Phytoplankton Communities in Channel Catfish Ponds

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Abstract: Phytoplankton communities of commercial catfish ponds in west-central Alabama were usually dominated by green algae (Chlorophyta). Blue-green algae, which were usually the dominant forms of algae in channel catfish ponds at the Auburn University Research Unit (east-central Alabama), were seldom present in great abundance in the commercial fish ponds. The pond waters in west-central Alabama had total alkalinity values of 69–148 mg/liter as $CaCO_3$ while total alkalinity values were much lower (10 to 15 mg/liter) in pond waters on the Fisheries Research Unit. Difference in total alkalinity likely resulted in the difference in proportions of blue-green algae in ponds of the 2 vicinities.

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Recent studies of channel catfish ponds on the Auburn University Fisheries Research Unit demonstrated close relationships among feeding rates, phytoplankton abundances, and the frequency and severity of low dissolved oxygen concentrations (Boyd et al. 1979*a*, Tucker et al. 1979, Hollerman and Boyd 1980). The phytoplankton communities in channel catfish ponds on the Fisheries Research Unit are often dominated by the blue-green algae *Oscillatoria, Anabaena, Spirulina, Microcystis,* and *Raphidiopsis.* In a series of 5 ponds, blue-green algae comprised an average of 50% to 95% of the phytoplankton between early July and late October (Boyd et al. 1979*a*). In a series of 37 channel catfish ponds on the Fisheries Research Unit, roughly

50% of the phytoplankters were blue-green algae, and in many individual ponds, blue-green algae greatly outnumbered other types (Boyd 1973). In commercial catfish ponds, high feeding rates also result in abundant phytoplankton growth and deterioration of water quality (Boyd et al. 1979*b,* Boyd 1982). Because of the studies mentioned above, many fish farmers and biologists assume that blue-green algae are the dominant phytoplankters in commercial channel catfish ponds in other areas of the Southeast. Furthermore, because of many popular references to the undesirable characteristics of blue-green algae in reservoirs and natural bodies of water, there is also a tendency to consider blue-green algae less desirable than other forms of algae in channel catfish ponds.

During a recent study of off-flavor in channel catfish from fish farms in west-central Alabama (Brown and Boyd 1982), data were collected on the composition of phytoplankton communities in these ponds. Although Brown and Boyd (1982) reported a surprisingly low proportion of blue-green algae in the channel catfish ponds, they did not present a thorough treatment of the phytoplankton data. Hence, the purpose of the present study is to assess the phytoplankton communities in commercial catfish ponds in west-central Alabama and to compare the findings with those reported earlier for channel catfish ponds at the Auburn University Fisheries Research Unit in east-central Alabama.

Methods

The 17 ponds used in this study were located on 3 channel catfish farms in west-central Alabama. Ponds (1.0 to 8.0 ha) were stocked with 7,400 to 12,400 fingerlings in February and March 1980. Feeding rates were gradually increased as fish grew. Ponds were divided into 2 feeding rate groups; low (maximum of 19-40 kg feed/ha/day) and high (maximum of 56-132 kg feed/ha/day). Ponds were filled either with water from wells or with runoff from wooded watersheds.

Single samples of water were collected from ponds on 8 dates between 20 April 1980 and 1 November 1980. Phytoplankton were preserved with merthiolate. After phytoplankton had settled to the bottoms of 1-liter containers, supernatants were siphoned off and phytoplankters in the concentrates were identified to genus and counted with aid of Sedgwick-Rafter counting cell (Am. Public Health Assoc. et al. 1975). Blue-green algae are known to float; however, examination of the supernatants revealed no blue-green algae. Hence, the sedimentation technique was reliable.

Results and Discussion

All ponds were managed according to the individual practices of their owners. Feeding schedules often were interrupted because of low dissolved

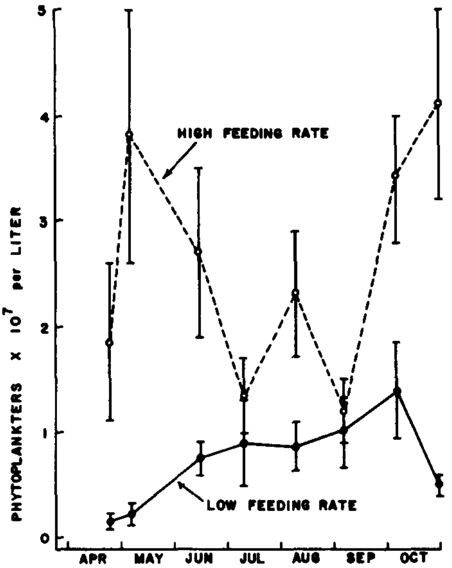

Figure 1. Average abundances of phytoplankton in channel catfish ponds. Ten ponds had maximum daily feeding rates of 56–132 kg/ha/day (high) and 7 had maximum daily rates of 19–40 kg/ha/day (low). Vertical bars indicate 2 standard errors.

oxygen, fish diseases, or other reasons. Several ponds were treated with hydrated lime, copper sulfate, and potassium permanganate. Emergency aeration was employed in ponds when dissolved oxygen concentrations were low. It was not possible to get complete records of management practices from pond owners; however, observation and discussions with pond owners indicated that water quality problems, especially low dissolved oxygen concentrations, were common in many of the ponds and particularly in ponds with high feeding rates.

