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Bottom Fauna as an Indicator of Lake Typology in Flathead Lake, Montana

Abstract

The horizontal and vertical distribution of the bottom fauna of Flathead Lake, Montana, is discussed. The benthic fauna of the lake suggests oligochaetes widespread at all depths. Larvae of *Stictochironomus* and *Procladius* comprised almost 75 percent of the chironomid fauna. The presence of species of *Heterotrissocladius, Monodiamesa,* and *Protanypus* reflects the existence of some ultraoligotrophic areas in the lake. There were no indications of eutrophic conditions. The evidence of widespread oligotrophic conditions supports previous evidence acquired from limnological studies.

Introduction

The purpose of this research was to describe the chironomid and oligochaete fauna of Flathead Lake, Montana, to investigate the depth distribution of the benthos, and to use the Chironomidae in a discussion of the trophic typology of this lake. Flathead Lake has been under intensive limnological investigation for several years and much of this research has been reviewed and consolidated by Gaufin *et al.* (1976). However, the investigation by Young (1935) is the last published report on the benthos of Flathead Lake.

The use of chironomids as indicators of lake typology was first proposed by Brundin (1949), but this technique has been used only sparingly on North American lakes. Saether (1975c), however, has reviewed this method and its application to North American lakes.

Results of benthic typology studies in the Okanagan Valley, British Columbia, are compared and contrasted with the Flathead Lake fauna (Saether and McLean, 1972). A secondary objective was to add to the present meager knowledge of chironomid and oligochaete zoogeography in western North America.

Study Area

Flathead Lake (Fig. 1) is one of the largest natural freshwater lakes west of the Mississippi River. It lies in Lake and Flathead counties in northwestern Montana at the southern end of the Rocky Mountain Trench and is part of the Columbia River drainage system. The lake is naturally dammed at its southern end by a terminal moraine from the Wisconsin glaciation. Lake levels are regulated between 879 m and 882 m (MSL) by a dam located 7 km downstream of the natural lake outlet. Some of the morphometric data on Flathead Lake are presented in Table 1.

The bottom material is variable throughout the lake. The bays have bottoms of coarse to fine organic matter and the depositional zone off the mouth of the Flathead River is predominately inorganic sediments. The east and west shores have substrates that include varying proportions of sand, gravel, cobble, and boulders.

Methods and Materials

The benthos of Flathead Lake was sampled using a drag dredge towed behind a boat (Fast, 1968). About 37 m (120 ft) of bottom were sampled at each station as the dredge was towed approximately 0.33 m sec^{-1} (1 ft sec^{-1}) along the bottom. Tows were made parallel to bottom contours. A total of 77 tows were made at 22 sampling stations variously located around the lake where depths ranged from 4 m (14 ft) to 55 m (180 ft). Samples of bottom fauna should only be considered as semi-quantitative as a result of the variable nature of the lake bottom and the efficiency of the drag dredge. At the completion of each tow the dredge was pulled to the surface and all organisms were removed and preserved in A.F.A. All sampling was conducted during the summer and fall over a three-year period.

In the laboratory all Chironomidae and Oligochaeta were mounted on glass slides using CMC-10 non-resinous mountant. All mounted specimens were allowed to air dry and clear for one week; after this time period, they were examined under a compound microscope and identified. Other larger organisms were examined under a dissecting microscope.

Results

Chironomids were collected at all depths sampled, but oligochaetes were absent from some samples (Table 2).

Individuals of the families Lumbriculidae and Naididae were not common in the samples. Three naidid taxa were collected at 12 m depth and one was taken at 17 m. Tubificids were evident through the entire depth range. Only one identifiable specimen of *Ilyodrilus templetoni* was taken at 12 m. *Limnodrilus hoffmeisteri* was found at depths of 21-55 m. A total of 236 oligochaetes were collected in 276 minutes of dredge time ecompassing some 40 sampling locations (Table 2).

