PHYTOPLANKTON IN AQUACULTURE PONDS

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ABSTRACT
Aquaculture ponds typically meet ideal conditions for the growth of several phytoplankton species. Green algae are considered the most desirable algae for fresh water ponds. Many producers managing sea or brackish water for shrimp culture prefer the growth of diatoms. The bloom of blue green algae cause broad daily fluctuations in dissolved oxygen concentrations, and can produce smelly compounds that are toxic for other algae or animals in the pond.

Introduction
Phytoplankton is the basis of food chain in aquaculture ponds. Nevertheless, the natural bloom of phytoplankton is not enough to obtain adequate phytoplankton levels for the production of shrimp or finfish. Fertilizers increase the natural fertility of culture ponds, leading to increased yields. Nonetheless, many producers have opted for feed-based aquaculture in order to increase production levels, beyond those that can be obtained using only fertilizers.
Natural productivity is important even in those ponds where artificial feed is used, particularly right after stocking. This is due to the fact that young post-larvae (PL) or fingerlings cannot use the feed as efficiently as adult animals. Some aquaculture farmers, particularly shrimp farmers, are evaluating the abundance and taxonomic composition of the phytoplankton communities present in the water of their ponds. They also apply a variety of treatments aiming to control the prevalence and composition of the phytoplankton communities.
Algal strains are ubiquitous. If we fill a new pond with water, several phytoplankton species will find their way in. Phytoplankton growth is regulated by several factors including water temperature, solar irradiation, turbidity, and nutrient concentrations.
Acidic pond water is typically treated with calcium-based compounds aiming to raise the pH. Turbidity resulting from suspended soil particles is typically settled down by precipitation in pond water. Nutrients are supplied by the use of fertilizers and artificial feeds. Aquaculture ponds usually meet the ideal conditions for phytoplankton growth.
Species composition/density

Phytoplankton bloom density is strongly dependent on nutrient availability, particularly nitrogen and phosphorus. Intensive culture ponds with high feed intakes usually have abundant phytoplankton, and also in semi-intensive culture ponds phytoplankton can reach important density levels.

Phytoplankton composition is highly variable and it can change rapidly with the time. Many workers have observed that even adjacent aquaculture ponds subjected to similar management practices and inputs, rarely show similar water clarities or colors. Differences in the appearance of pond water are the result of phytoplankton composition and density.

One pond could have a phytoplankton bloom including several green algal species, but only a few weeks later, the phytoplankton community can consist of nearly only one single blue green algal species. Alternatively, green algae can persist, but such algal composition could change within a few weeks. Total phytoplankton bloom also grows and declines (Figure 1), even if incoming nutrients remain relatively constant.

