CHLOROPHYLL *a* IN THE ILLINOIS RIVER

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ABSTRACT. — Chlorophyll *a* in the Illinois River near Peoria was measured during the summer and fall of 1966. Highest chlorophyll *a* concentration observed was 0.496 mg/liter on 7 July 1966.

The effect of enrichment on the biota of the Illinois River by effluent from industrial and domestic wastes is well documented (Mills, Starrett and Bellrose, 1966). In 1963, it was estimated that a BOD population equivalent of 1,170,000 was being discharged into the river or its tributaries above Peoria. As a result, phosphorus concentrations at Peoria were observed to be among the highest of 128 sampling stations (Public Health Service Water Pollution Surveillance System, 1963). A comparative study of 103 stations on the major rivers and Great Lakes of the United States by Williams (1964) revealed that the Illinois River at Peoria exhibited low phytoplankton diversity coupled with extremely high phytoplankton counts.

Chlorophyll *a* concentration in the Illinois River was determined during the summer and fall of 1966. The concentration of this substance was measured to determine the effect of organic enrichment on the phytoplankton and to establish a base line for further studies. Organic enrichment of the Illinois River should allow support of large standing crops of phytoplankton. As a result, chlorophyll *a* concentration should be higher than that in a river not receiving organic effluent. In effect, chlorophyll *a* is being used as an indicator of organic enrichment. The term chlorophyll *a* is equivalent to chlorophyll "A" as used by Odum, McConnell and Abbott (1958) and refers to . . . . "an extractable pigment fraction defined spectrophotometrically. It is recognized that more than one chemical entity may be involved."

PROCEDURES

Ten stations along an eight mile reach of the Illinois River near Peoria were selected for study. Stations were numbered by miles upstream from the Mississippi River (FIG. 1). The upper station was located in the lower end of upper Peoria Lake while the lower station was located below the city. Water depth at all stations was relatively shallow and ranged from two to four meters during the study.

Water samples were taken from the surface approximately once each week from each station between 17 June 1966 and 30 November 1966. Aliquots of 100 ml were filtered through membrane filters of 0.45 micron pore size for chlorophyll analysis. The residues, consisting of algal cells and other particles, were extracted in 10 ml of 90% acetone and refrigerated in the dark at approximately 5C for 24 hours. Upon removal, the samples were centrifuged and optical density of the liquid was determined with a Bausch and Lomb Spectronic 20 photoelectric colorimeter with a 2.54 cm cuvette at 665 millimicrons.

