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OBSERVATIONS OF THE EXPERIMENTAL TREATMENT OF SWAN LAKE, IRON COUNTY, WITH ALGAECIDE, JULY 18, 1953

by

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The chemical that has been widely used in the control of algae in Michigan and elsewhere has been copper sulfate ($CuSO_4 \cdot 5\ H_2O$). Although it has proven to be effective in controlling certain types of algae (particularly blue-green algae), objections have been raised to the use of inorganic copper compounds because of an apparent toxicity to bottom fauna organisms (Schoenfeld, 1947; Hasler, 1947). This report records observations made of the experimental treatment of Swan Lake, Iron County, Michigan with "Cutrine", a new organic copper compound believed to be less toxic to bottom organisms than copper sulfate. This compound was developed by Dr. B. Domogalla of Butler, Wisconsin.

Mr. Joe Green of Crystal Falls, Michigan, a property owner on Swan Lake was issued the permit for treatment. Dr. Domogalla was employed to treat the lake and to furnish the necessary chemical and equipment. On July 18, 1953, 205 gallons of Cutrine were applied to 13,000 feet of shoreline. Treatment extended lakeward from the shoreline, a distance of approximately 150 feet.

The author wishes to express his appreciation to Mr. Green for the fine hospitality shown to members of the party from the Department of Conservation who were present during the treatment. The author also wishes to thank Mr. Florin Warren, District Fisheries Supervisor for his assistance in collecting water samples.

Swan Lake is located about 6 miles north of Crystal Falls, Michigan (T.43, 44N., R.33W., Secs. 2, 35). The lake appears to be a typical pit lake of glacial origin located in moraine and outwash. The surrounding area is covered with hardwood forest except for a small strip of farm land southeast of the lake. The lake has a surface area of 160 acres and a maximum depth of 20 feet. The 15-foot contour encloses roughly 60 percent of the lake area but there is very little water of greater depth. Thus the lake has a large, flat, central basin of moderate depth and narrow shoals. The slope to the 15-foot contour is abrupt along the east shore--on the west side the slope is less abrupt and portions of the bottom are covered with dense growths of pondweeds (*Potamogeton pectinatus*, *P. zosteriformis*, *P. amplifolius*).

Observations of Algae Prior to Treatment

Mr. Green reported that periodic mats of algal scum formed on the lake during the entire spring and summer of 1952. The "blooms" continued up until the lake froze in the fall. In 1953 Mr. Green did not notice an algal growth until the week of July 5-11. Rains and high water levels were believed to have prevented the algae from developing earlier in the season. During the week of July 5-11 a large part of the south shore was reported to have been covered by a thick scum of algae. By July 18 the scum had largely disappeared from the lake itself. Masses of decayed algae which had been washed up on the shore near Mr. Green's cottage could still be seen. At the time of treatment living algae were not abundant in the lake water. Surface water samples collected at several points in the lake contained an abundance of dead algal material but little living algae. Much of this material could not be identified but a large part was dead colonies of *Volvox*. The principal living plankters were *Volvox aureus*, *Pediastrum duplex*, *Ceratium hirundinella*, *Eudorina* sp., a variety of rotifers, and large numbers of *Daphnia pulex*. A surface sample collected about 200 yards north of Mr. Green's boat dock contained 2,200 *Daphnia* per liter of water. Elsewhere in the lake numbers of *Daphnia* were smaller. Samples collected near the maximum depth contained an average of 35 *Daphnia* per liter. Water containing the high concentration of *Daphnia* occurred principally at the south end of the lake. Here it could easily be recognized from a boat by its high turbidity.

Plankton Collections after Treatment

Mr. Florin Warren, District Fisheries Supervisor, collected a vertical series of water samples from the lake on July 28, 10 days after treatment. These samples indicated that there had been a rapid build-up in plankton subsequent to treatment. Surface water samples and collections made at depths of 5 and 10 feet were bright green with living algae. The predominant species was *Volvox aureus*. Over 95 percent of all the particulate organic matter of these samples was living *Volvox* colonies. The number of young daughter colonies indicated that the population was growing rapidly. Zygospores and colonies with antheridia were also numerous. *Pediastrum*, *Ceratium* and *Staurastrum* were present in low concentration.