The chironomid fauna was represented by 1677 individuals separable into 25 taxa (Table 2). All taxa were present in the 4-21 m depths, but only seven taxa were taken in the profundal zone (22-55 m). Individuals of *Microchironomus* and *Pagastiella* were confined to the littoral zone (4 m). The greatest sampling effort was expended at the 21 m depth resulting in the greatest number of taxa (15) and individuals (491) taken from that depth.

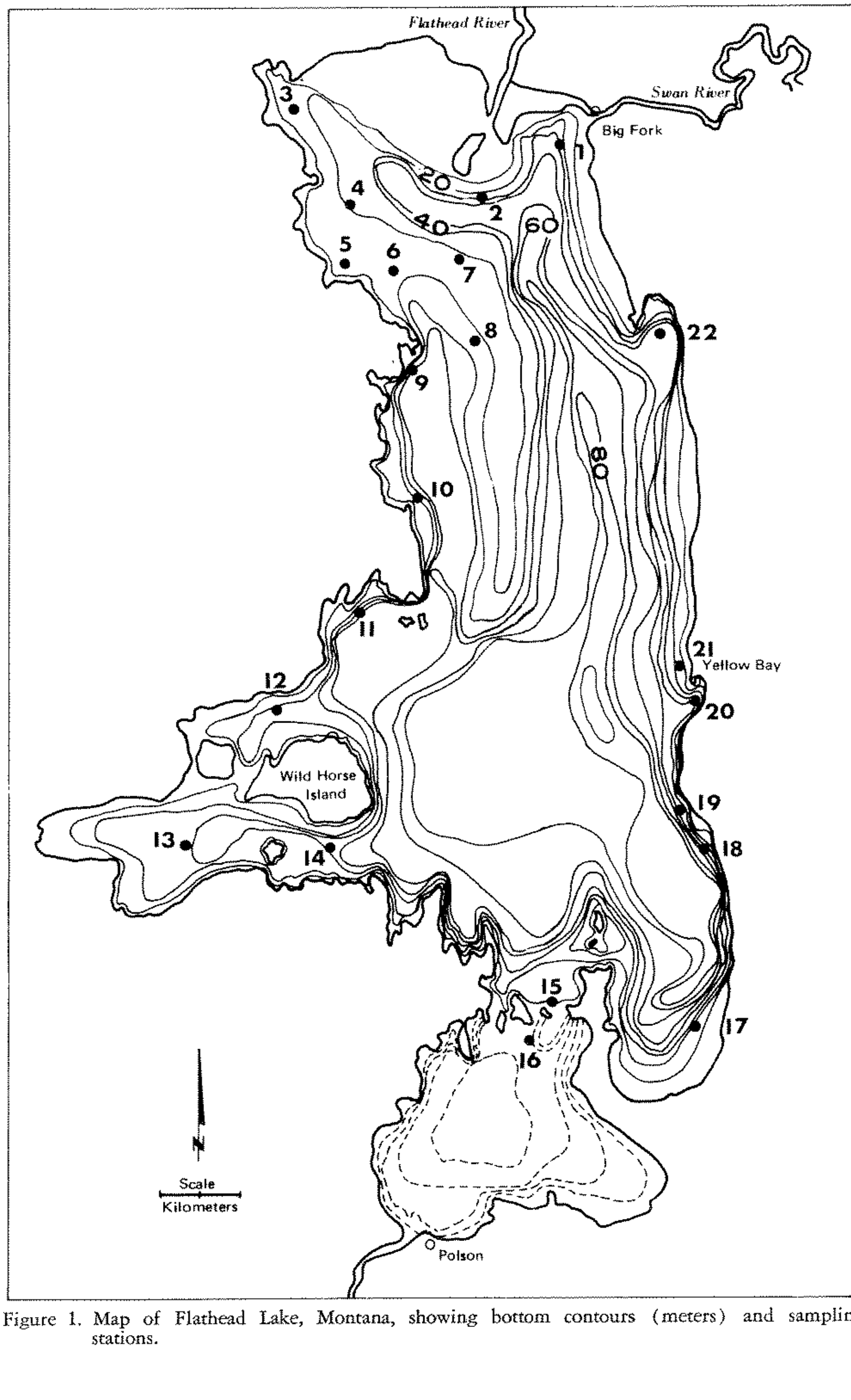

Figure 1. Map of Flathead Lake, Montana, showing bottom contours (meters) and sampling stations.

