mortality of fishes resulting from the decomposition of algae in the Yahara River, Wisconsin. Trans. Amer. Fish Soc. 75:175-180.
McLaughlin, J. J. A. 1956. The physiology and nutritional requirements of some chrysomonads. Ph.D. Thesis N. Y. Univ. Library: 71 pp.
Olson, T. A. 1952. Toxic plankton. Water Sewage Works 99(2):75-77.
Palmer, C. M. 1959. Algae in water supplies. U. S. Public Health Service Publ. No. 657:1-88.
Ray, S. M. and W. B. Wilson. 1957. Effects of unialgal and bacteria-free cultures of *Gymnodinium brevis* on fish. U.S.F. & W. S. Fish. Bull. 57 (123): 469-496.
Rose, E. T. 1953. Toxic algae in Iowa lakes. Proc. Iowa Acad. Sci. 60:738-745.
Shilo, M. and M. Aschner. 1953. Factors governing the toxicity of cultures containing the phytoflagellate *Prymnesium parvum* Carter. Journ. General Microbiol. 8(3): 333-343.
Wheeler, R. E., J. B. Lackey and S. Schott. 1942. A contribution on the toxicity of algae. U. S. Pub. Health Rep. 57(45):1695-1701.

THE PENETRATION OF LIGHT AND THE CONCENTRATION OF DISSOLVED OXYGEN IN FERTILIZED POND WATERS INFESTED WITH *MICROCYSTIS*

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ABSTRACT

Weekly measurements were made of light intensity, dissolved oxygen concentration, and water temperature at selected depths in five earthen experimental ponds. Measurements were made on a given pond on the same day between 7:00 a.m. and 8:45 a.m. and again between 10:00 a.m. and 11:45 a.m.

The depth at which the average light intensity, as measured with submersible Weston Photronic photoelectric cells, was less than 1 per cent incident radiation varied from 2.5 to 7.5 feet among the ponds, depending on the degree of *Microcystis* infestation. Generally, at depths where the average light intensity was not in excess of 1 per cent incident radiation, the average dissolved oxygen concentration was not in excess of 1 ppm. The average dissolved oxygen concentration in the pond with the most dense growth of *Microcystis* was usually less than 1 ppm. below 5 feet and less than 1 ppm below 7.5 feet in the ponds with the least amount of *Microcystis*.

Generally, the decrease in water temperature with increased depth was directly related to the abundance of *Microcystis*.

This study suggests that dense growths of scum-forming algae, such as *Microcystis*, limit the water depth at which the dissolved oxygen concentration is in excess of 1 ppm by limiting light penetration and by contributing to thermal stratification by heat absorption in the dense blooms near the water surface.

INTRODUCTION

In Alabama, fertilization of farm ponds has been advocated since the early work of Smith and Swingle (1939, 1941, 1942) and Swingle (1947). The application of inorganic fertilizers has been advantageous not only for increasing fish production but also in controlling obnoxious growths of submersed aquatic vegetation by inducing abundant growths of phytoplankton.

In contrast, the death of fish has been attributed to the depletion of oxygen caused by death and decay of dense growths of phytoplankton

(Smith and Swingle, 1939). Ponds located on the Agricultural Experiment Station, Auburn, Alabama, have been infested with the blue-green algae, *Microcystis* spp., for several years. The detrimental effects of heavy algal blooms, especially blue-green algae, have been variously reported (Tilden, 1929; Domogalla, 1935; Woodbury, 1942, and Rose, 1953).

Phytoplankton photosynthesis contributes significantly to the dissolved oxygen content in bodies of water. In turn, photosynthesis in the microscopic plants depends on the intensity, quality, and duration of light received. The extent to which dense growths of phytoplankton retard light penetration in fertilized farm ponds was unknown. Information concerning the relation between the depth of light penetration and the presence of dissolved oxygen was also unknown. Consequently, this investigation represented a preliminary effort to study the effect of varying amounts of *Microcystis* on light penetration into farm ponds and to determine the relationship between light penetration and dissolved oxygen content.

