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RECORDS OF PISCIVORUS LEECHES (HIRUDINEA) FROM THE CENTRAL COLUMBIA RIVER, WASHINGTON STATE

No records of leech infestations on fish of the Columbia River exist in the published literature. As a whole, the freshwater hirudinean fauna of the Pacific Northwest remains a relatively unsurveyed, little known, and neglected biotic group. This is due, in part, to problems in leech identification as well as in obtaining representative collections.

We obtained leeches from the external surface, oral cavity, and gill chambers of fish during a continuing environmental assessment program on the central Columbia River above Richland, Wash. (Benton and Franklin Counties), from 1975 through 1977. This paper identifies four piscivorous species, provides new host and distribution records, and reviews some recent taxonomic changes for the species encountered. Ecological observations are included.

The leeches recorded herein are *Myzobdella lugubris* Leidy 1851, *Piscicola salmositica* Meyer 1946, *Placobdella montifera* Moore 1906, and *Actinobdella inequiannulata* Moore 1901.

Methods and Site Description

Fish were collected at monthly or bimonthly intervals by a variety of gear (gill nets, trammel nets, hoop nets, beach seines, and electroshocker) from January 1975 to December 1977. Over 20,000 fish, representing nearly 40 species, were examined during this period (Gray and Dauble 1977). Leech specimens were preserved in 10% Formalin[1] solution, either when captured or after being examined alive in the laboratory.

Our leech collections were more qualitative than quantitative because leech-fish associations in nature are normally periodic and facultative despite the nutritional requirement of piscivorous leeches for fish blood. Also, piscivorous leeches can readily detach from fish captured by most types of fishing gear, particularly from fish recovered when moribund or dead.

Occurrence of many freshwater leech species can be correlated with characteristic aquatic habitats. Water quality parameters vary seasonally in the central Columbia River, as follows: dissolved oxygen, 8.0-12.0 mg/l; pH, 7.4-8.6; phosphate (as PO_4), 0.03-0.04 mg/l; ammonia-nitrogen, 0.01-0.2 mg/l; hardness (Ca, Mg), 55-75 mg/l; and alkalinity ($CaCO_3$), 50-67 mg/l. Water temperatures range from 1° to 3°C in midwinter to about 21°C in late August and early September. There are no significant quantities of organic and inorganic pollutants (our data). The water carries minimal silt loads.

The central Columbia River in the Hanford Reach where our collections were made (river km 550-629) survives as the last free-flowing section of the main channel above Bonneville Dam. Decades of hydroelectric development have transformed other sections into a consecutive series of river-run reservoirs. River flows in the study area usually range from about 2,000 m^3/s over much of the year to over 12,000 m^3/s during the annual spring spate, when surplus runoff is passed downriver over spillways from reservoirs (Nees and Corley[2]).

Additionally, Hanford flows are now regulated at Priest Rapids Dam in response to daily and weekly power demand peaks, causing water levels in the river to fluctuate widely. This periodically exposes and inundates a rocky or muddy shoreline zone, apparently restricting development of a diverse leech fauna along the river margins. Water levels in Wanapum Reservoir behind Priest Rapids Dam (river km 639) and in Umatilla Reservoir behind McNary Dam (river km 470) are relatively stable, although subject to controlled summer drawdowns. Substantial populations of such common omnivorous leeches as *Erpobdella punctata* (Leidy 1870), *Helobdella stagnalis* (Linnaeus 1758), and *Theromyzon* spp. occur along the

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[2]Nees, W. L., and J. P. Corley. 1974. Environmental surveillance at Hanford for CY-1973. Unpubl. manuscr., 56 p. R&D Rep., BNWL-1881, Battelle, Pacific Northwest Laboratories, Richland, WA 99352.

margins of these mid-Columbia River reservoirs (our observations).

