

AN EPIDEMIC AMONG THE FISHES OF HUFFMAN'S LAKE.

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This paper describes an epidemic among the fishes in Huffman's lake during October and November, 1917. The data indicate that these fish died from poison which was derived from a blue-green algæ, either by its metabolism or decay.

Huffman's lake is located in Kosciusko County, Indiana, (Tp. 33 N., R. 5 E.) about one mile northwest of Atwood. It is just west of the Erie-Saginaw interlobate moraine and lies in a slight depression of the ground moraine. It is roughly oval in outline. Its greatest length is about one mile and its greatest width is about one-half mile. Its longitudinal axis extends north and south. Near the middle of the lake there are three small islets situated along the major axis of the lake. Its maximum depth is 9.8 meters.

The land surrounding the lake is low. Much of it near the shore is marshy. To the east, a short distance, the rougher topography of the interlobate moraine begins. The lake is therefore quite exposed to the action of the wind especially to the south, west, and north.

Dead and dying fish were first noted in large numbers after a storm that occurred on October 29th. This storm left a distinct wave deposit some distance above the normal lake level. On November 16 the fish were counted in several sections of this deposit. The average was about one fish per lineal foot of deposit. Six species were collected and identified, bluegill, (*Lepomis pallidis* Mitchill); large mouthed black bass (*Micropterus salmoides* Lacépède); calico bass (*Pomoxis sparoides* Rafinesque); sucker (*Catostomus commersonii* Lacépède); hickory shad (*Dorosoma cepedianum* Le Sueur), and yellow perch (*Perca flavescens* Mitchill).

One hickory shad was identified struggling on its side near the center of the lake. It was able to avoid a dipnet and escape. Near the shore, two rock bass and five bluegills were taken swimming slowly on

* I am under obligation to Mr. Chauncey Juday for identifying the alga, to Mr. J. H. Armington for the Winona Lake temperatures, and to Mr. S. L. Blue who made the field work possible.

their sides. Several small bluegills, that were still alive, were picked up stranded at the edge of the water.

Nothing is known of the summer conditions of this lake. The autumnal overturn in Eagle Lake (Winona) takes place the latter part of November. It seemed possible that there might be a deficiency in oxygen in the lower levels of the lake that was killing the fish as their actions simulated those of fish suffering from dyspnea.

An examination of the water for dissolved gases and carbonates demonstrated that the lake is a hard water lake and that there was an abundance of oxygen. (See table. 4cc. O. per liter. Temperature 6°C.) The fall overturn had taken place but the water was only about half saturated. It is barely possible that the first fish to die may have died from dyspnea, although this is not likely on account of the shallowness of the lake, the contour of its bottom, and its exposure to the wind. It is certain that the fish that were dying in November were not suffering from the lack of oxygen.

TABLE OF TEMPERATURES AND DISSOLVED GASES.

	T.	O.	C _g Sat.	CO ₂	Cb.
Surface	6.9	4.09	49%	1.51	42.72
2 M	6.9				
Bottom	6.9	4.06	47%	1.26	42.72

Air temperature 10°C.

Secchi's disc reading .9 M.

Gases expressed in cc. per liter. Cb. is CO₂, as carbonate.

The fish were examined very carefully for infections, sporozoan and bacterial, but the tissues showed no lesions or postules. The anus, nares, mouth, and gills were examined with especial care. There was no indication of gas disease.

It has been suggested that the lake might have been dynamited. There were no ruptured blood-vessels to indicate that the fish had suffered from concussion. Moreover, the fish were dying during a period of more than six weeks, a fact that would preclude their having been killed by a single charge of explosive.