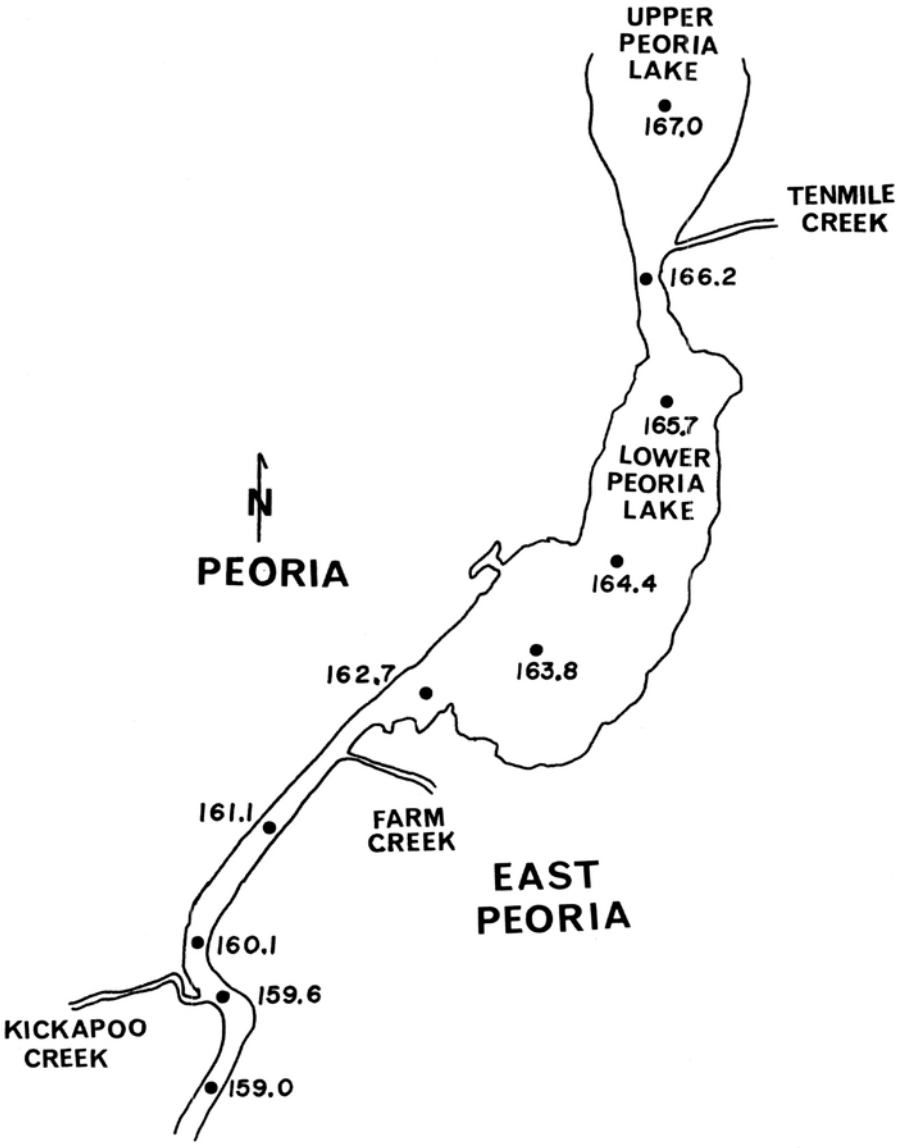

FIGURE 1.—Map of Illinois River near Peoria. Station locations indicated by numerals.

The methods of Odum et al. (1958) were used to estimate chlorophyll *a* concentration where chlorophyll *a* in mg/liter of 90% acetone = 13.4 d_{665}. After correction for acetone and sample volumes this equation became:

Chlorophyll *a* in mg/liter = 1.34 d_{665}

Water temperature and dissolved oxygen were measured in the field according to standard methods. Turbidity was determined in the laboratory by the use of a Bausch and Lomb photoelectric

colorimeter with a 2.54 cm cuvette at d_{450}. The pH was measured by means of a portable Sargent pH meter.

Results and Discussion

Dominant photosynthesizing organisms collected during this study were *Melosira* sp., *Stephanodiscus* sp., *Nitschia* sp., *Cyclotella* sp., *Ankistrodesmus* sp. and *Scenedesmus* sp. The highest chlorophyll *a* concentration observed during the study was 0.496 mg/liter at Station 166.2 on 7 July 1966 (Table 1). Chlorophyll concentration was highest during the summer months when sunlight and water temperatures were maximum. Chlorophyll concentration in oil refinery effluent holding ponds was also greatest during late spring and summer when the water was warmer and sunlight more intense (Copeland, Minter and Dorris, 1964).

Chlorophyll concentration is also apparently dependent upon the amount of available nutrients (Odum *et al.,* 1958). Bacterial degradation of organic materials in the Illinois River could proceed more rapidly during warmer months and thus release nutrients to the photosynthesizing organisms at a faster rate than during colder months. Copeland *et al.* (1964) reported maximum chlorophyll in an oil refinery effluent holding pond located nearest the effluent source during late June and early July. They concluded that large amounts of nutrients were available earlier in the pond system at higher temperatures.

The same combination of environmental factors encountered in the study of oil refinery effluent holding ponds was undoubtedly responsible for higher chlorophyll readings in the Illinois River during summer. In addition, however, turbidity was considerably lower during summer than fall (Table 2). Turbidity refers to the degree of opaqueness produced in water by suspended particulate matter (Reid, 1961). In the Illinois River,