Results and Discussion

Four leech species were recovered from Columbia River fish (Table 1). About 90% of the specimens were *Myzobdella lugubris*. Two families belonging to the order Rhynchobdella were represented, Glossiphoniidae and Piscicolidae. Members of this order typically possess a small pore on the anterior sucker for a mouth, from which a muscular pharyngeal proboscis can be protruded, and lack biting jaws or denticles. Relatively few glossiphoniids are piscivorous (Klemm 1975). However, the piscicolids characteristically are ectoparasites of fish and feed on fish blood. The muscular proboscis of piscicolids is effective in penetrating epidermal layers of fish wherever scales are reduced or absent, although gills are favored feeding sites.

Myzobdella lugubris

Myzobdella lugubris has not been recorded previously as a common ectoparasite of Columbia River fish. Its distribution and host records are included in previous publications that refer to the genus *Illinobdella* in which *M. lugubris* was formerly placed.

Myzobdella lugubris and *M.* (syn. *Illinobdella*) *moorei* (Meyer and Moore 1954) were until recently believed to be two distinct species. The former was considered characteristic of brackish and marine waters, while the latter was considered characteristic of freshwater. The distinction was primarily ecological since anatomical features of both species were remarkably similar. However, *M. lugubris* and *M. moorei* are now considered to be a single euryhaline species (Sawyer et al. 1975).

Further, it now appears that all members of the related piscicolid genus *Illinobdella* are synonymous with *M. lugubris*. Thus species reported in the literature as *Illinobdella alba*, *I. elongata*, and *I. richardsoni*, as well as *M.* (=*I.*) *moorei*, all preying on fish in North American waters (Meyer 1940, 1946b), are junior synonyms of *M. lugubris*, which holds taxonomic priority. Locality and host records of the ubiquitous *M. lugubris* under these synonyms are given by Hoffman (1967), Klemm (1972a, b, 1977), and Sawyer et al. (1975). Studies on *M. lugubris* infesting the blue crab, *Callinectes sapidus*, and the white catfish, *Ictalurus catus*, in a South Carolina tidal river support this synonymy (Daniels and Sawyer 1975).

Myzobdella lugubris was recovered from a wide size range of adult chiselmouth, *Acrocheilus alutaceus*, and northern squawfish, *Ptychocheilus oregonensis*, in our collections, and less frequently from adult suckers, *Catostomus macrocheilus* and *C. columbianus*. The associations were apparently facultative. *Myzobdella lugubris* occurred primarily in the oral cavity of chiselmouth (Figure 1) and northern squawfish, where they were retained during the struggle of hosts captured in overnight net sets. Leeches were recorded and counted the next day when fish were recovered. Many leeches on the external surfaces of moribund or dead fish may have detached before net recovery. *Myzobdella lugubris* were never found in the mouth of suckers but only in the axila of pelvic or pectoral fins, on fin rays, or in the gill chambers.

Myzobdella lugubris was also a fairly common ectoparasite of brown bullhead, *I. nebulosus*, collected by angling in backwater sloughs of the central Columbia and lower Snake Rivers during the summer. Infestations on bullheads usually consisted of one or two small leeches attached to the pectoral or pelvic fins.

The incidence of *M. lugubris* on adult chiselmouth and northern squawfish (Table 2) shows infestations only during June, July, and August when Columbia River water temperatures ranged from 13° to 21°C. The leeches were primarily sexually mature. Collections from the oral cavity of chiselmouth in October 1975, 1977 and November 1977 contained numerous small, immature leeches that had apparently hatched within the preceding 1 or 2 mo.

TABLE 1.—Piscivorous leeches (Hirudinea) collected in this survey from teleost fishes in the central Columbia River, Washington State.

