Toxicity Of Blue-Green Algae In Livestock

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Introduction

Blue-green algae (Phylum Cyanophyta) occur in nearly every pond, stream, and lake in Oklahoma. Under proper conditions in ponds or lakes certain toxic species may accumulate in such quantities that a hazard to livestock develops. At least one case of algae toxicity has been confirmed at the Oklahoma Animal Disease Diagnostic Laboratory since the summer of 1977.

Algae accumulate from population explosions called "water blooms" or simply "blooms".[2] A bloom usually contains only one or 2 species. The algae will accumulate to the point of tinting the water bright breen or covering the surface with a thick gelatinous mass. When these blooms are dominated by a toxic species of blue-green algae poisonings may occur. Poisoning may occur during a bloom from species producing an exotoxin or immediately following a bloom when dying cells release their endotoxins. Toxic conditions may be very short lived so samples of water should be taken and refrigerated at the first sign of animal distress.

There are five genera of blue-green algae that are universally accepted as toxic or capable of producing toxins. They are *Microcystis, Nodularia, Anabaena, Aphanizomenon, Gloeatrichia. Microsystis* is generally the most noxious and is the only genus known to produce an exotoxin. Along with *Anabaena* and *Aphanizomenon* (Annie, Frannie, & Mike) it is the most common form of toxic algae in substantiated cases of blue-green algae poisoning.[2] All toxic algae contain pseudovacuoles which tend to bouy them to the surface.

The proper conditions for toxic blooms are:

1) warm sunny days of late spring and summer[2]
2) a gentle and continuous wind[1,2]
3) an abundance of nutrients such as nitrogeneous[2] compounds from feed lot run off or nitrogen fertilizer.

Descriptions

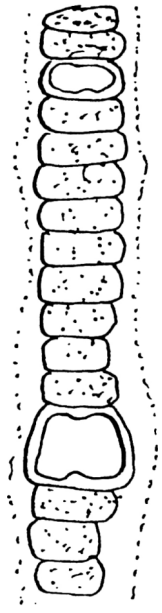
Anabaena spp. - solitary or many plants embedded in a soft matrix forming gelatinous masses on substrate and other plants. (Fig. 1). Cells are spherical or barrel shaped. Trichomes (individual plant filaments) are straight, regularly coiled or entagled. Contains pseudovacuoles. *Anabaena* produces the most toxic endotoxin.[3]

Aphanizomenon spp. - occurs as many trichomes together, parallel in bundles and embedded in a commun mucilage. Cells are cylindrical and each trichome contains one heterocyst and one large akinete at mid-region. (Fig. 2). It is the predominant noxious algae with deteriorating blooms giving off a "fishy smell", discoloring water, and releasing an endotoxin.[3]

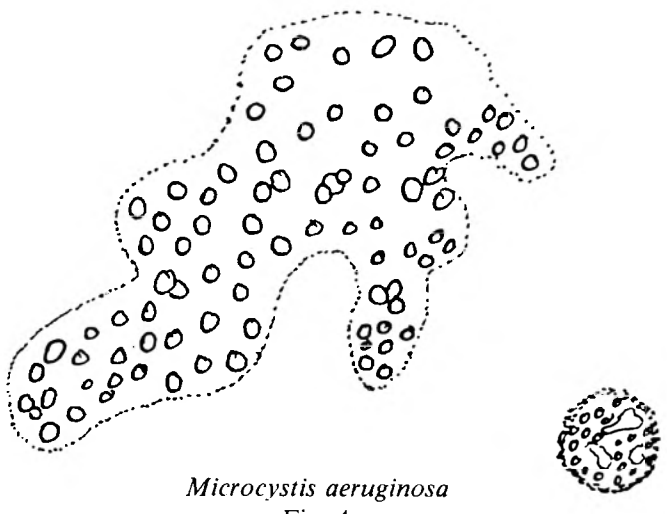
Nodularia spp. - found in fresh, brackish and marine waters. Trichomes solitary in gelatinous sheath. (Fig. 3). Cells are compressed and are wider than long. Seldom occur in abundance but was the first genus reported to produce toxic blooms (Australia).[3]

Anabaena sp.
Fig. 1

Aphanizomenon flos-aquae
Fig. 2



Nodularia spumigena
Fig. 3



Microcystis aeruginosa
Fig. 4

Gloeotrichia spp. - Compactly arranged filaments in a firm mucilage. Filaments radiate from a common center. (Fig. 5). Colonies are epiphytic on aquatic plants and form globular gelatinous masses, grey-green to black to color. Bloom may become very dense during warm periods. Colonies appear as minute globular "tapioca" grains at or near the surface of the water. The species *G. echinulata* causes severe skin irritation in humans often confused with swimmers itch.[3]

