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An Ecological Catalog of the Lake Okoboji Gastropods

Richard V. Bovbjerg
State University of Iowa

Martin J. Ulmer
Iowa State University

An Ecological Catalog of the Lake Okoboji Gastropods

RICHARD V. BOVBJERG[1] and MARTIN J. ULMER[2]

Abstract. A five year survey was made of the gastropods of Lake West Okoboji, Iowa. Only 11 species comprise the present fauna, a remnant of what was earlier in this century several times larger. These species are: *Amnicola limosa* (Say), *Amnicola lustrica* Pilsbry, *Ferrissia rivularis* (Say), *Gyraulus parvus* (Say), *Helisoma trivolvis* (Say), *Lymnaea reflexa* Say, *Lymnaea obrussa* Say, *Menetus exacuous* (Say), *Physa gyrina* Say, *Physa sayii* Tappan, and *Valvata tricarinata* (Say). These are now confined to areas less than 10 meters in depth with numbers of species and densities much greater in the bays than in the main body of the lake. Other pertinent ecological data are noted.

The following records of snails from West Lake Okoboji are the result of systematic collecting in the years 1954 through 1959 during the summer sessions of the Iowa Lakeside Laboratory.[3] It is hoped that this catalog by station and habitat will be useful to the malacologist and to those concerned with these animals as intermediate hosts of helminths. Of particular significance as a result of the survey herein reported is the striking paucity of the present gastropod fauna in contrast to earlier records of abundance.

Compared to some American deep lakes, the Okoboji limnological information is meager. A survey was made in 1913 (Ford) and a very brief reconnaissance was made by Birge and Juday (1920). More extensive studies were published by Stromsten (1926, 1927) and a few others have appeared more recently (Jahn and Taylor, 1940; Taylor and Jahn, 1940; Bardach *et al.*, 1951; Bardach, 1955; Weber, 1958). From these emerge certain facts germane to the present problem. Lake Okoboji is approximately 9 by 5 kilometers, with a shore line of 29 kilometers. Although it has a depth of 40 meters, one half of the lake is 10 meters or less; this extensive area of shallow water is largely contained in a few bays. (See map.) The main north-south axis of deep water characteristically stratifies in a summer thermocline with resultant anoxic, profondal waters. The water of the bays mix and warm to the bottom where oxygen is adequate.

The substratum reflects the original nature of the basin and the subsequent silting and organic deposition. Geologically, the lake is

[1]Department of Zoology, State University of Iowa, Iowa City, Iowa.
[2]Department of Zoology and Entomology, Iowa State University, Ames, Iowa.
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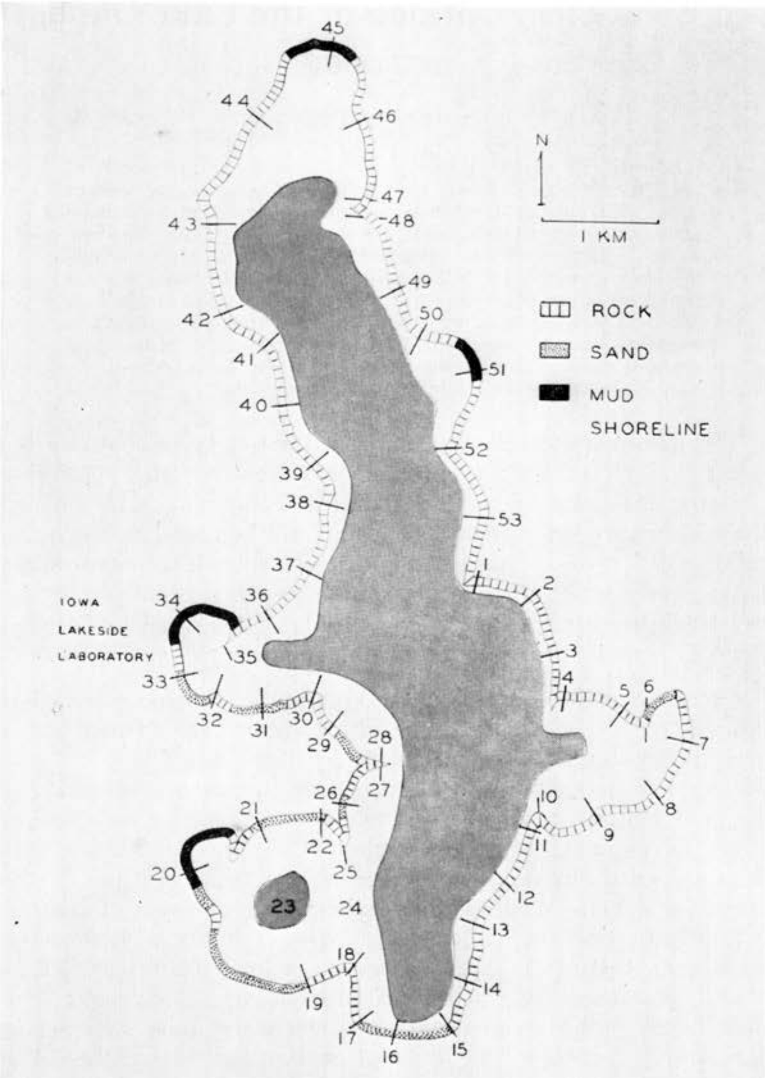