MATERIALS AND METHODS

Five earthen fish ponds located on the Agricultural Experiment Station, Auburn University, Auburn, Alabama, were studied. On each of four ponds (S-1, S-6, S-8 and S-14), a pier extending into the pond from the dam was utilized as a data collection station. In the fifth pond (S-3), the data were collected from a boat. Physical data on these ponds are as follows:

Pond No.	Surface area in acres	Average depth in feet	Water depth at station in feet
S- 1	22	6	12.5
S- 3	9.75	5.6	12.5
S- 6	25.5	5.9	15
S- 8	10.7	6	10
S-14	12.4	6	10

Ponds S-1, S-3, and S-6 were fertilized ponds. In addition, pond S-1 received daily applications of pelleted fish feed. Ponds S-8 and S-14 received daily applications of fish feed, but they did not receive inorganic fertilizer during the last two years.

Surface light intensity was measured with a Weston model 756 sunlight illumination meter with quartz filter and ranges of 0-120/1,200/-12,000 foot-candles. Surface and subsurface light intensities were measured with 3 hermetically sealed Weston type 3 Photronic photoelectric cells mounted on a bakelite plate and enclosed in a waterproof housing. The housing was mounted on the base of a 23-inch triangular frame made from 7/16-inch aluminum rod. The photocells were mounted in series and connected by 25-foot wire leads to a Weston D. C. microammeter, model 622, with ranges 0-200/500/1,000 microamperes.

A 10-foot boom of 2-inch aluminum tubing was used to support the photocell mount. At one end of the boom was mounted a boat-winch containing 25 feet of ¼-inch nylon rope that was threaded through the tubing and secured to the triangular frame with a swivel snap. This same end of the boom was attached to an adjustable bracket for mounting on a boat transom.

An oxygen-temperature meter constructed by Sneed and Dupree was used for determination of dissolved oxygen concentration and temperature (Sneed and Dupree, 1962). The electrode was covered with a 1 mil polyethylene membrane.

During August and September, 1961, measurements of light intensity, dissolved oxygen concentration, and temperature were made at weekly intervals in each of the five ponds at depths of 0.5, 1.0 and 2.5 feet and at intervals of 2.5 feet thereafter. On a given day measurements were made on the same pond between 7:00 a.m. and 8:45 a.m. and again between 10:00 a.m. and 11:45 a.m.

RESULTS

The data obtained for light intensity, dissolved oxygen concentration, and temperature at various depths are reported as averages for each pond for either the early or late morning sampling period (Tables 1, 2, 3). It is pointed out that the data were obtained during various conditions of cloud cover ranging from overcast to clear.

The average *Microcystis* colony count per milliliter was as follows:

S- 1	28,867
S- 3	6,967
S- 8	3,750
S- 6	733
S-14	416

Table 1. Average Surface Light Intensifies as Foot-Candles and Average Light Intensities As Per Cent Incident Radiation In Five Farm Ponds

Depth	S-1		S-6		S-3		S-8		S-14	
(Feet)	A(1)	B	A(1)	B	A(1)	B	A(1)	B	A(1)	B
Surface(3)	2,636	5,210	4,320	7,740	3,450	9,200	4,050	7,640	3,610	10,140
0.5(4)	25.6	31.6	77.1	75.5	65.0	79.6	60.9	68.5	64.9	80.9
1.0(4)	6.8	8.0	58.6	63.3	41.4	61.2	32.4	42.2	46.3	62.9
2.5(4)	0.5	0.4	31.0	35.1	13.6	28.0	9.2	9.5	22.8	29.8
5.0(4)	—(2)	—	10.6	12.1	2.2	4.4	1.1	1.2	7.2	9.4
7.5(4)	—	—	3.5	2.3	0.4	0.9	0.1	0.1	1.9	2.1
10.0(4)	—	—	0.2	0.5	0.1	0.5	—	—	0.2	0.2
12.5(4)	—	—	—	—	—	—				

(1) A. Measurements made 7:00-8:45 A.M.
B. Measurements made 10:00-11:45 A.M.
(2) Values less than 0.1 percent incident radiation not recorded.
(3) Surface light intensity in foot-candles.
(4) Percent incident radiation under conditions of given surface foot-candles of light intensity