The average abundances of phytoplankters were usually greatest in ponds with high feeding rates (Fig. 1). This observation is in agreement with earlier work by Tucker et al. (1979) which showed that high feeding rates favored the growth of phytoplankton.

For ponds with low feeding rates, blue-green algae (Cyanophyta) were, on the average, more numerous than other types of algae from April to June (Fig. 2), but afterwards, green algae (Chlorophyta) were the most abundant. Green algae had greater average abundances than other algae on all sampling dates in ponds with high feeding rates (Fig. 3). Yellow greens (Chlorophyta), euglenoids (Euglenophytes), and dinoflagellates (Pyrrophyta) never had high average abundances, but in some individual ponds, these forms were occasionally quite numerous.

The number of genera of phytoplankters and the diversity (diversity = [number of genera − 1] ÷ $\log_e$ number of individual phytoplankters) were usually quite high in all ponds, regardless of feeding rate. The average number of genera ranged from 10.7 to 14.7 and the average diversity varied from 0.60 to

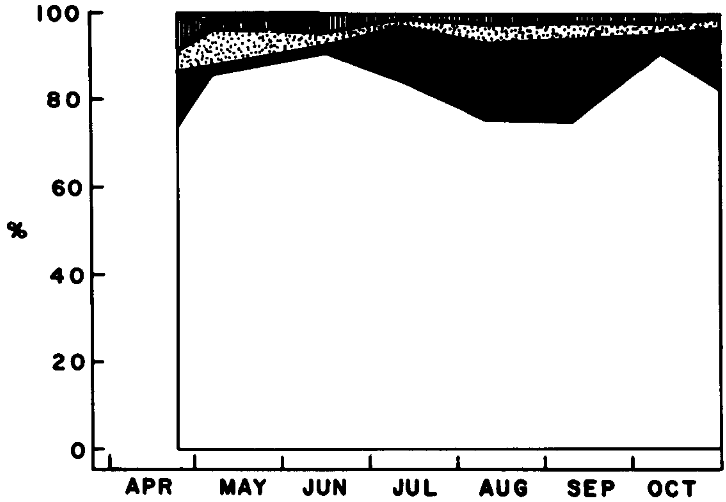

Figure 2. Average composition of phytoplankton communities by taxonomic division in 7 channel catfish ponds with low feeding rates (maximum of 19–40 kg feed/ha/day). Unshaded area = green algae (Chlorophyta), black area = blue-green algae (Cyanophyta), stippled area = euglenoids (Euglenophyta), vertically-hatched area = yellow-green algae (Chlorophyta).

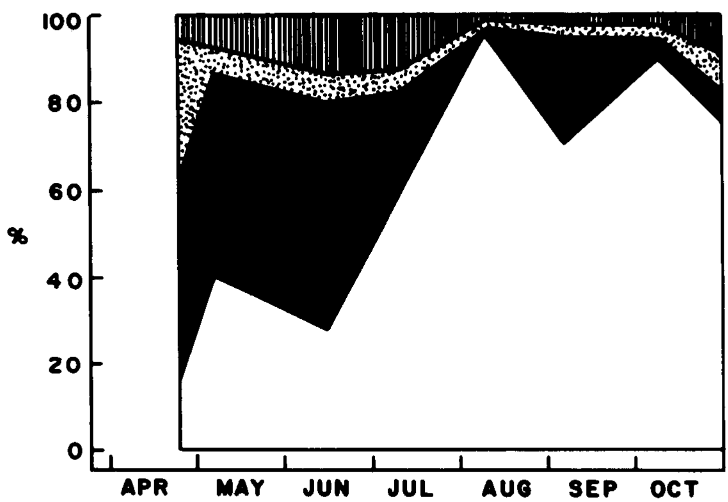

Figure 3. Average composition of phytoplankton communities by taxonomic division in 10 channel catfish ponds with high feeding rates (Maxima of 56–132 kg feed/ha/day). Unshaded area = green algae (Chlorophyta), black area = blue-green algae (Cyanophyta), stippled area = euglenoids (Euglenophyta), vertically-hatched area = dinoflagellates (Pyrrophyta).

0.94. Occasionally, 4 or 5 genera of algae would compromise almost all of the phytoplankton. More often, 4 or 5 genera were well represented in a sample and 5 or 10 more genera were present in small numbers. These findings contrast with data from channel catfish ponds at Auburn, Alabama, where 1 algal genus—usually a blue-green—often comprised 75% or more of the phytoplankton (Boyd 1973; Boyd et al. 1979*a*).