Species	Host infected
Piscicolidae:	
Myzobdella lugubris	Northern squawfish, *Ptychocheilus oregonensis*
	Chiselmouth, *Acrocheilus alutaceus*
	Brown bullhead, *Ictalurus nebulosus*
	Largescale sucker, *Catostomus macrocheilus*
	Bridgelip sucker, *C. columbianus*
Piscicola salmositica	Chinook salmon, *Oncorhynchus tshawytscha*, fry
	Sucker, *Catostomus* sp., fingerling
Glossiphoniidae:	
Placobdella montifera	Sucker, *Catostomus* sp., fingerling.
Actinobdella inequiannulata	Largescale sucker, *C. macrocheilus*

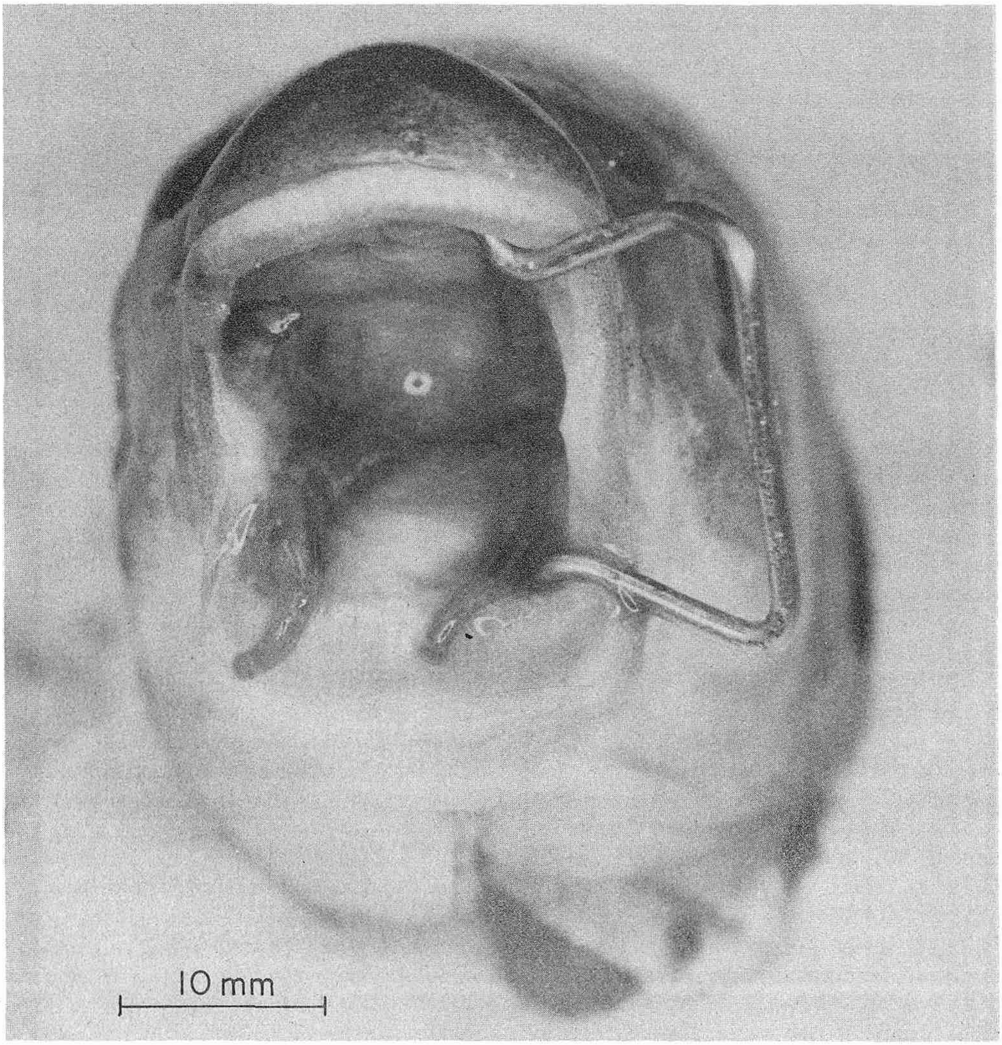

FIGURE 1.—Four sexually mature *Myzobdella lugubris* in the oral cavity of chiselmouth collected in the central Columbia River. The small subterminal mouth of the host is bordered by a cartilaginous upper and lower lip for grazing on sessile algae. The leeches occupy most of the available space in the oral cavity when the mouth is closed.