Plate 1. Map of West Lake Okoboji. Shaded area encloses waters over 10 meters in depth. Shore materials: solid—mud, stipled—sand, bar—rock.

of Wisconsin glacial origin and the shores are dominated by ice-thrust boulder and cobble. About 80 percent of the shoreline is of rock, 12 percent gravel and sand, and 8 percent is bordered by mud flats. The several points projecting into the lake extend as underwater boulder ridges which tend to enclose the embayments.

From dredge samples and underwater observations some generalizations may be made concerning bottom materials. In the major bays, the substratum converges to thick silt regardless of the shore materials. This silt, however, does not quite approach the black, creamy consistency of the deep water bottom materials. The 10 meter line in the major basin is close to shore; the bottom is steeply sloping and is of gravel, sand, scattered boulders and cobbles.

Vegetation occupies about 30 percent of the lake's area. As substratum and perhaps in some instances as food, these plants influence snail distribution. In terms of mass, the hornwort (*Ceratophyllum demersum*) is surely the dominant plant (Wylie, 1920; Jones, 1925, 1931). Its distribution is well within the 10 meter line and 72 percent occupies the larger bays where it becomes a solid mass by midsummer. Particularly within these bays, plants of 11 genera (8 species of *Potomageton*) are interspersed (Wylie, 1920).

The abrupt shores have far less vegetation and the rocky headlands are characterized by beds of *Chara*. In general, the waters out to a meter's depth are free from vegetation with the exception of such small plants as *Chara, Heteranthera, Naias, Elodea,* and *Vallisneria.*

The algal flora of the lake is extensive and of importance as gastropod food. The rocky substratum tends to develop a heavy green covering of filamentous forms and diatoms. Large beds of filamentous algae, particularly *Rhizoclonium,* develop among the pond-weeds of the bays and form a conspicuous "Aufwuchs" on those plants, together with a micro-fauna. Later in the summer planktonic and encrusting blue-green algae have an extraordinary bloom.

PROCEDURES

The shoal waters of the lake were sampled at 53 stations selected prior to the investigation with a view to comprehensive coverage and to specific ecological situations. Each station was visited at least twice. Soundings were made and bottom materials sampled. Plants were collected by grappling or diving. Snails were handpicked from vegetation aboard the boat; dredge samples were examined for specimens as were the larger stones brought up by diving. Each station was also examined from the shore to about one meter. Since this stretch has a sparse vegetation, the collecting here was largely from rocks. All living snails collected were examined for helminth parasites, identified, and recorded.

It should be noted that unit effort of collecting per station was not equivalent. In almost all stations a minimum of one hour of work was done. In some areas several hours were spent when it appeared that infected snails might be present. Usually two to four investigators were present; however, in some instances there was only one. Consequently, while the data are presented quantitatively, many cross-comparisons between stations are of doubtful value. Regardless of the variable collection effort, sampling was not selective, so that comparative numbers per species do indicate some validity.

