Journal of the Minnesota Academy of Science

Volume 38 | Number 2 Article 7

1972

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the trawl doors are pulled up to the boom. The port sweep ropes are then secured and passed over the outboard motor while the boat is turned to starboard. The motor is then shifted to neutral, the starboard sweep ropes are secured, and the trawl is pulled manually into the boat over the starboard quarter. There is no independent control of the winch drums and no level-wind mechanism, so occasionally one warp will pile up on the drum and be retrieved at a faster rate than the other. This has caused no problems, since the inequality in length has been only two to three feet, and is eliminated when the warps are paid out for the next haul.

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Poriferan fauna of a Minnesota pond

LOUISE A. ROLLINS*

ABSTRACT — An examination of sponges in Lund's Pond, within Itasca State Park, Clearwater County, Minnesota, was conducted in the summer of 1970. Five species, representing four genera, were identified. Some physical characteristics and water chemistry of the pond also were examined.

Lund's Pond is located on Two Spot Trail 1.8 miles west of 15-Mile Park Drive in Itasca State Park, Clearwater County, Minnesota. It has long attracted the attention of students in limnology and invertebrate zoology classes a the University of Minnesota Itasca Biological Station. Some of the more striking aspects of the pond are the scarcity of aquatic flowering plants, the paucity of algae, and the great abundance of freshwater sponges. The purpose of this study was to identify the sponges of Lund's Pond and to examine physical and chemical features that might be significant in their ecology.

The pond is a small, well-sheltered body of water surrounded by slopes approximately 30 feet high. The trees on the slopes are mostly aspen and birch, and some conifers. The elevation, approximately 1,700 feet above sea level, is one of the highest points in Itasca State Park. The source of water for the pond seems to be rainwater falling directly or washing down from the surrounding slopes. The substrate is relatively firm, with 10-15 cm of mud and decaying vegetation. The dimensions of the pond as measured in August 1969 are as follows:

Length — 132 meters
Maximum width — 64.7 meters
Shoreline length — 358 meters
Area — 0.303 hectares
Volume — 4028 cubic meters
Maximum depth — 3.4 meters
Mean depth — 1.33 meters
Volume development — 2.8

Figure 1 shows the pond's shape and depth contour lines of the pond as determined in the summer of 1969.

Collection and analysis

Sponges were collected by hand from depths ranging from approximately 0.1 to 1.0 meter, placed in small jars and taken to a laboratory for identification. Sponges exhibiting a variety of growth forms were collected on the following dates: 7/2/70, 7/13/70, and 7/19/70.

In the laboratory, a small portion of the sponge (about 1 cm^3) was placed in a test tube, and gemmules of the same sponge were separated with a fine forceps and placed in another test tube. Preparation of spicules were made by placing concentrated nitric acid and a few crystals of potassium dichromate in the test tubes and boiling until only silicon spicules remained, usually within 5 to 10 minutes. The test tubes were then centrifuged and the acid was decanted. The spicules were rinsed three or four times with distilled water to remove all acid and finally suspended in 95 per cent ethanol. A drop of ethanol containing the spicules was placed on a clean microscope slide and ignited to concentrate the spicules on the slide.

The spicules were examined with a compound microscope, and some of the preparations were made permanent by the addition of a drop of Canada balsam or Permount® mounting medium and a cover glass.

Chemical and physical determinations were made for oxygen, temperature, phenolpthalein alkalinity, total alkalinity, calcium, magnesium hardness, calcium hardness, pH and silica. Temperatures were taken with a standard temperature probe and thermistor. A Kemmerer water sampler was used to obtain water samples from various depths. Oxygen content was determined by the azide modification of the Winkler Iodometric Method. Alkalinities and hardness were measured by means of a standard volumetric method (Golterman, 1969). Silica content was determined by a standard colorimetric molybdosilicate method (Golterman, 1969). The pH was measured with a standard pH meter or pH-paper. Transparency was measured by means of a Secchi disc.