**Figure 1.** Chlorophyll “a” concentration changes indicating the bloom of phytoplankton in a fertilized fresh water pond
Blue green algae
In aquaculture ponds, some phytoplankton species are more desirable than others. Blue green algae, sometimes called cyanobacteria, are particularly troublesome. The dense flourish of blue green algae, as it also occurs with other algae, causes broad daily fluctuations in the concentration of dissolved oxygen. Mechanical aeration has been used as a means to prevent extremely-low dissolved oxygen concentrations during the night time in intensive aquaculture ponds.
During calm weather, blue Green algae frequently float in the surface, resulting in foam, which absorb heat thus increasing water surface temperature. Foam typically agglomerates in pond corners where algae die, resulting in poor water/soil quality spots.
Dense, single blue-green-algal species flourishing, combined with calm, hot weather and intense solar irradiation, are conditions that promote phytoplankton mortality. Massive mortality can result in decreased oxygen levels even if mechanical aerators are working.
Blue green algal blooms also tend to undergo sudden death. In addition of causing water quality problems, some species of the Oscillatoria, Anabaena, Microcystis, Lyngbya, Aphanizomenon and other genuses of blue green algae are particularly prone to producing smelly compounds which, when absorbed by finfish and shrimp, result in poor meat taste.
Once smelly/mistasting compounds disappear from the water, they undergo natural detoxification in the flesh of the species under culture. Ponds can be treated with copper sulfate at the rate of 1% of total alkalinity, aiming to remove blue green algae. One or two weeks after removing the smelly compounds, cultured animals frequently (though not always) recover their normal taste. In shore ponds, water exchange can be used to remove mistasting algae from the ponds.
Factors promoting the growth of BGA in the ponds include high nutrient concentrations and high pH, in excess of 8.3. Alkaline pH encourages BGA to grow, since these algae are more competitive than others for the low concentration of available inorganic carbon at an elevated pH. Aquaculture ponds are ideal for BGA bloom due to the abundance of nutrients that promote the rapid proliferation of these algae, which results in decreased carbon dioxide concentrations and increased pH, so that these algae prevail in the long range.
Research has also shown that BGA can release toxic substances that have the ability to kill other algal types. In the US, 75-80% of channel catfish ponds contain phytoplankton communities where BGA prevail during the late summer/early fall. BGA occur in brackish waters, even though they mostly prevail at salinity levels <1‰ (parts per thousand, ppt).
Some BGA species produce toxins that can kill both finfish and shrimp. The best known toxic algae include species of the Prymnesium and Chrysochromulina genuses. These algae are mostly marine in nature, but some Prymnesium species can strive in in-land waters, as far as salinity levels exceed 2 ‰.
Fish mortality is a frequent result of golden alga \((P.\ parvum)\) overgrowth. Recently, this species caused poor growth and mortality among shrimp farmed in inland ponds in Alabama, USA, with salinity levels of 2-5‰. Other toxic algae include some dinoflagellates species (Notice: red tide is caused by the dinoflagellate \(Ptychodiscus\ brevis\)), some diatoms, and marine \(Chloromonas\). In fresh water ponds copper sulfate is used to remove toxic algae. Some producers treat their water with 2-4 mg potassium permanganate/L aiming to oxidize algal toxins remaining in the water. In shore ponds, the eradication of toxic algae from the ponds using water exchange is sometimes possible.

**Algal bloom management**

Besides BGA, most other plankton algae are not particularly concerning for aquaculture ponds. Green algae are considered as more desirable in fresh water ponds. Many marine/brackish water shrimp producers prefer the bloom of diatoms, since these algae are considered a good food source for shrimp.

No reliable methods exist to maintain the bloom of green algae in freshwater ponds. Even though ponds can harbor green algae early in the culture, BGA frequently prevail later on.

Research using water confined to large, enclosed plastic containers within an eutrophic lake showed that BGA were replaced by green algae when carbon dioxide was forced into the containers. As a result, some shrimp producers add manure or molasses to the ponds in an attempt to promote bacterial production of carbon dioxide, thus lowering the pH and decreasing BGA populations. The benefit of such procedure has not been carefully studied.

Shrimp farmers have successfully promoted the growth of diatoms in sea/brackish water ponds by the use of fertilizer with a broad nitrogen to phosphorus ratio (10-20 times more nitrogen than phosphorus). Numerous shrimp producers believe that abundance of diatoms is promoted by fertilization with nitrate and silicate. A fertilizer commercially available in Chile has been specifically formulated to contain sodium nitrate and silicate aiming to increase diatom bloom in shrimp ponds. Research conclusions also suggest that adding iron to sea water should promote diatom bloom, but no scientific reports exist to support the efficacy of this treatment in shrimp ponds.

In an attempt to reduce phytoplankton bloom, calcium, iron, and aluminum compounds have been applied to ponds aiming to precipitate water phosphorus. The rationale behind this method is that phosphorus removal results in lower photosynthesis rate, increased carbon dioxide availability, and reduced pH, a sequence of events unfavorable for BGA growth. Research has shown some benefits of these treatments, but they are rarely used by commercial producers.
Algal assessments
Several shrimp producers routinely estimate the numbers of different algal genera in the water of their ponds. Besides adding fertilizers aiming to increase diatom populations or remove unpleasant taste-producing algae using copper sulfate, little can be done to control the composition of algal communities. The value of the tremendous effort involved in performing algal counts is questionable. Nevertheless, some evaluation of the algal community is needed in order to determine if potentially-toxic species or those that have the ability of causing bad odors are present.