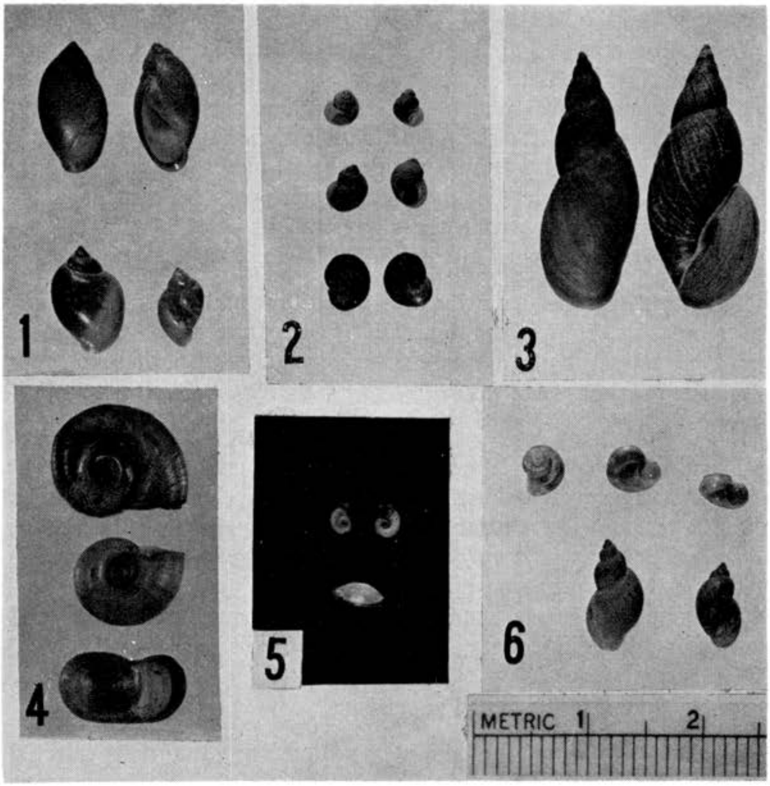

Plate 2. Snails collected in Lake West Okoboji.
Figure 1. Upper, *Physa gyrina* Say; lower, *Physa sayii* Tappan.
Figure 2. Upper, *Amnicola limosa* (Say); middle, *Amnicola lustrica* Pilsbry; lower, *Menetus exacuous* (Say).
Figure 3. *Lymnaea reflexa* Say.
Figure 4. *Helisoma trivolvis* (Say).
Figure 5. Upper, *Gyraulus parvus* (Say); lower, *Ferrissia rivularis* (Say).
Figure 6. Upper, *Valvata tricarinata* (Say); lower, *Lymnaea obrussa* Say).

Gastropod Distribution and Density By Habitat

A total of 4,660 snails was identified and recorded by station. Included are eight genera and 11 species; these are figured in Plate 2.

Compilation of data from representative studies made in nearby states (Baker, 1928; Goodrich, 1932; Goodrich and Van der Schalie, 1944) indicates certain habitat preferences for these 11 species, as follows:

Amnicola limosa (Say). Quiet, shallow waters of lakes and streams; on mud or in dense vegetation.

Amnicola lustrica Pilsbry. Lakes, ponds, streams; in dense vegetation.

Ferrissia rivularis (Say). Ponds, lakes, streams; attached to stones or to vegetation.

Gyraulus parvus (Say). Sluggish waters of lakes, ponds, slow streams; on sticks, stones, but largely on vegetation.

Helisoma trivolvis (Say). Quiet, shallow waters; dense vegetation; on mud or sand bottom in protected areas.

Lymnaea reflexa Say. Small pools, and swales, not in large lakes; highly resistant to sewer discharge pollution.

Lymnaea obrussa Say. Marginal waters and mud flats of streams, ponds and in bays of lakes.

Menetus exacuous (Say). Quiet, marshy waters; swamps, pools, rarely in large lakes; on mud flats and in dense vegetation.

Physa gyrina Say. Stagnant, shallow, slow-moving waters, ditches, pools, lake margins; on mud bottoms.

Physa sayii Tappan. Wave-beaten shores; on lakeshore boulders, sand gravel, mud bottoms.