Microcystis spp. - consists of thousands of marble-like cells grouped in a common mucilagious matrix. Colony may be round and definite in shape or irregular. (Fig. 4). Extrametabolites inhibit development of other algal species.[3] Microcystis is known to produce both exotoxin and endotoxin. Considered the most lethal of all toxic blue-green algae.[3]

Toxicity

Few animals are immune to the effects of toxic algae. Cattle, sheep, horses, swine, dogs, cats, fowl, geese, ducks, game and song birds, fish and rodents have been killed, often in large numbers.[2] In Iowa 700 Franklin gulls were killed at one time by a species of *Anabaena.*[3] Thousands of cattle die yearly in South Africa from *Microcystis toxica* intoxication.[3] Outbreaks of poisoning occured in Kansas i 1964 and 1967 and in Missouri in 1959 and 1966.[1]

Several toxic agents have been isolated from toxic species. The very fast death factor (VFD) causes death within three minutes and is connected with the exotoxin of *Microcystis.*[2] The fast death factor (FDF) produces death within 2 hours and the slow death factor kills in 4 to 48 hours.[2] The exotoxin of *Microcystis* has been identified as a non-volitile peptide composed entirely of amino-acids. It is a neurotoxin with similar effects to the fungi *Amanita phalloides* in humans.

The LD^{50} of the FDF is 0.47 mg/kg interperitineally in the mouse. Two calves given *Anabaena flos-aquae* by stomach tube collapsed from respiratory arrest.[4] An estimate of the oral minimum lethal dose is 420 mg/kg in ruminants.[4]

Among 500 Coniedale lambs exposed to water containing *Anabaena circinalis* 20 died after 48 hours of exposure.[6] All of the dead animals were found where the wind had concentrated the bloom. A sample of water collected 7 days later was given to a sheep at the rate of 6.1 liters per 4 days with no ill effect.

Calves, rats, ducks and goldfish dosed with lyophilized cell suspensions from *Anabaena flos-aqua* died of respiratory arrest.[5]

Clinical signs

Nasuea, vomiting, abdominal pain, diarrhea, muscular tremors, dyspnea and convulsions are all commonly accepted clinical signs.[2] Less acutely affected animals may show bloody diarrhea, trembling of skeletal muscles, incoordination, icterus, and severe photosensitization.[1]

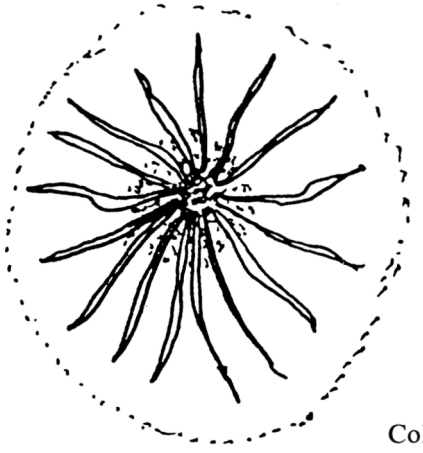
The exotoxin of Microcystis may cause a failure of blood to clot.

Necropsy

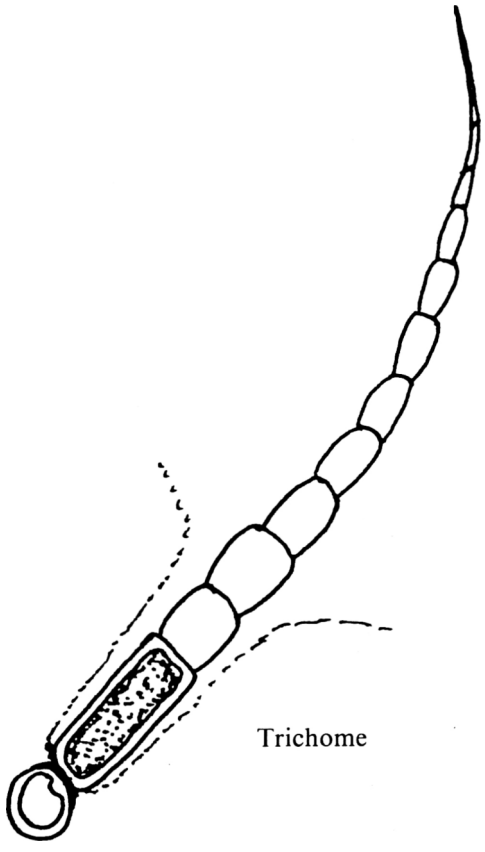
Lesions usually found are inflamation of the digestive tract increasing in severity toward the posterior end, sometimes hemorrhagic, acute degeneration of the cells of the liver and kidney. Liver swollen and mottled with yellow areas. Kidney shows signs of toxic tubular nephritis. Congestion fo the spleen has been reported.[3]

Case History

In July of 1977, the Oklahoma Animal Disease Diagnostic Laboratory investigated a case of suspected algae toxicity in livestock. Several cattle were lost by a rancher near Ada,



Colony



Trichome

Gloetrichia echinulata
Fig. 5

Oklahoma. The animals' only water source contained an algae bloom that tinted the entire pond dark green. A sample of this water was viewed microscopically and large numbers of the blue-green algae *Microsystis sp.* were identified.

