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Blue Green Algae (BGA) - Detailed Fact Sheet

For Distribution to Veterinarians and Physicians

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INTRODUCTION

The blue green algae (BGA), now considered to be a type of bacteria called cyanobacteria, are an ancient family of photosynthetic organisms. The fossil record shows that BGA has existed for around 3.5 billion years. It is thought to be one of the first organisms able to carry out photosynthesis. BGA also are noted for their ability to "fix" gaseous nitrogen, and some produce deadly toxins as secondary metabolites. BGA can produce nervous system poisons (neurotoxins), liver poisons (hepatotoxins), or compounds that cause allergic responses (lipopolysaccharide endotoxins). BGA neurotoxins can kill animals within minutes by paralyzing the respiratory muscles, while the hepatotoxins can cause death within hours by causing blood to pool in the liver. The same BGA species can be toxic or nontoxic at different times.

Since the summer of 2001, 9 dog deaths following contact with water bodies in Humboldt and Mendocino Counties may have been caused by BGA poisoning, prompting the preparation of this fact sheet for animal health workers and other interested parties. The Humboldt County Division of Environmental Health (DEH) hopes to prevent future pet deaths and impacts to water users by obtaining prompt reports of BGA exposure incidents.

BGA BLOOMS

BGA periodically "blooms," that is, creates floating mats, forming what is commonly known as "pond scum." These blooms can be blue-green, olive green, grey-green, yellow–brown or purple to red. The bright lime green algal mats commonly seen in our fresh water bodies are green algae, not BGA.

The occurrence of BGA toxins in the freshwater environment is unpredictable. Blooms may persist for up to seven days but the resulting toxins may last for as long as three weeks. BGA move up and down within the water column and thus may not always float to the surface. Currents and surface winds can push them toward the land, causing poison-filled cells to accumulate in a thick layer near the leeward shore. Low flow river conditions in the summer and fall may result in large build-ups of BGA. When algae cells die or are damaged, toxins may be released at levels harmful to pets and livestock if they drink the water or eat the algae.

Blooms are most likely to form when three conditions converge:

1. the wind is quiet or mild
2. the water is warm but not hot (60 to 86 degrees F, 18 – 25 ºC))
3. the water harbors an abundance of the nutrients nitrogen and phosphorus (i.e., from agricultural or urban runoff, or failing sewage disposal systems).

EFFECTS OF BGA ON ANIMALS

There are numerous reports of thirsty domestic animals and wildlife consuming fresh water contaminated with toxic BGA and dying within hours from neurotoxicity or hepatotoxicity, or developing sublethal chronic liver disease. Canine deaths from BGA exposure include dogs dying from neurotoxic exposure in lakes in Scotland, from drinking BGA-contaminated lake water in Saskatchewan, Canada, and from contact with a lake in Idaho. Reported neurological symptoms included stumbling and falling, followed

by an inability to rise, elevated heart rate, foaming at the mouth, howling, tremors, loss of bowel control, eyes rolling back into the head, and seizures (see Duy et. al., 2000, for details on symptoms).

The amount of BGA-tainted water needed to kill an animal depends on many factors but typically the volume ranges from a few ounces to several gallons. Thirsty animals are often undeterred by the foul smell and taste of contaminated water. Additionally, dogs can consume large quantities of BGA by licking their fur after swimming in a bloom.

Recent Dog Deaths Following Contact With Big Lagoon and South Fork Eel River

From July through October 2001, 5 dogs died after swimming in Big Lagoon, mostly in the northeastern boat launch area known as the "Yacht Club." Symptoms included severe gastrointestinal distress, such as vomiting, bleeding, diarrhea and dehydration, and elevated liver enzyme levels. A pathology report found massive liver damage in one of the dogs. Two other dogs became ill after swimming in the lagoon and showed heightened liver enzyme levels. The onset of symptoms was within twelve hours and deaths occurred 2 to 4 days later. One dog had been covered in green slime after swimming in the lagoon. Water samples taken from Big Lagoon in November of 2001 (11/9/01), approximately one month after the last dog death on 10/7/01, were tested for microcystins, and found to be negative for this BGA hepatotoxin. Since 2001, no dog illnesses or deaths that could be attributed to BGA were reported from Big Lagoon. The deaths in 2001 may have been associated with the following factors: 1) heavy nutrient loading because the lagoon did not breach to the ocean during the winter, and 2) unusually warm weather.