The genus *Stictochironomus* was the most abundant chironomid collected, comprising 53 percent of the fauna (889 individuals). *Procladius* was the second most abundant taxon with 400 individuals or 23.9 percent of the fauna. In decreasing order of abundance, the other common chironomid taxa included *Chironomus* (93), *Protanypus hamiltoni* (73), *Heterotrissocladius oliveri* (63), and *Pagastiella* (33).

TABLE 1. Morphometric data on Flathead Lake (from Potter and Stanford, 1975).

Area (km^2)	476.6
Drainage (km^2)	18,378.6
Average Annual Discharge (km^3)	10.5
Shoreline (km)	259.7
Maximum Length (km)	43.9
Maximum Breadth (km)	24.9
Maximum Depth (m)	113.0
Mean Depth (m)	32.5
Volume (km^3)	24.9
Mean Water Retention (years)	2.37

Protanypus hamiltoni was distributed at depths ranging from 17 to 47 m. With the exception of a single specimen captured at station 20 on the east shore, all larvae were taken in the northeast quadrant of the lake at stations 3-12. A variety of substrates occurs at these sampling stations.

Heterotrissocladius latilaminus was confined to the littoral-upper profundal zone (9-21 m depth). This species was common in the northern part of the lake (stations 3, 5, 7) and rare elsewhere in the lake (station 20). *Heterotrissocladius oliveri* was found in the 17 to 37 m depth range and its greatest densities were at station 7 and 8 in the depositional region at the mouth of the Flathead River.

Larvae of *Monodiamesa prolibata* preferred the littoral and upper profundal zones (9-21 m) and were found at scattered locations (stations 3, 5, 15, 20) around the lake.

The list of larger macroinvertebrates collected in Flathead Lake, together with their depth distribution, is found in Table 3. Individuals of Hydrazoa and Trichoptera were collected out to 18 m depth, Amphipods to 29 m, and mayflies (Ephemeroptera) to 33.5 m. Only Oligochaeta and Chironomidae were commonly taken at deeper sampling stations.

Discussion

Comparison with Other Western Lakes

Wiederholm (1976) noted that the bottom fauna of Lake Sammamish, Washington, was dominated by chironomids out to his maximum sampling depth of 25 m. The most abundant chironomid collected in this mesotrophic lake was *Chironomus salinarius* (kieff). Eighteen genera of Chironomidae were reported identified from Lake Sammamish, most of which were also found in Flathead Lake.

In mesotrophic-oligotrophic Lake Washington, Washington, Thut (1965) found the benthos dominated by chironomids down to depths of 25 to 30 m, below which oligochaetes dominated. *Chironomus atritibia* was the most abundant benthic chironomid reported.

Although identifications were not recorded to the species level for the genus

TABLE 2. Depth distribution of Oligochaeta and Chironomidae in Flathead Lake.