Table 2. Average Dissolved Oxygen Concentration (PPM) In Five Farm Ponds

Depth	S-1		S-6		S-3		S-8		S-14	
(Feet)	A(1)	B	A(1)	B	A(1)	B	A(1)	B	A(1)	B
0.5	5.6	9.8	6.6	7.7	6.1	8.0	7.5	9.3	7.1	9.0
1.0	5.5	9.1	6.6	7.7	6.0	7.8	7.4	8.9	7.0	8.8
2.5	5.4	7.1	6.6	7.6	5.8	7.1	7.2	8.4	6.3	8.2
5.0	2.5	2.3	6.3	7.1	3.6	5.0	4.7	4.3	5.4	6.1
7.5	0.4	0.4	5.3	3.5	0.6	0.6	0.4	1.3	1.5	1.9
10.0	0.3	0.1	0.7	0.5	0.3	0.4	0.2	0.2	0.2	0.2
12.5	0.1	0.1	0.2	0.2	0.2	0.2				

(1) A. Measurements made 7:00-8:45 A.M.
B. Measurements made 10:00-11:45 A.M.

Table 3. Average Temperatures (°F) In Five Farm Ponds

Depth	S-1		S-6		S-3		S-8		S-14	
(Feet)	A(1)	B	A(1)	B	A(1)	B	A(1)	B	A(1)	B
0.5	80.4	85.4	81.8	83.3	81.1	84.2	82.0	85.6	82.0	84.4
1.0	80.2	84.7	81.8	83.1	81.1	83.6	82.0	85.4	82.0	84.0
2.5	80.2	82.2	81.8	82.9	81.1	81.8	82.0	84.0	81.9	83.1
5.0	79.5	79.2	81.5	81.8	80.1	80.4	81.0	81.0	81.1	81.9
7.5	76.6	77.0	80.8	80.4	78.1	77.9	78.4	78.4	79.3	80.0
10.0	73.4	73.8	76.6	77.0	71.1	71.6	75.7	75.7	73.2	73.2
12.5	70.3	71.0	71.1	71.0	64.8	64.8				

(1) A. Measurements made 7:00-8:45 A.M.
B. Measurements made 10:00-11:45 A.M.

In the most heavily infested pond, S-1, average light intensity was less than 1 per cent incident radiation at 2.5 feet, whereas in the least infested ponds, S-6 and S-14, average light intensity was in excess of 1 per cent incident radiation at 7.5 feet. Average light intensity was in excess of 1 per cent incident radiation at 5 feet in ponds S-3 and S-8, which were intermediate in *Microcystis* infestation.

This decrease in depth of light penetration with increased abundance of *Microcystis* was generally paralleled by a corresponding decrease in dissolved oxygen content. The average dissolved oxygen content was in excess of 1 ppm at 7.5 feet in the two ponds containing the smaller amounts of *Microcystis*, S-6 and S-14, but was below 1 ppm at the same depth in the other ponds. The implication is not made that the presence of light *per se* would have resulted in increased dissolved oxygen concentration at a specific depth at a given time. Individual observations of light intensity ranging from 18 to 200 foot-candles were occasionally made in ponds S-3, S-6, S-8, and S-14 at depths where the dissolved oxygen concentration was less than 1 ppm. Conversely, in S-1 the average dissolved oxygen concentration was above 2 ppm at 5 feet, yet the average per cent incident radiation was less than 1. Obviously, the presence or absence of oxygen at a given depth and time would not depend on the light intensity value measured at the same time but rather upon the depth of water circulation and the light received during the preceding hours.

A comparison between the average dissolved oxygen concentration of the early and late morning sampling periods in each pond showed that in S-1, the most heavily infested pond, the average dissolved oxygen concentration increased 2.7, 3.6 and 4.2 ppm at depths of 2.5, 1.0 and 0.5 feet, respectively. In the other ponds no change was greater than 1.9 ppm at these same depths. Thus, it would seem that a very dense growth of a scum-forming alga such as *Microcystis* tends to increase the dissolved oxygen in the surface waters and at the same time limits light penetration to the greater depths, which may result in decreased dissolved oxygen concentration by retarding the photosynthetic process.

