidia per fish thereafter, although the small samples may not reliably show the true changes in abundance through the season. In the early part of the season, the glochidia were most numerous on the gills; the fins had the most parasites in the small samples collected later. In most samples, the mouth and skin had relatively

TABLE II

Incidence of glochidia of *Anodonta beringiana* on 56 sticklebacks in Otter Creek, 1948.

| Date | Number of fish | Average size of fish (mm.) | Average number of glochidia per fish | Percentage of glochidia | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fins | Gills | Mouth | S |
| May 22..... | 33 | 40 | 29.7 | 20 | 72 | 4 | |
| Jun. 5..... | 20 | 48 | 44.6 | 18 | 77 | 2 | |
| Jun. 15..... | 2 | 50 | 44.5 | 46 | 40 | 3 | |
| Aug. 23..... | 1 | 40 | 18 | 61 | 11 | 28 | |

small numbers of glochidia. In the 56 fish, only four had no glochidia, these four were relatively small, 30–32 mm. in length.

Most of the glochidia counted were not deeply encysted. Two stic backs and one king salmon had glochidia very deeply imbedded in skin; no deeply encysted glochidia were found on gills, fins, or mo On one fish, three glochidia were attached to the gills, directly *Glugea* cyst; all other glochidia were attached to areas remote from cy

The numbers of glochidia found on salmon fingerlings were sr compared with those on the stickleback. The incidence on king sal was one glochidium per fish; on red salmon it was 3.5 glochidia per

*Ergasilus turgidus* Fraser

This copepod has been reported only from the shiner sea-p (*Cymatogaster aggregatus*) in the vicinity of Vancouver Island (Fraser, 1 and from *Gasterosteus aculeatus* at Vancouver (Carl, 1937). The pre collections, therefore, add a new fish, the red salmon, to the host list, extend the range of the parasite about 1,100 miles.

The copepods on sticklebacks were found infesting the fins and almost exclusively, only one parasite having been found on the skin host fish, and none in the mouth. The copepods on red salmon finger were attached to the gill filaments; more were seen on the fins. T III summarizes the occurrence of *Ergasilus turgidus* on the sticklebac

The incidence of copepods during the summer season follows a pat similar to that of the glochidia on the same host, with the heaviest inf tions in the middle of the season. This seasonal distribution can be pared with the observation of Gadd (1901) in Sweden. His remark

TABLE III

Incidence of the copepod, *Ergasilus turgidus*, on 56 sticklebacks in Otter Creek, 1948.

| Date | Number of fish | Average size of fish (mm.) | Average number of copepods per fish | Percentage of copepods | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fins | Gills | Mouth | S |
| May 22..... | 33 | 40 | 3.6 | 25 | 75 | 0 | |
| Jun. 5..... | 20 | 48 | 6.4 | 33 | 66 | 0 | |
| Jun. 15..... | 2 | 50 | 1.0 | 50 | 50 | 0 | |
| Aug. 23..... | 1 | 40 | 0 | 0 | 0 | 0 | |

stickle-backs and a parasite, *Thersilina gasterostei* Pugenstecher, are translated as: "The species, which is like *Ergasilus gasterostei* Kr., was found in August as a parasite on *Gasterosteus aculeatus* and on *G. pungitius*. It is at least in this time of the year extremely common." The parasites in the present study do not seem to reach a peak in August, but rather at an earlier time.

Sixteen of the 56 sticklebacks examined bore no copepods. The fish hosting *Ergasilus* were relatively small, averaging only 35.8 mm. in length. Most copepods were found on the fins and gills, almost none on the skin, and none in the mouth. The *Ergasilus* in the gill chambers were attached chiefly to the gill filaments. Gurney (1913) found that *Thersilina* on sticklebacks in Europe attached themselves to the mucous lining of the operculum.

The king salmon examined bore no copepods; the red salmon fingerlings had 2.5 copepods per fish.

## Discussion

Wilson (1916), in a comprehensive study of the inter-relationships between mussel glochidia and parasitic copepods on their hosts, reached several conclusions which are of interest in respect to the parasites considered here. He found, with few exceptions, that species of fish which carry copepods are also those that serve as hosts for glochidia. This general observation applies in the case of the stickleback and the red salmon reported here. Further, Wilson included nine species of fish in his list of 47 which are hosts to species of *Anodonta* as well as *Ergasilus*. Thus, the presence of species of these genera on *Gasterosteus* and *Oncorhynchus* fits into a well-established pattern. For example, in those fish bearing no copepods, the average number of glochidia per fish was 3.35, and among those fish having no glochidia, the average number of copepods per fish was 1.25. Wilson, referring to individual fish, proposed that "The presence of even a small number of copepods upon the gills of a fish reduces its susceptability to infection by glochidia to one-third or one-fourth of what it would be if no copepods were present." He also stated that, "As the number of copepods upon a fish's gills increases, its susceptability to infection by glochidia diminishes," and *vice versa*. The present data for sticklebacks, on the contrary, suggest that the individual fish with the smallest numbers of glochidia have the smallest numbers of *Ergasilus*, and those having larger infestations by glochidia have greater incidences of *Ergasilus*. These numbers can be compared with those in Tables II and III, which show that the average numbers of glochidia and *Ergasilus* per fish were 33.7 and 4.4, respectively.

A matter of some interest is the apparent discrepancy in the literature in respect to growth of glochidia during the parasitic stage on the host fish. Pennak (1953, p. 702), in his discussion of the parasitic stage of the glochidium, said, "Usually, however, there is little increase in size" (during encystment). Murphy (1942) reported on *Margaritifera margaritifera* in the Truckee River, California, and pointed out that the glochidia of that species measured 0.05 to 0.06 mm. at attachment and 0.39 to 0.42 mm. at the end of the parasitic stage. This represents an increase in length of about 660 percent.

*Anodonta beringiana* glochidia on sticklebacks and salmon in Otter Creek showed no measurable increase in size during encystment.

Glochidia ready for discharge from the marsupia of several adult mus were measured and found to measure the same as attached glochidia, b encysted and non-encysted, taken at various times of the season. measurements, 0.275 mm. by 0.300 mm. indicated that no growth t place in this species during parasitism.

## Summary

Sticklebacks, red salmon, and king salmon from a stream in Cen Alaska were examined and found to be infested with parasites, al which represent new host or distributional records. The glochidium *Anodonta beringiana* was found on all three fish; it has never before b reported on any fish. Females of *Ergasilus turgidus* were found stickleback and red salmon; this extends the known range of this cope by 1,100 miles and adds one new host. *Nosema anomela* was found the stickleback, apparently for the first time in the new world.

The data suggest that the incidence of *Nosema* cysts on stickleba increases as the season progresses, and that the skin and gills are preferred areas for infestation. The glochidia and *Ergasilus* appea be in greatest numbers in the middle of the growing season, and to found mostly on the fins and gills. Wilson's remarks on glochidia copepods are reviewed in the light of the present data; the inhibi action of the two parasites, each with respect to the other, was not den strated in the present study, since individual fish with high number glochidia also had relatively high numbers of *Ergasilus*.

*Anodonta* glochidia did not increase in size during encystment.

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