

Toxic Cyanobacteria (blue-green algae) associated with groundwater conduits in the Bahamas

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Fig. 1 Typical Bahamian groundwater conduit (*white sandy patch*) surrounded by the olive-colored toxic cyanobacterium *Nodularia* cf. *spumigena* and white strands of the sulfur-fixing bacteria *Beggiatoa*. *Inset* shows the anatomical characters (cells, trichomes, heterocysts, akinetes) characteristic of *Nodularia spumigena*

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During a marine algal pilot study in the Abacos Islands, Bahamas (July 2004), we noted many spring-like submarine pockets of outflowing low-salinity groundwater. Interestingly, the mouths of these conduits were consistently encircled by conspicuous populations of the blue-green alga *Nodularia* cf. *spumigena* Mertens (Fig. 1), in association with filmy strands of white sulfur-fixing bacteria (*Beggiatoa*) smelling strongly of hydrogen sulfide.

Cyanobacteria of the nitrogen-fixing genus *Nodularia* are well known to form harmful algal blooms (HABs) worldwide. *Nodularia* spp. blooms occur in both planktonic and benthic habitats and are frequently toxic, due to their contribution of organic matter that fuels broad scale outbreaks of hypoxia and anoxia, with concomitant high levels of hydrogen sulfide. *Nodularia spumigena* produces the cyclic pentapeptide hepatotoxin called nodularin (Rinehart et al. 1988), which, when ingested, can cause death (by liver hemorrhaging) in domestic and wild animals. Affected animals include cattle, horses, sheep, pigs, fowl, dogs, rodents, wild birds and fish. The olive-colored blue-green alga depicted (Fig. 1) is morphologically and anatomically consistent with *N. spumigena* (inset), although this species is holoplanktonic elsewhere.

Such *Nodularia* blooms are a further matter of economic importance because of significant human health hazards. Detrimental effects include bioaccumulation leading to toxic fish and shellfish poisoning (Falconer et al. 1992), as well as human ingestion of seawater contaminated by nodularin, which causes diarrhea, vomiting, weakness, anorexia and coldness of extremities (Carmichael 1997). Consequently, HABs of *Nodularia* have had serious impacts on tourism and recreational usages of waterways. Because *Nodularia* cf. *spumigena* (1) commonly forms groundwater-associated blooms producing hydrogen sulfide, (2) fixes atmospheric nitrogen and (3) ranks among the world's most toxic plants, further study of its ecological/environmental ramifications in Bahamian waters should receive high priority.

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