Comparison of the ash-free dry weight of seston of one-liter water samples collected near the center of the lake before and after treatment (Table I) indicates little change in the total quantity of organic matter. A slight increase in seston is suggested at the surface and 5-foot depth. At 10 feet a significant increase is clearly indicated. Although the weight of suspended organic matter in the water changed very little, it was apparent from microscope examinations that the dead algal material had been largely replaced by living Volvox. These observations indicate that the treatment did not inhibit the growth of Volvox except perhaps temporarily.

Notes upon the Plankton Productivity of Swan Lake

Frequent algal blooms are not characteristic of lakes of this general region. Many of the lakes of this region are underlain by hard rocks and are soft water lakes of low productivity. However, lakes of moderate water hardness are not at all unusual in Iron County. The range of surface methyl-orange alkalinity of 32 lakes in Iron County for which partial or complete survey records are available is from 4 to 141 p.p.m. Sixteen lakes have alkalinities less than 40 p.p.m.; 8 lakes range between 40 and 80 p.p.m., and 7 lakes exceed 80 p.p.m. Swan Lake falls in the intermediate category of hardness; the surface alkalinity was 71 p.p.m. and is within the range of hardness of many highly productive Michigan lakes. Spring water entering the lake at the north end had an alkalinity of 85 p.p.m. The highly stained water from the small creek entering the west side of the lake (color 360 p.p.m.) measured 35 p.p.m. This appears to be intermittent swamp drainage and it gives the lake water its characteristic light-brown color (Table II). The phosphorus content of the clear spring water entering the north inlet was low (13 micrograms per liter). The brown-water drainage at the west inlet contained a moderate amount of phosphorus (26 micrograms per liter). Neither of these values are sufficiently large to suggest fertilization due to domestic drainage or pollution. The phosphorus content of the bottom water of the lake, however, was unusually high. The total phosphorus content was 103 micrograms per liter. Over half of this phosphorus was in the inorganic state and was readily available to plants. This suggests that decomposition of organic matter in the bottom water and regeneration from the bottom mud was rapid. At the time of treatment the lake was stratified but lacked a hypolimnion. Bottom water (17 feet) had a temperature of 62.6° F.; at the upper limit of the thermocline the temperature was 73.1° F. The bottom temperature indicates that partial circulation of the lake water takes place late in the spring. Very probably there is sufficient mixing after a few cool nights or following heavy winds to bring some of the bottom water into the photosynthetic zone even in midsummer. The shape of the lake basin is such that there is a comparatively large zone of decomposition closely overlying the photosynthetic water. The algal blooms are probably related to the periodic transport of the nutrient-rich water into the photic zone. The dying off of a crop of algae and the attending nuisance to property owners is very likely related to exhaustion of nutrients during periods of warm-calm weather. Raising the water level of the lake would tend to isolate more of the nutrient-rich bottom water and thus reduce the incidence of summer algal blooms. Deepening of the extensive zone below the 15-foot contour 5 feet or more would prevent much of the nutrient from reaching the photosynthetic zone except during the spring and fall, provided the wind-effective length at the new water level was not much greater than at present. If algaecide is to be used, treatments should be made early in spring before the spring pulse begins. Treatment at the height of a bloom is not likely to be very effective and will in itself create a nuisance. The present data indicate that treatment following a bloom, at the concentration employed, does not prevent rapid recovery of *Volvox*.

Literature Cited

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INSTITUTE FOR FISHERIES RESEARCH

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Table I

Ash-free dry weight of seston, Swan Lake

before and after treatment with algaecide.

	BEFORE TREATMENT July 28, 1953				AFTER TREATMENT July 28, 1953		
Depth	Surface	5 feet	8 feet	10 feet	Surface	5 feet	10 feet
Ash-free Dry wt., milligrams per liter	4.6	3.8	3.0	2.0	4.8	4.1	4.4

Table II

Physical and Chemical Data, Swan Lake
July 18, 1953

Station	Depth in ft.	Temp. °F.	Oxygen p.p.m.	Free CO_2 p.p.m.	Methyl orange alkalinity p.p.m.	Soluble phosphorus Micrograms per liter	Total phosphorus Micrograms per liter	Color p.p.m.
Lake	sfc.	75.2	6.1	0.1	71.0	3	12	88
"	5	73.5						
"	8	73.1	6.0		75.0			
"	10	69.1	4.2					
"	12	68.2	1.0		80.0			
"	15	66.2						
"	17	62.6	0.8	20.0	91.1	66	103	90
North Inlet [1]	sfc.	48			85.0	4	13	20
West Inlet [1]	sfc.	70			35.0	2	26	360

[1] July 28, 1953.