A comparison of temperature differences in the ponds reveals a second general effect of *Microcystis*. As might be expected the average temperature at a given depth usually increased from the early to late morning sampling period. The greater temperature increases occurred at depths of 0.5 and 1.0 feet in all ponds and the magnitude of increase was apparently directly related to the abundance of *Microcystis*. In pond S-1, the average temperature increased 4.5°F. and 5.0°F. at depths of 1.0 and 0.5 feet, respectively, but in ponds S-6 and S-14, which contained less *Microcystis*, the increase was less than 2.5°F. at either depth. In ponds of moderate infestation, S-3 and S-8, intermediate temperature increases were recorded.

This increase in temperature in the upper foot of water during the course of a day would in turn result in greater temperature differences between the upper and lower strata of water, which would retard the circulation of water in the pond. Thus, in ponds S-6 and S-14 in which the dissolved oxygen concentration was in excess of 1 ppm at 7.5 feet, the difference in temperature between 0.5 and 7.5 feet was 2.9°F. and 4.4°F., respectively. In ponds S-1, S-3, and S-8 in which the dissolved oxygen concentration was not in excess of 1 ppm at 7.5 feet, the temperature difference was in excess of 7°F.

Exact physical and chemical conditions responsible for dense blooms of *Microcystis* are unknown. However, in this study the greatest infestation of *Microcystis* apparently occurred in a pond that received both inorganic fertilizer plus supplemental fish feed (organic fertilization).

LITERATURE CITED

Domogalla, Bernard. 1935. Eleven years of chemical treatment of the Madison lakes; its effects on fish and fish ponds. Trans. Amer. Fish. Soc., 65:115-121.

Rose, Earl T. 1953. Toxic algae in Iowa lakes. Proc. Iowa Acad. Sci., 60:738-745.
Smith, E. V. and H. S. Swingle. 1939. The relation between plankton production and fish production in ponds. Trans. Amer. Fish. Soc., 68(1938):309-315.
____________________. 1941. The use of fertilizer for controlling the pond weed, *Najas guadalupensis.* Trans. 6th N.A. Wildlife Conf. :245-251.
____________________. 1942. The use of fertilizer for controlling several submersed aquatic plants in ponds. Trans. Amer. Fish. Soc., 71(1941):94-101.
Sneed, Kermit E. and H. K. Dupree. 1962. An electrical oxygen-temperature meter for fishery biologists. Spec. Sci. Report—Fisheries No. 426, U. S. Fish and Wildl. Serv. 13 pp.
Swingle, H. S. 1947. Experiments on pond fertilization. Ala. Poly. Inst. Agr. Expt. Sta. Bulletin No. 264: 34 pp.
Tilden, Josephine E. 1929. Plant material and debris: the algal food of fishes. Trans. Amer. Fish. Soc., 59:178-187.
Woodbury, Lowell A. 1942. A sudden mortality of fishes accompanying a supersaturation of oxygen in Lake Waukesa, Wisc. Trans. Amer. Fish. Soc., 71(1941):112-117.

AN INTERIM REPORT ON THE USE OF HORMONES TO OVULATE STRIPED BASS (*Roccus saxatilis*)

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ABSTRACT

A total of 429 female striped bass were treated with hormones during the spring spawning seasons of 1962 and 1963. Of this number, 118 (26.6%) were induced to ovulate while held captive. One hundred of the ovulated fish were treated with chorionic gonadotropin while used alone or in combination with other preparations. Eighteen of the ovulated fish were treated with follicle stimulating hormone while used alone or in combination with preparations other than chorionic gonadotropin.

Fry production amounted to 2.6 million in 1962 and 13.8 million in 1963. All of the fry were stocked in the major reservoirs of South Carolina except the Santee-Cooper Reservoir.

INTRODUCTION

Within the past decade several southeastern states, including South Carolina, have attempted to establish a population of striped bass in large impoundments. This activity was prompted by the spectacular success that striped bass had in establishing themselves in the Santee-Cooper Reservoir in South Carolina (Stevens 1957). This population not only serves as an excellent food and game fish but also effectively controls gizzard shad (*Dorosoma cepedianum*) through predation.

Despite repeated stocking of adult and sub-adult striped bass in the other large reservoirs of South Carolina, no population has developed. It has been tentatively concluded that the reservoirs of South Carolina, other than Santee-Cooper, do not provide the spawning requirement