In the summer of 2002, 3 dog deaths were reported after contact with the South Fork of the Eel River. Near Standish-Hickey State Park in Mendocino County, 2 dogs died within a few minutes of swimming in the river, and another dog died after swimming near Tooby Park in Garberville in Humboldt County. The vet who saw the dogs from Standish-Hickey stated that the animals had seizures within 5-10 minutes of exposure to the water, and were dead within 15 minutes (J. Horvath, pers. comm.).

A water sample taken a few days later in this area by Mendocino County Environmental Health Division (MEH) was found to contain *Anabaena* and *Lyngbya,* two toxin-producing BGA genera. A separate water sample was sent to the California Animal Health and Food Safety Laboratory System (CAHFS) who collaborated with the University of North Carolina (UNC) on the algae identification. The only toxin-producing BGA found by the UNC scientists in the sample was *Planktothrix. Planktothrix* and *Lyngbya* sometimes produce neurotoxins, including what are known as "paralytic shellfish toxins," while *Anabaena* may produce another neurotoxin called anatoxin.

CAHFS first analyzed the dogs' stomach samples for commonly encountered neurotoxins not associated with BGA, such as strychnine, metaldehyde and zinc phosphide: none were present. They then collaborated with Wright State University to analyze the stomach contents for BGA neurotoxins. The contents contained green plant-like material, and low concentrations of paralytic shellfish toxins. Most notably, the stomach contents contained very high concentrations of anatoxin-a, even though the water sample that CAHFS obtained did not include the BGA genera that produce this toxin. However, MEH staff had identified *Anabaena*, a genus that produces this toxin, in their water sample, and it is possible Anabaena was present only in one of the water samples, while the toxin was present in both. BGA and their toxins move with winds and currents, and a species of BGA could turn up in one water sample, but not another, depending on the time and location of sampling.

Therefore, based on analyses of the stomach contents of the dead animals, and the water sample collected from the river, CAHFS believes that the dogs were most likely poisoned by anatoxin-a, a neurotoxin produced by BGA (B. Puschner, oral communication). This conclusion was supported by a recent survey

of the South Fork Eel River by Denbo (2003), who observed *Anabaena* during the summer of 2003 on the river near the Humboldt/Mendocino County line.

In 2004, a dog that died in July shortly after swimming in the South Fork Eel River in Mendocino County near Indian Creek (Piercy) may have ingested BGA toxins; however, the dog was buried before this could be confirmed.

Guidelines for Veterinarians on Water and Necropsy Sample Collection:

Evidence of an algae bloom and/or a case history of sudden illness or death after water contact should raise suspicion of BGA poisoning. This may be supported if wild species (e.g., mice, muskrats, birds, snakes or fish) have also died in the vicinity. If BGA is suspected, samples should be taken as soon as possible, in the same location where an animal fell ill after swimming. Any questions regarding sample collection from water sources or affected animals should be directed to the California Animal Health and Food Safety Laboratory (CAHFS), Toxicology Laboratory in Davis at 530-752- 6322. Samples should be collected as follows:

- Collect water samples in plastic water sample bottles or other plastic bottles. Collect samples in duplicates (freeze one sample, and refrigerate the other sample)
- Collect at least one liter of water for each sample.
- Send samples to the CAHFS Toxicology Laboratory, Davis on cold packs (call first).
- Undiluted, refrigerated samples can be examined microscopically using low power magnification. Microscopic examination may provide evidence that potentially toxic genera are present, not that harmful levels of toxins exist. On the other hand, the absence of visible algae does not exclude poisoning, especially if heavy rain or wind suddenly dispersed blooms.
- Specimens from affected animals: In general, the best samples for accurate diagnostic work are: vomitus, gastric lavage fluid, stomach content, liver, urine, and serum. Veterinarians can call the CAHFS Toxicology Laboratory in Davis for case-related consultations.