Sponge and pond data

Table I shows lists the species of sponges collected, the substrate from which they were obtained, and average spicule length of a sampling of ten spicules in each

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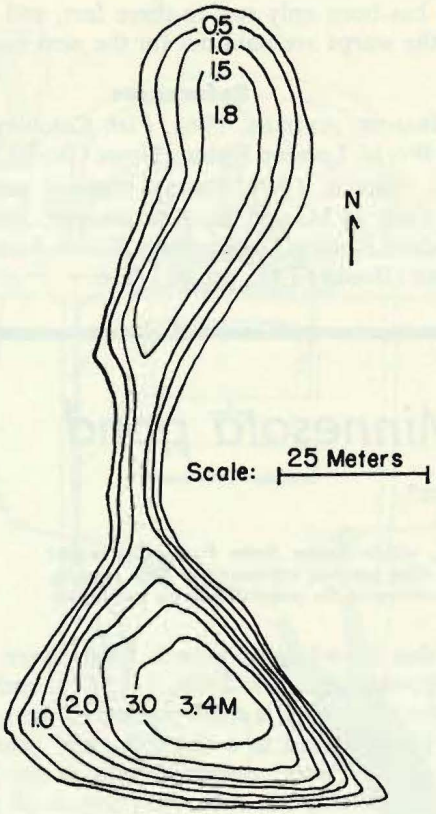

Figure I. Depth Contour Map of Lund's Pond

spicule category. Representative spicules from each category are shown in Figure 2.

Table II is a summary of data for oxygen, temperature, pH, total alkalinity, phenolpthalein alkalinity, calcium, magnesium hardness, calcium hardness, and silica according to the date of survey.

Transparency of Lund's Pond in meters visibility of Secchi disc on August 2, 1969 was 1.5-1.75 meters.

An oxygen hypothesis

Five species of sponges representing four genera occur in Lund's Pond (spicules from these species are shown in Fig. 2). In addition, one spicule preparation revealed some unusual birotulate spicules about 47 microns in length. This suggests another species of the genus *Meyenia* or *Heteromeyenia*. This research has not yet been able to identify the species.

The concentration of dissolved oxygen in surface water samples varied from 3.5 parts per million (ppm) at 25°C (44% saturation) to 9 ppm at 13°C (90% saturation). The sponges seem to be indifferent to low oxygen concentrations. Perhaps they are provided with oxygen in daylight hours by the symbiotic zoochlorellae present within nearly all of the sponges collected. Miller (1964) has demonstrated that growth and survival of *Spongilla lacustris* Leidy is enhanced by the presence of symbiotic algae. Muscatine et al (1967) have demonstrated that chlorellae isolated from sponges release 4.4% of their total photosynthate as glucose to the medium. This is interpreted as an adaptation to symbiosis. Whether the

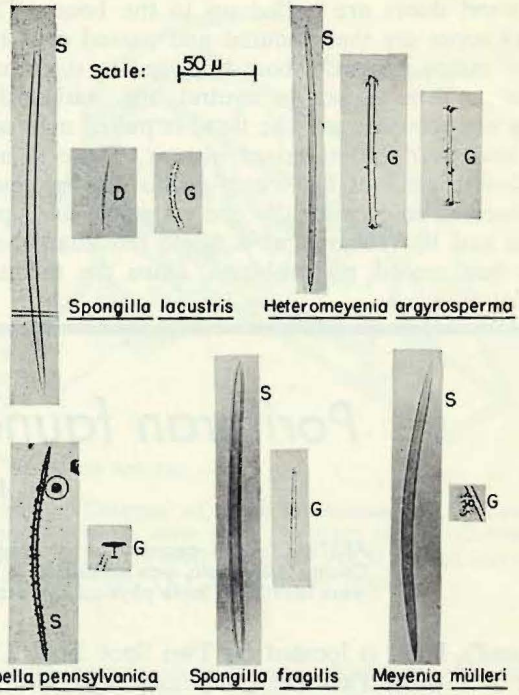

Figure 2. Representative Spicules of Lund's Pond Sponges
S, Skeletal; D, Dermal; G, Gemmule

algae provide oxygen as well as metabolites is yet to be shown.