The only phenomenon that could be associated with the death of the fishes as a causal factor was a tremendous growth of blue green alga *Oscillatoria prolifica* (Grenville) Dumont. This alga occurred near

the surface of the lake in enormous quantities. It was difficult to make a quantitative estimate of it by the ordinary limnological methods on account of the wind drifting it. Some notion of its abundance may be gained from the following observations:

At 10:00 a.m. there was still a very heavy fog on the lake. When rowing to the center of the lake the water appeared pink when disturbed by the oars, and in the wake of the boat. By 3:00 p.m. a slight breeze had drifted the algæ in a solid scum along the east side of the lake. In the bays this scum reached a thickness of 4-6 mm. The alga when concentrated in this scum had a rather dark brick-red appearance.

That the alga caused the destruction of the fish is probable on account of two facts. First, it is the only associated extraordinary phenomenon. This is of course only presumptive. Second, certain blue-green algæ (cyanophycæ) seem to produce substances, either by their metabolism or decay, which when concentrated are toxic to vertebrates, and may even cause death.

Arthur ('83) reports two instances in which cattle were poisoned by drinking water that was covered with a thick scum of blue-green alga (*Rivularia fluitans* Cohn).

Nelson ('03) after discussing the cyanophycæ that cause "water bloom" closes with these words: "In several instances it has been almost conclusively proved that the presence of one or more of these species in drinking water used by stock has caused fatal results."

CAUSE OF THE EXCESSIVE GROWTH OF ALGÆ.

This lake has been under the observation of Mr. Maurice Miller for thirty-two years. He reports that this autumn (1917) is the first time that a red scum has appeared.

Olive ('05) identified this algæ from the ice in Pine Lake (Wisconsin), where there evidently had been a considerable growth just before the lake froze.

Red pigment is very characteristic of the plankton of arctic and alpine regions (Steuer 1910, pp. 277-8). The red coloration of lakes and ponds in the Swiss Alps seems to be a rather common phenomenon.

Brunn ('80) reports the ice on Lake Neuchatel being colored red with a growth of *Pleurococcus palustris* Kützigg. He also refers to the

freezing of Lake Morat in 1825 in which the ice was colored by *Oscillatoria rufescens*.

Klausener ('08) made a study of the so-called "Blutseen" of the High Alps. Most of these were colored by *Euglena sanguinea* Ehr.

TABLE SHOWING THE MEAN TEMPERATURES FOR OCTOBER AND NOVEMBER, DURING THE DECENNIOUM 1908-1917.

Station: Winona Lake, ten miles from Huffman's Lake.

YEAR.	October.	November.
1908	54.6	42.1
1909	49.6	48.4
1910	57.2	35.8
1911	53.0	36.2
1912	54.8	41.4
1913	53.4	45.7
1914	56.7	41.9
1915	54.0	42.8
1916	53.0	41.4
1917.	44.0	39.0
Mean	53.0	41.5

The appended table of temperatures* indicates that the mean for October, 1917, was 5.6 degrees F. lower than for any other October in the ten years preceding, and 9 degrees F. colder than the mean for this decennium. This means that the lake was cooled early in the autumn and remained at a rather low temperature for six to eight weeks instead of the normal, much shorter, period. That is, arctic conditions maintained in this lake for nearly two months. This is, I think, one of the factors that caused this alga to develop so luxuriantly.

Against this view, are the observations of Hyams and Richards ('01, '02, '04), and others on *O. prolifica* in Jamaica Pond. Here the maxima occurred in the warmer months, although a dense growth often developed just before the ice formed.

In the present state of our knowledge it is impossible to harmonize these observations with those on the so-called "blood lakes" of the Alps, those of Olive (loc. cit.) and the ones here presented on Huffman's lake.

Brunn ('80) suggests the presence of iron compounds as one of the conditions for the development of red pigment in the blue-green algæ. This condition is satisfied by the large amounts of iron oxide in the affluent springs at its margin.

* These temperatures are for the Winona Lake Station, which is about 10 miles east of Huffman's Lake.

REMAINING PROBLEMS.

It remains to be determined experimentally whether or not this alga produces a toxin, the nature of the toxin, the action of the toxin on fishes, etc.

A much more difficult problem is to determine the exact condition under which this alga will develop. If this alga reappears this problem will be attacked.

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