Depth (m)	4	9	12	17	18	21	22	24	25	26	27	28	29	30	31	34	35	36	37	47	55	
No. Samples	1	2	1	1	2	12	1	1	1	1	2	3	1	1	1	2	1	1	3	1	1 = 240	
Tow Time (min.)	2	1½	1½	1½	3	22½	1½	1½	1½	3	4	7½	1½	1½	1½	4½	1½	1	9	1½	3 = 276	Total
Oligochaeta																						
Lumbriculidae		3			2	5					6	2			1		1					20
Naididae																						
Nais cf. *barbata* Muller			1																			1
Paranais litoralis (Muller)			3																			3
Pristina Ehrenberg				1																		1
Slavina appendiculata (d'Udekem)			2																			2
Tubificidae																						
Ilyodrilus templetoni (Southern)			1																			1
Limnodrilus claparedianus Ratzel						5		1											5			11
L. hoffmeisteri Claparede						18					1	4					4		15	2	1	45
Rhyacodrilus montanus (Brinkhurst)						6																6
Immature with capilliform chaetae		1	1		2	13		1	1	1		1	1									22
Immature w/o capilliform chaetae		2		4	2	85		5			9	2	1	3	1		4		12	1	3	124
																						236
Insecta																						
Chironomidae																						
Tanypodinae																						
Macropelopini																						
Procladius Skuse	13	17	4	32	11	129		10	5	3	6	39	48	2	1	3	41		34		1	400
Diamesinae																						
Diamesini																						
Potthastia (Kieff.)		1																				1
Protanypini																						
Protanypus hamiltoni Saeth.				7	10	23		1			9	10					8		3	2		73
Prodiamesini																						
Monodiamesa prolibata Saeth.		1		1	1	4																7
Orthocladiinae																						
Cricotopus (v.d. Wulp)						1																1
Heterotrissocladius latilaminus Saeth.		5			1	3																9
Heterotrissocladius oliveri Saeth.				5		18		2	1	2	13	10	5				4		3			63
Paracladius cf. *alpicola* (Zett.)		3																				3
Parakiefferiella (Thien.)	13				7	3	1						1									25
Psectrocladius (Kieff.)	2					4																6
Chironomini																						
Chironomus (Mieg.)			3		2	27					12	4			3	3	6		27	3	3	93
Cladopelma Kieff.						1																1
Cryptochironomus Kieff.		1			1																	2
Demicryptochironomus Lenz		1																				1
Dicrotendipes Kieff.					1																	1
Microchironomus Kieff.	3																					3
Microtendipes Kieff.		1																				1
Pagastiella Brund.	33																					33
Paracladopelma Harn.	1					1																2
Paralauterborniella Lenz	1	1																				2
Stictochironomus Kieff.		1		87	39	267	1	13	6	2	52	104	46	20	20	1	26		200	2	2	889
Tanytarsini																						
Cladotanytarsus Kieff.	13	2			2																	17
Micropsectra Kieff.				3		5				1					2	1						12
Tanytarsus v.d. Wulp		18	1	2	3	3					1	1	1									29
Zavrelia Kieff.					1	2																3
																						1,677

Chironomus in this study, tentative separations of those larvae yielded about 95 percent *C. atritibia* type and only 5 percent *C. attenuatus* type. No larvae of the *C. semireductus* Lenz or *C. plumosus* (L) types were noted.

Saether (1970) and Saether and McLean (1972) did not use a holistic approach in their typing of British Columbia lakes utilizing chironomid distributional data. Instead they demonstrated that different areas of the same lake can have vastly different typologies. They reported that the presence of *Heterotrissocladius subpilosus* type larvae was indicative of ultraoligotrophic conditions, *Stictochironomus* illustrates a moderately oligotrophic to mesotrophic situation, and the presence of *Chironomus plumosus* and *C. semireductus* types suggests a strongly eutrophic situation.

TABLE 3. Depth distribution of all aquatic macroinvertebrates collected in Flathead Lake.

Taxa	Depth (m)
Hydrazoa	16-18
Turbellaria	16-29
Nematoda	9-47
Bryozoa	9-37
Oligochaeta	9-55
Lumbriculidae	9-55
Tubificidae	9-55
Amphipoda[1]	4-29
Ephemeroptera[2]	4-33.5
Trichoptera[3]	4-18
Hydracarina	4-27
Diptera-Chironomidae	4-55
Mollusca	6-47
Gastropoda[4]	6-37
Pelecypoda[5]	6-47

1—*Hyalella azteca*
2—*Caenis, Ephemera*
3—*Molanna*
4—*Gyraulus, Physa, Lymnaea*
5—*Pisidium, Muscilium*

The dominant chironomids in Flathead Lake differed considerably from those of Lake Sammamish, Lake Washington, or any of the Okanagan Valley Lakes. Unfortunately, the most abundant genera collected in Flathead Lake, *Stictochironomus* and *Procladius,* were not identified to species because of the lack of adult specimens. Probable species designations for these two genera can only be inferred from published distributional records.