The field veterinarian reported clinical signs consistent with algae toxicity; nausea, abdominal pain, diarrhea, muscular tremors, dyspnea, convulsions, and death.

Several other cases of suspected blue-green algae toxicity were investigated during the summers of 1977 and 1978 with inconclusive results.

Discussion

Fortunately, blue-green algae poisoning is not a major toxicological phenomenon in Oklahoma. Since several external factors must be optimized to permit an algae bloom, outbreaks over large geographical areas are not common. However, all 5 major toxic genera are represented by species in Oklahoma. All of the conditions necessary for an algae bloom are present during spring and summer in the state.

Each year there are many livestock losses in Oklahoma that go unexplained. It is a good possibility that at least some of these cases could be attributed to blue-green algae toxicity. The extremely short and unpredicatable toxic period of algae toxicity coupled with the rapid action of the toxin (minutes to hours) make it difficult to either isolate toxic algae or observe clinical signs. Most livestock killed by algae are simply discovered in the morning laying next to the water souce and most evidence of the toxic bloom has deteriorated.

It is important that water samples be collected and sent for laboratory investigation at the first sign of an abnormally bright green to blue-green tint especially if the water is the only source for livestock.

References

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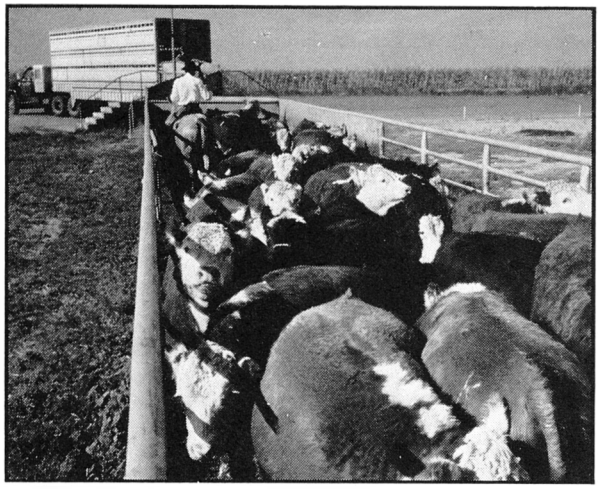

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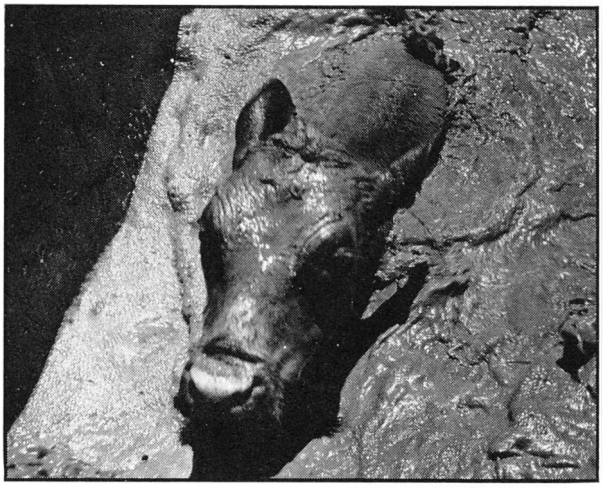

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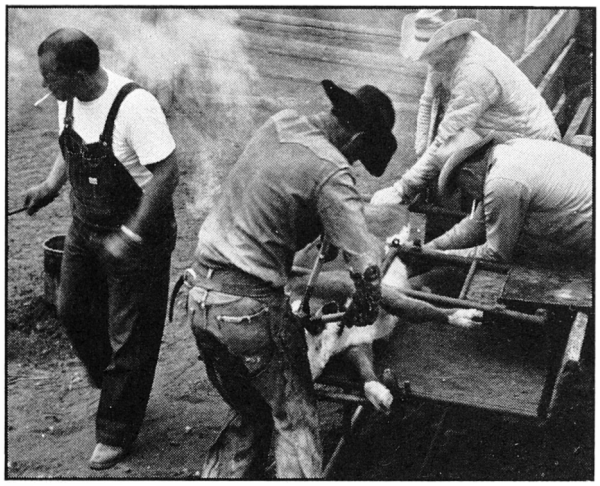

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