Due to the comparatively high elevation of Lund's Pond, the main source of water seems to be rain, and dissolved minerals are low in concentration. Surface calcium concentrations varied from 3.2 ppm to 12.6 ppm. Surface silica concentrations varied from 0.5 ppm to 1.2 ppm. The observation that these five species of sponges thrive under conditions of low calcium agrees with the findings of Jewell (1939). Although concentration of silica is very low, it seems to be adequate for abundant spicule growth. It should be noted, however, that the spicules of sponges in Lund's Pond are generally shorter

TABLE I. – Sponges of Lund's Pond: Substrate and Spicule Dimensions.

Sponge	Substrate	Spicules (m-microns) S	D	G
Spongilla lacustris Leidy	bottom	275	47	49
Spongilla fragilis Leidy	small submerged logs or sticks	220		77
Heteromeyenia argyrosperma Potts	vegetation on bottom	251		110, 71
Tubella pennsylvanica Potts	bottom, vegetation on bottom, small submerged sticks or logs	179		10
Meyenia mülleri Lieberkühn	small submerged logs or sticks	215		12

Symbols: S = skeletal spicules
D = dermal spicules
G = gemmule spicules

TABLE II. – Lund's Pond: physical and chemical characteristics.

Date	Depth (m)	Oxygen (ppm)	Temp. (°C)	pH	TA (ppm $CaCO_3$)	PA (ppm $CaCO_3$)	CM (ppm $CaCO_3$)	C (ppm $CaCO_3$)	Silicia (ppm SiO_2)
4/24/71	0	9	13	7.5	14.9	0	9.0	7.0	1.2
	1	9	9	7.7	9.1	0	8.0	8.0	0.8
5/22/71	0	8.5	14.7	6.8	10.0	0	..	10.0	0.5
	1	7.5	12.6	6.8	14.0	0	..	7.0	0.5
7/31/69	0	6.2	20.9	5.3	24.0	..	..	..	..
	1	6.1	20.9	..	..	..	..	..	..
	3	0.0	9.8	5.3	23.0	..	..	..	..
8/10/69	0	7.7	27	5.3	17.0	..	..	..	..
	1	6.6	22.2	..	..	..	..	..	..
8/19/70	0	3.5	25	6.8	15.0	0	12.6	12.6	..
	0.3	3.8	22	6.7	14.0	0	14.8	14.8	..
10/ 4/71	0	9.05	12.8	7.6	2.0	0	3.2	3.2	1.15
	1	8.65	12.0	8.0	2.0	0	4.8	3.6	1.15

than those described in a standard classification scheme (Pennak, 1953). For example, skeletal spicules of *Tubella pennsylvanica* Potts are about 28 percent shorter than described; dermal spicules of *Spongilla lacustris* Leidy are 33 percent shorter than described; and skeletal spicules of *S. lacustris* Leidy are 10 percent shorter than described.

Closely related to calcium concentration in fresh waters is the level of bound carbonates. Total alkalinities of surface samples from Lund's Pond were low and highly variable. They ranged from 2 ppm to 24 ppm. Since low alkalinities indicate a poor carbonate buffering capacity, perhaps it is to be expected that the pH of Lund's Pond would fluctuate considerably. The pH of surface samples varied from 5.3 to 7.6. Possibly, the variable pH may account for the occurrence of these six species of sponges in a single pond. Jewell (1935) reports an optimum pH range for each species studied and refers to a small bog (Smith's Bog) with a highly varia ble sponge fauna and a pH which varied from 4.3 to 6.8 in three weeks.

Acknowledgments

The author acknowledges the work of Nancy Sather, James Wavrunek, Marjorie Collings Hall, and Roger Hermanutz for the 1969 physical and chemical determinations and construction of the depth contour map of Lund's Pond presented in this paper. The author also wishes to thank Drs. James Underhill and Donald Gilbertson of the University of Minnesota for advice and encouragement.

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