Saether (1975) noted there are eleven described species of *Stictochironomus* in North America and two to three of these are probably profundal inhabitats. *S. rosenscholdi* Zett. is characteristic of median oligotrophic and mesotrophic lakes and is present in nearby British Columbia, as is the shallow water form *S. histrio* Fabr. (Saether and McLean 1972). Sublette and Sublette (1965) recorded *S. virgatus* from Montana.

Roback (1971) noted that *Procladius* larvae are predators that feed on other chironomids and small crustaca. *P. (Psilotanypus) bellus* (Loew) is known from Montana and *P. (Procladius) freemani* Sublette has been previously collected on the west shore of Flathead Lake (Roback, 1971). Other species known in this general area of

North America include *P. (Ps.) nietus* Roback, *P. (P.) ruris* Roback, *P. (P.) abetus* Roback, and *P. (P.) denticulatus* Sublette.

Chironomus anthracinus Zett. is known from Montana (Curry, 1962), and this species may include the *C. attenuatus* type larvae that Saether (1972) collected in moderately eutrophic lakes of British Columbia. *C. atritibia* (Malloch) occurs in British Columbia (Curry, 1962), and this species may be identical to the *C. salinarius* type of cold-stenotherm collected in British Columbia by Saether and McLean (1972). The absence of *C. plumosus* and *C. semireductus* types in Flathead Lake suggests that areas of serious enrichment were not encountered.

The Oligochaeta fauna of Okanagan Lake are similar to the fauna of Flathead Lake (Saether, 1970; Saether and McLean, 1972). However, most of the oligochaete fauna of Flathead Lake is widespread and common in all kinds of freshwater biotopes except *Rhyacodrilus montanus*, which is indicative of a cold, oligotrophic habitat.

Typology of Flathead Lake

Protanypus hamiltoni occurs in three large, deep oligotrophic lakes in British Columbia and on the shore of Great Slave Lake in the Northwest Territory. This species is usually confined to the littoral zone but occurs as deep as 117 m (Saether, 1975a). Since all *Protanypus* species seem to be characteristic of ultraoligotrophic to moderately oligotrophic conditions, its presence at several depths and locations indicates that these conditions exist in most parts of Flathead Lake.

Heterotrissocladius has been found in the littoral to upper profundal zone of lakes and is present in a similar habitat (9 to 21 m) in Flathead Lake. *H. oliveri*, which occurs in the deeper parts of the profundal zone of temperate lakes (Saether, 1975b), was collected from 17 to 37 m depth in Flathead Lake. All species of *Heterotrissocladius* seem to be characteristic of ultraoligotrophic to moderately oligotrophic lakes (Saether, 1975b).

Monodiamesa prolibata is distributed from 9 to 21 m depth and this profundal species indicates oligo-to-mesotrophic nearctic lakes (Saether, 1973, 1975c). If the *Paracladius* cf. *alpicola* identification from Flathead Lake is accurate, it too would be indicative of ultra-to-moderately oligotrophic conditions.

The Oligochaeta and Chironomidae data from Flathead Lake suggest that areas of the lake vary from ultraoligotrophic to mesotrophic. After an anaysis of the algal flora, Gaufin *et al.* (1976) concluded that the lake has oligotrophic characteristics. Water quality and nutrient investigations suggest some shallow bays such as Yellow Bay, Hell Roaring Bay, and Polson Bay are gradually undergoing eutrophication. Potter and Stanford (1975) concluded that Flathead Lake is maintaining its oligotrophic nature as a result of a balance between increased nutrient loading and sedimentation. Analysis of the benthic macroinvertebrate community supports the contention of widespread oligotrophic conditions with areas of ultraoligotrophic and mesotrophic conditions.

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