TABLE 2.—Incidence of infestation of chiselmouth and northern squawfish by the piscicolid leech, *Myzobdella lugubris*, indicated by infestation ratio.[1]

	Chiselmouth			Northern squawfish		
Month	1975	1976	1977	1975	1976	1977
Jan.	0/5	0/4	—	0/5	0/2	0/1
Feb.	0/1	—	—	0/3	0/2	0/1
Mar.	—	—	—	0/1	—	—
Apr.	0/5	0/3	0/4	0/14	0/9	0/7
May	0/22	0/5	0/10	0/34	0/7	0/14
June	0/32	0/16	6/27	0/33	0/3	0/19
July	1/32	8/19	1/12	3/38	0/16	6/25
Aug.	1/19	0/4	19/42	0/13	0/2	0/8
Sept.	0/46	0/9	0/13	0/18	0/15	0/4
Oct.	[2]7/37	0/10	[2]3/13	0/23	0/2	0/1
Nov.	0/7	0/2	[2]7/9	0/4	—	0/3
Dec.	0/6	0/7	0/2	0/2	—	0/1

[1]Infestation ratio = number of fish infested/number of fish examined.
[2]Numerous small leeches, recently hatched, were attached to some hosts.

According to Sawyer et al. (1975), *M. lugubris* is a relatively warm-water species encountered most often at 21°-30°C, occasionally at 16°-20°C, and less often in colder water. They reported that the leech appeared to be injured if the water was suddenly cooled to 10°-15°C in laboratory experiments. Obviously some *M. lugubris* survive over winter at low temperatures, but it must remain inconspicuous due to dormancy in temperate regions of North America. We have never recovered *M. lugubris* during winter in the central Columbia River, either from fish or from benthic samples designed to quantitatively collect invertebrates.

Large, adult *M. lugubris* from Columbia River fish were characterized by a green background coloration, superficially suggesting that they fed on algal cells ingested by the host. Chiselmouth and suckers commonly feed on sessile, green-colored diatoms from bottom substrates. However, microscopic examination revealed that this coloration was due entirely to pigments in the adult leech's musculature and not to the presence of algae in their digestive tract. *Myzobdella lugubris* fed entirely on fish blood cells and plasma.

Feeding on fish blood is clearly required by *M. lugubris* for growth and reproduction. Copulating *M. lugubris* were noted on fish. But since deposition of a cocoon requires hard substrates, sexually mature leeches must eventually detach, thus freeing fish of infestations. The breeding, growth, and reproductive cycle of piscivorous leeches may account for the periodic infestations of fish so frequently documented in the literature.

In the Columbia River, the cycle in *M. lugubris* is correlated with a seasonal change in water temperatures, with peak activity occurring in late summer and fall.

In tidal estuaries on the east coast of the United States, *M. lugubris* has a life cycle that involves two hosts, a fish and a crustacean. It engorges on fish blood before detaching to deposit cocoons on crabs (Daniels and Sawyer 1975). This indicates possible involvement of a freshwater crustacean in the life cycle of *M. lugubris* in the Columbia River. The only large crustacean available is *Pacifasticus leniusculus*, but extensive collections of this crawfish in previous years by the senior author disclosed no attached leeches. Therefore, stones are probably used as cocoon deposition sites in the Columbia River.

Piscivorous leeches are often vectors of hemoflagellates (genera *Trypanoplasma* and *Trypanosoma*) found in the blood of freshwater and marine fishes (Khaibulaev 1970; Becker 1977). Although we have occasionally detected *Trypanoplasma* in Columbia River fish, we found no hemoflagellates in the digestive tract of over 20 *M. lugubris* taken from various hosts.