EFFECTS OF BGA ON HUMANS

Recreational Use

Human poisoning is infrequent because people usually avoid swimming in or ingesting algae. Children and infants are more susceptible to ill effects from exposure. Deaths are rare but in one notorious case, BGA-contaminated water used for liver dialysis produced over fifty liver failure fatalities in Brazil. Most exposures are through oral, dermal, or intra-nasal contact. Swimmers or even boaters on water containing BGA may experience skin irritation (not to be confused with “swimmer’s itch” caused by flukes), gastrointestinal symptoms, and other reactions such as eye irritation, asthma, pneumonia, and hay fever symptoms. However, locally there have been no reported human illnesses attributed to BGA.

Guidelines for Recreational Users:

Predicting where and when toxic blooms will form is difficult if not impossible. The best alternative is to prevent exposure to the BGA blooms and toxins, especially by children or dogs. Green or blue-green scum of algae blooms in the water or against shorelines is an indication that toxic conditions may exist. People who recreate in any Humboldt or Mendocino County water body should follow these guidelines:

- Avoid wading or swimming in water where algae blooms are visible and avoid dense mats of algae. Closely supervise young children, as they are more at risk due to their small body size.

- Do not drink, eat or handle the algae and avoid ingesting the river water.
- Do not allow pets to swim in or drink river water that is heavily infested with algae.
- Swimmers should shower and pets be rinsed with tap water immediately after bathing.
- Use water-resistant gloves to remove unwanted algae from shorelines.
- Ranchers should not allow livestock to drink water from contaminated rivers or streams.

Domestic Water

Conventional water treatment processes only partially filter out BGA and dilute their toxins. Water from small water systems using only chlorination and no filtration might still exceed safe levels of hepatotoxins. An acute lethal dose reaching the consumer through the drinking-water supply is very unlikely – an adult would have to ingest an incredible amount of the bloom to receive such a dose – but the risk of gastrointestinal disorders and chronic effects is present. Two studies indicate that BGA toxins may contribute to the development of cancer in nonlethal doses (Carmichael 1994, Duy et al. 2000). Repeated low-level exposure to hepatotoxins could favor the development of chronic liver or gastrointestinal disorders. For microcystins, a common BGA hepatotoxin, a level of 1 microgram/liter should be considered a maximum allowable concentration based on an adult consumption of 2 liters/day.

Guidelines for Domestic Water Users:

Domestic water supplies should not be affected unless the water intake is submerged in or exposed to heavy algal blooms. An expensive treatment process, granular activated carbon filtration, can remove up to 100% of BGA toxins. Barring this, owners of private surface water diversion systems should:

- Check for algae near water intakes.
- Be alert for odor or taste changes in the water.
- Filter water first and then disinfect it before drinking. Disinfection prior to filtration kills the BGA causing it to release its toxins. For the same reason, algicides such as copper sulfate should never be used if BGA are present. Water boiling is not recommended as a disinfection method.
- Change from surface water to groundwater supply if contamination is continuous.
- Withdraw water from different depths to minimize the intake of BGA cells.
- Minimize nutrient input to source waters.

CONTACTS AND INFORMATION

Report algal blooms, pet deaths/illnesses following water contact and/or unusual numbers of dead animals around water bodies to the appropriate County Environmental Health Division:
Humboldt County – **Kevin Metcalfe, REHS, 707-445-6215 or 1-800-963-9241**
Mendocino County – **David Koppel, REHS, 707-463-4466**

For information on animal health contact the **State Animal Health Branch: 530-225-2140**
For information on specimen collection, laboratory testing and animal diseases contact the CAHFS Toxicology Laboratory – **Drs. Birgit Puschner or Robert Poppenga, 530-752-6322**

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