Valvata tricarinata (Say). Lakes, small streams; shallow water to over nine meters; on gravel, boulder, sand, mud substrata; favor algal covered rocks; tolerant of pollution.

Our data on these species reveal the usual exceptions to such "habitat preferences" expressed as generalities. No really decisive habitat correlations could be made, as may be seen in Tables 1 and 2 which demonstrate the wide ranges of habitats and wide distribution throughout the lake of most of the species, almost all of which were found in the vegetation as well as on the bottom. We were unable to find any preferences for specific plants, nor, in most instances, for specific types of substratum. There is, however, an inherent difficulty in assigning an arbitrary designation to a habitat; we frequently collected snails from occasional rocks and sticks in an area labelled a mud bottom station.

If we may be permitted generalities of our own, some correlations may be derived from the quantitative data, whose limitations have been noted.

Table I
Numbers of Each Species Recorded by Station

Station Number	*Physa gyrina*	*Physa sayii*	*Amnicola limosa*	*Amnicola lustrica*	*Menetus exacuous*	*Gyraulis parvus*	*Valvata tricarinata*	*Ferrissia rivularis*	*Helisoma trivolvis*	*Lymnaea reflexa*	*Lymnaea obrussa*	Substratum*	Total snails	Total species
1		11										BC	11	1
2		4										BC	4	1
3		7			2							BC	9	2
4	8	39	3		7							M	57	4
5	3	1	4									M	8	3
6	87	3	2		2							M	94	4
7	4		56		5		5					M	70	4
8	10	14	2									M	26	3
9		3	1									M	4	2
10	119	32										BCGS	151	2
11	4	2	4									CGS	10	3
12	8	2	3									CGS	13	3
13	5	4	4									CGS	13	3
14		6	1									BC	7	2
15			8									SM	8	1
16	1	4	29		25							SM	59	4
17	34	14	14	2	41							M	105	5
18		2	33	4		2	4					CGSM	45	5
19	1	4				1						S	6	3
20	4	13	43		2		1					M	63	5
21		3										M	3	1
22	78	9	4		7				1			M	99	5
23												M	0	0
24			20	13	1	2	5					BC	41	5
25	198	69										BC	267	2
26	86	4										GSM	90	2
27	3	1	4				1					GSM	9	4
28			4									BC	4	1
29	4		6		1							BCG	11	3
30	13	2	24		1							GSM	40	4
31	10	43	28		70							SM	151	4
32	42	65			2	3		1		2		BCG	115	6
33	95	80	64		53	18	8	1		1		M	320	8
34	122	88	2		38	14		1			202	M	467	7
35	67	38	166		110	58	19					GSM	458	6
36	6		16		43		4					SM	69	4
37	2		9		18		3					SM	32	4
38	8	4	8		4	5						SM	29	5
39			1									GS	1	1
40	100	32										BCGS	132	2
41												BCG	0	0
42	22	68			23							BCS	113	3
43			2									BCS	2	1
44	29	327	2	1		1				3		BCS	363	6
45	2	2	13	8	3							M	28	5
46	131	292	55		182	6	3			3		BCSM	672	7
47	43	168	61		6	1						BCS	218	5
48	8	3	3									BCG	14	3
49	2	1	1		7							SM	11	4
50		1										CG	1	1
51		21	4		14	8						SM	47	4
52						3						BCG	3	1
53	12	14										BCGM	26	2
Total snails	1,371	1,500	704	28	667	122	53	3	1	9	202		4,660	
Total stations	36	41	37	5	25	13	10	3	1	4	1			

*Substratum materials; B—boulder, C—cobble, G—gravel, S—sand, M—mud or silt.