Table 1.—Chlorophyll *a* Concentration in the Illinois River

Station	Summer*		Fall**	
	Range (mg/1)	Mean ± SD (mg/1)	Range (mg/1)	Mean ± SD (mg/1)
167.0	0.035—0.335	0.192±0.097	0.065—0.174	0.132±0.034
166.2	0.052—0.496	0.204±0.147	0.065—0.174	0.138±0.034
165.7	0.037—0.335	0.133±0.085	0.065—0.164	0.122±0.032
164.4	0.060—0.295	0.134±0.064	0.070—0.189	0.127±0.039
163.8	0.080—0.288	0.149±0.057	0.065—0.150	0.124±0.026
162.7	0.042—0.348	0.172±0.075	0.065—0.217	0.140±0.042
161.1	0.052—0.268	0.137±0.060	0.065—0.201	0.120±0.051
160.1	0.040—0.335	0.188±0.094	0.070—0.174	0.131±0.034
159.6	0.038—0.415	0.167±0.093	0.070—0.261	0.145±0.060
159.0	0.032—0.375	0.150±0.107	0.070—0.173	0.121±0.033

* Data based on 10 samples per station.
** Data based on 8 samples per station except for Station 167.0. This Station was sampled 7 times.

TABLE 2.—Mean Physico-Chemical Conditions

Station	Temperature C		Oxygen (ppm)		Turbidity (ppm)		pH	
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
167.0	27.5	12.4	6.5	8.6	45	76	7.8	7.5
166.2	27.1	12.4	6.3	8.3	55	86	7.8	7.6
165.7	26.7	12.4	6.1	8.3	47	73	7.9	7.8
164.4	26.7	12.7	5.8	8.5	46	71	7.7	7.9
163.8	26.8	12.7	5.7	8.7	47	72	7.9	7.7
162.7	27.0	12.5	7.3	8.5	47	72	7.9	7.9
161.1	26.9	13.4	5.4	7.8	52	71	7.8	7.8
160.1	26.8	13.1	4.6	8.2	53	74	7.8	7.8
159.6	26.6	13.1	4.6	8.1	50	85	7.6	7.6
159.0	27.2	13.1	4.6	8.4	48	76	7.7	7.7

this condition is attributed primarily to a heavy silt load.

Effluents entering the Illinois River at Peoria had little immediate effect on chlorophyll concentration. Bacterial degradation apparently does not proceed rapidly enough to provide large quantities of additional nutrients for the phytoplankton in the immediate area. Evidence that some degradation of organic materials occurred as the water mass passed Peoria is shown by the decrease in dissolved oxygen at downstream stations during summer (TABLE 2). During fall, however, degradation apparently proceeded at a much slower rate since all stations exhibited approximately the same dissolved oxygen concentrations. Nutrients added to the river at Peoria and Pekin are moved downstream to the La Grange pool and provide even greater enrichment. As a result, dissolved oxygen in this pool is extremely low (Mills *et al.*, 1966).

Chlorophyll concentrations in various phytoplankton communities varies throughout the world but there is less of the pigment in unpolluted waters (Copeland *et al.*, 1964) than in the Illinois River. Bartsch and Allen (1957) reported a maximum concentration of 7.32 mg/1 of chlorophyll *a* in one sewage pond during summer. This concentration is considerably greater than the summer maximum in the Illinois River. In this same study, however, chlorophyll *a* concentrations in other sewage ponds ranged from 0.0004 mg/1 to 0.65 mg/1, quantities not too unlike the range (0.032 mg/1 to 0.496 mg/1) in the Illinois River during summer.

In a study of chlorophyll *a* in oil refinery effluent holding ponds, Copeland *et al.* (1964) reported a maximum concentration of 1.350 mg/1 during summer, a concentration approximately three times that found in the Illinois River.

Sewage ponds and oil refinery effluent holding ponds contain small volumes of water in comparison to the volume of water in the Illinois River, yet all three systems exhibit high concentrations of chlorophyll *a*. This condition is to be expected in sewage

ponds and oil refinery effluent holding ponds where highly concentrated nutrients are continuously being added. Two factors are apparently responsible for the high chlorophyll *a* concentration in the Illinois River. First, the high calcium hardness of the water apparently helps support large standing crops of phytoplankton (Williams, 1966). The second and most important reason is the enrichment caused by the presence of untreated or partially treated sewage and industrial wastes from municipalities and industries situated near the river or its tributaries.

Acknowledgment

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