We did not examine histopathology of leech attachment and feeding sites in the oral cavity of infested Columbia River fish, although petechiae were evident during the fall on some chiselmouth. Inflammatory conditions and hyperplasia were described previously from a massive infestation of *M. lugubris* (misidentified as *Cystobranchus virginicus*) on white catfish in Virginia (Paperna and Zwerner 1974).

Piscicola salmositica

The salmonid leech, *P. salmositica*, was described from specimens taken, in part, from sea-run steelhead trout, *Salmo gairdneri*, transferred from the Columbia River to Mason Creek, Chelan County, Wash. (Meyer 1946a). The leeches infesting the fish originated either in the Columbia River or from Mason Creek. Thus the salmonid leech has previously been recorded from the upper Columbia River system. This species is usually associated with fall spawning runs of adult salmonid fishes in coastal streams, but it occurs elsewhere in the Pacific Northwest (Becker and Katz 1965a).

We collected several *P. salmositica* at various times from chinook salmon, *Oncorhynchus tshawytscha*, fry and once from a fingerling sucker. Each infestation consisted of a solitary leech attached to the dorsal surface of its host and feeding on blood. All specimens were taken in April and June as water temperatures (10°-14°C) increased and consisted of small leeches that presumably had hatched from cocoons the previous fall or winter. Three specimens contained developing trypanoplasms among their intestinal contents, evidence of prior feeding on infected fish. Therefore, *P. salmositica* is confirmed as a vector transmitting trypanoplasms among various fish in the central Columbia River. The salmonid leech is the only known vector of the piscine hemoflagellate *Trypanoplasma salmositica* (Katz 1951) in the Pacific Northwest (Becker and Katz 1965b).

Piscicola salmositica requires meals of fish blood before detaching to deposit cocoons on bottom substrates (Becker and Katz 1965a). Thus salmonid leeches presumably occur among and infest populations of anadromous chinook salmon that spawn each fall in the central Columbia River near our fish collection sites. However, we have not detected *P. salmositica* on transient adult fall chinook salmon returning from the sea to spawn or from downstream drifting, spawned out salmon carcasses. Neither have we found salmonid leeches on several adult steelhead trout and spring-run chinook salmon examined during the summer at the Ringold Hatchery (Washington State Department of Game) above Richland. On the basis of our observations, *P. salmositica* is not an abundant leech in the central Columbia River.

Placobdella montifera

One immature *P. montifera* was recovered from the dorsal surface of a fingerling sucker in early October 1976. We also collected one adult specimen from beneath shoreline rocks at Umatilla Reservoir during June where it was depositing a cocoon. The species is not a common ectoparasite of fish. It probably occurs mostly along reservoir shorelines where water levels remain relatively stable, rather than along the margins of the free-flowing Columbia River above Richland.

Placobdella montifera has been reported to attack aquatic worms, insect larvae, mussels, frogs, toads, and fish, but the only specific host records are fish (Hoffman 1967; Klemm 1972a, 1975, 1976; Sawyer 1972; and others). This leech, as do most glossiphoniids, broods its cocoon and carries its young. An uncommon but widely distributed species, *P. montifera* is listed as having been reported previously from Washington (Klemm 1972b). Distributional records probably valid include British Columbia, Saskatchewan, Ontario, and the northern states east of the Mississippi River southward to Georgia (Sawyer 1972; Klemm 1977).

Actinobdella inequiannulata

Six *A. inequiannulata* were collected from the axila of the pelvic and pectoral fins of one adult largescale sucker in mid-August 1975. According to Sawyer (1972), this glossiphoniid is known from Illinois, Minnesota, and Ohio; Klemm (1972a, b, 1977) adds Michigan, Pennsylvania, and New York; and Daniels and Freeman (1976) add Ontario. *Actinobdella triannulata* Moore 1924, a name common in earlier literature, is now considered a junior synonym of *A. inequiannulata* (Daniels and Freeman 1976; Klemm 1977).