Forty-nine genera of phytoplankters were identied from the ponds in west-central Alabama. Examinations of the data failed to reveal any apparent seasonality in the occurrences of individual genera or assemblages of genera. Dominant genera, those which at any time comprised 10% of a phytoplankton communtiy or had abundances of 1,000,000 individuals/liter or more, are listed in Table 1. The genera which were dominant only in samples from 1 of the 2 feeding rate groups were not found in a large percentage of the samples—56 and 80 samples were collected from ponds with low and high feeding rates, respectively. Algae which occurred in 20% or more of the samples were:

Table 1. Percentages of samples in which different genera of phytoplankters comprised at least 10% of the total phytoplankton or had abundances of 1,000,000 individuals/liter or more. Numbers in parentheses indicate the number of samples in which a particular genus comprised 50% or more of the phytoplankton. There were 8 samples (20 Apr 80–1 Nov 80) each from 10 ponds with high feeding rates (56–132 kg feed/ha/day) and from 7 ponds with low feeding rates (19–40 kg feed/ha/day). Ponds were located on fish farms in west-central Alabama.

Genus	Feeding rate		Genus	Feeding rate	
	High (%)	Low		High (%)	Low
Actinastrum	1.2	0.0	*Kirchneriella*	3.8	3.6
Anabaena	1.2	12.5 (5)	*Lyngbya*	17.5 (4)	7.1 (2)
Ankistrodesmus	32.5	23.2	*Melosira*	0.0	1.8 (1)
Aphanizomenon	0.0	1.8	*Microcystis*	3.8 (2)	0.0
Calothrix	1.2	0.0	*Nephrocytium*	1.2	0.0
Chlamydomonas	23.8 (2)	19.6	*Oocystis*	56.2 (2)	41.0(1)
Chroococcus	7.5	10.7	*Pediastrum*	16.2	0.0
Closterium	31.2	35.7 (2)	*Pleurotaenium*	1.2	0.0
Cosmarium	21.2	19.6 (3)	*Radiococcus*	1.2	1.8 (1)
Crucigenia	32.5 (9)	5.3	*Raphidiopsis*	3.8	5.4 (3)
Cyclotella	1.2	1.8	*Scenedesmus*	56.2 (14)	8.9
Diatom (unidentified)	12.5	19.6 (3)	*Schroederia*	15.0	8.9 (1)
Dictyosphaerium	3.8	3.6	*Sphaerocystis*	17.5	21.4 (5)
Dimorphococcus	0.0	3.6	*Staurastrum*	10.0	26.8 (4)
Euastrum	0.0	3.6	*Tetrastrum*	10.0	0.0
Golenkinia	2.5	0.0	*Trachelomonas*	25.0	23.2 (1)
Gomphosphaeria	23.8 (1)	19.6 (3)	*Trichodesmium*	1.2 (1)	0.0
Gymnodinium	1.2	0.0			

Low feeding rate—*Ankistrodesmus, Oocystis, Closterium, Trachelomonas, Staurastrum, and Sphaerocystis.*

High feeding rate—*Ankistrodesmus, Oocystis, Closterium, Trachelomonas, Crucigenia, Scenedesmus, Gomphosphareria, Cosmarium, Chlaymdomonas, and Coelastrum.*

On some dates, 1 genus would comprise 50% or more of the phytoplankton in a particular pond. In ponds with high feeding rates, *Scenedesmus, Crucigenia, Coelastrum,* and *Lyngbya* were the genera most frequently encountered, found in 50% or more of the phytoplankton. In ponds with low feeding rates, *Anabaena, Sphaerocystis,* and *Staurastrum* were noted most frequently at 50% or more.

When the phytoplankton data for samples from channel catfish ponds in west-central Alabama (Figs. 1, 2, 3; Table 1) were compared with those from channel catfish ponds at Auburn, Alabama, 2 striking differences were noted. Although ponds in both vicinities covered similar ranges in feeding rate and phytoplankton abundance, ponds in west-central Alabama generally had more diverse phytoplankton communities and smaller proportions of blue-green algae than ponds at Auburn, Alabama. However, based on observations and discussions with pond managers, problems with water quality were about as common in ponds at one location as at the other. In general, the higher the feeding rate and the more abundant the phytoplankton, the more frequent and severe the problems with water quality. Furthermore, off-flavor in channel catfish was extremely common in west-central Alabama in spite of the low abundance of blue-green algae (Brown and Boyd 1982). Hence, water quality problems in channel catfish ponds appear to be more closely related to the total abundance of phytoplankton than to the composition of the phytoplankton communities.

Waters in catfish ponds at Auburn, Alabama, had total alkalinity values of 10-15 mg/liter of $CaCO_3$, but the ponds in west-central Alabama had total alkalinities of 69-148 mg/liter as $CaCO_3$. Waters with higher alkalinity are well buffered against pH change when phytoplankton are rapidly removing carbon dioxide, and they have a greater reserve of available carbon for phytoplankton growth than waters of lower alkalinity (Boyd 1982). Blue-green algae are more competitive for carbon in waters with high pH and low available carbon concentrations than other forms of algae (King 1970). Hence, the large proportion of blue-green algae in waters of channel catfish ponds at Auburn, Alabama, was likely related to the low total alkalinities of these waters.

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