Table 2

Numbers of Each Species Collected from Vegetation and from Bottom Samples

Species	In vegetation	On substratum	Total
P. gyrina	596	775	1,371
P. sayii	325	1,175	1,500
A. limosa	645	59	704
A. lustrica	28	0	28
M. exacuous	493	174	667
G. parvus	84	38	122
V. tricarinata	49	4	53
F. rivularis	3	0	3
H. trivolvis	0	1	1
L. reflexa	3	6	9
L. obrussa	0	202	202
	2,226	2,434	4,660

The figures of Table 2 reveal the essential equality of numbers collected in vegetation and on the bottom. Of the 11 species, two have far larger numbers from the substratum, namely, *P. sayii* and *L. obrussa.* The former were found in equal numbers at stations designated rock or mud; this was probably an instance of snails on rocks in an essentially mud bottom area. We retain the impression that *P. sayii* is predominantly a rocky bottom species. *L. obrussa* was located entirely on shallow mud flats. The remaining species predominated on the vegetation, except for the apparently ubiquitous *P. gyrina* found in large numbers in the plants as well as on various types of bottom. No selection of a particular substratum material was noted for this species with dense populations on both rocky points and on mud bottoms.

One negative correlation to vegetation was noted, namely those shallow waters dominated by *Chara.* No snails were found in or about such beds.

Depth and form of the basin were related to snail distribution. No sampling over 10 meters yielded living specimens. Although shells of *V. tricarinata* were present, no living specimens were found. Bardach *et al.* (1951) report this species at 15 meters; either it no longer lives at these depths or the dead shells were being recorded for that report. Shimek (1935) had collected *V. tricarinata* and other species at 10 meters in earlier years, but by 1935 found only old, bleached shells. Our collections 20 years later confirm the lack of living snails at depths greater than 10 meters.

Various areas of the lake differ in their support of the gastropod fauna. Even considering the differences in collecting effort, one sees that the four major bays yield the greatest numbers of snails; five times as many per station were taken from these bays as from areas along open shores and steeply sloping bottom. More significantly, the average number of species per station in the bays was 4.5 compared to 2.5 along the major basin. There are, of course, major differences between these two general habitats. In terms of substratum, the bays are silted in their central regions but have diverse substrata nearer shore, ranging from boulder to mud. Shoal areas of the major basin have bottoms largely of gravel and sand with interspersed boulder and cobble. Bays support a dense and diverse flora while the shallow waters of the open lake are characterized by sparse plant growth and are frequently *Chara* dominated. Some shores of the bays are open and wave-washed while others are protected. The shores of the major basin are all exposed and wave-beaten. This relative multiplicity of ecological niches of the bays permits the larger number of snail species. Increased vegetation and food would support greater densities in the bays.

Evidences of Gastropod Destruction

From the papers of Shimek (1915, 1935) and from his shell collection at the Iowa Lakeside Laboratory, it is evident that a dramatic gastropod extinction in this lake has occurred in a short time. It is difficult to determine precisely the number of species Shimek collected from Lake Okoboji, since some of his data do not include exact locations and some lists are incomplete. Moreover, taxonomic revisions have altered the number. However, at least 25, and more probably 40, additional species were found in the lake during the first quarter of this century which are not present today. Two very conspicuous genera of Shimek's day are almost gone today. The lymnaeids were at one time represented by at least 10 species. Today, *L. obrussa* is known from one locality and *L. reflexa* may be collected in very small numbers at a few scattered stations. The once common genus *Helisoma* is represented in our collections by one specimen of *H. trivolvis.* However, shells of *Helisoma* and *Lymnaea* were present in some of our dredge samples. Actually, of the 11 species reported here, only six are fairly widely distributed and in any numbers. The other five species may well vanish shortly. Unquestionably the dominant genus is *Physa,* since well over half of the snails collected were of this genus.

One other aspect of what Shimek (1935) calls "the most complete and most heart-breaking destruction of a molluscan fauna which has taken place in the formerly fine, and malacalogically rich Okoboji Lakes" is the reduction in density as well as in species numbers. He remarks further that "a 6-inch dredge usually brings up 25 to more than 100 specimens at each haul." This is almost unbelievable to those of us who were fortunate to dredge five snails in one haul when the usual number was zero. We must agree with

Shimek that pollution has been the major cause of this precipitous decline in the molluscan fauna. Storm sewers and street tiles enter from three small, adjacent towns and the increased use of the lake as a resort area involves septic tank seepage on a large scale (personal communication, R. A. Furman, County Engineer). Okoboji may be on the way to the fate of heavily polluted Storm Lake in Iowa (Shimek, 1935) where the last snails were a few physids.

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