Daniels and Freeman (1976) provide a redescription of *A. inequiannulata* on basis of specimens collected from two species of suckers (genus *Catostomus*) and preserved material from the U.S. National Museum. The species was earlier considered as free-living with no known hosts (Sawyer 1972; Klemm 1972a). Since its synonym *A. triannulata* displayed a predilection for suckers (Hoffman 1967), the host preference of *A. inequiannulata* is now partially resolved. Little is known of its ecology and life cycle. We did not examine our specimens for ingested fish blood.

The host relationship for glossiphoniids is generally considered to be less obligatory than for piscicolids, and most are omnivorous feeders. Apparently *A. inequiannulata*, *P. montifera*, and *P. pediculata* Hemingway 1908 are the only three American glossiphoniids consistently reported to parasitize fish. Several authors have reported *P. pediculata* from the freshwater drum, *Aplodinotus grunniens*, and Sawyer (1972) has indicated a high degree of host specificity; it has not been reported from the Pacific Northwest, nor would it be expected in this region due to its narrow host preference.

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INDUCED SPAWNING AND LARVAL REARING OF THE YELLOWTAIL FLOUNDER, *LIMANDA FERRUGINEA*

The yellowtail flounder, *Limanda ferruginea* (Storer), a commercially important flatfish, occurs in North American continental waters from the north shore of the Gulf of St. Lawrence southward to the lower part of Chesapeake Bay (Bigelow and Schroeder 1953). The yellowtail flounder spawns from March through August where water temperatures over its range vary from about 5° to 12°C (Colton 1972). The eggs are pelagic and lack an oil globule; diameter of the live eggs (range 0.79-1.01 mm) averages 0.88 mm (Colton and Marak 1969).

A program to obtain viable yellowtail eggs through hormone induction, to rear larvae through metamorphosis, and to determine the mechanisms of survival of early life stages under controlled laboratory conditions was undertaken. The successful induction of yellowtail flounder and subsequent rearing of the larvae through metamorphosis marks the first time the early life history of this flatfish has been completed in the laboratory.

Materials and Methods

Adult yellowtail flounder were captured by otter trawling in Block Island Sound in the winters of 1974, 1975, and 1976 and transported to the Narragansett Laboratory in a 380-l live car equipped with an aerator. In the laboratory the fish were held in a 28,000-l aquarium. A continual supply of filtered seawater was pumped to the aquarium from Narragansett Bay.

Individuals presumed to be sexually mature were selected by length. Available length-weight data (Lux 1969) indicated that yellowtail flounder in southern New England waters mature when they attain a length near 35 cm or an age of 3 yr (Lux and Nichy 1969). After acclimating in the laboratory, the fish were segregated by sex, measured and weighed, and tagged with numbered plastic pennants secured through the caudal peduncle. Yellowtail flounder were sexed by holding the white underside to the light and looking through the flesh. The outline of the ovary extending posteriorly from the mass of viscera can readily be seen even in immature females (Royce et al. 1959). Yellowtail flounder are delicate and excitable. To minimize injury, the fish were anesthetized in a solution of tricane methanesulfonate (MS-222[1]) at a concentration of 1:20,000 (Leitritz and Lewis 1976) during each examination.

While the fish were held in captivity, a photoperiod of 11 h of light and 13 h of dark simulated spawning light conditions. Four banks of fluorescent lights (each bank composed of 16 40-W bulbs) were suspended 4 m from the ceiling and mechanically timed. The light banks were sequentially turned on and off in the morning and evening at 15-min intervals to simulate dawn and twilight. Prior to receiving hormones the fish were fed a daily diet of chopped frozen hake, whiting, or squid. During the trials the fish were not fed.

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.