LETTERS

Edited by **Jennifer Sills**

Algal blooms: Noteworthy nitrogen

NUTRIENT OVER-ENRICHMENT in lakes drives water-quality deterioration. The August 2014 water supply shutdown from Lake Erie to over 500,000 residents in Toledo, Ohio (*1*), highlights this problem, which has been historically addressed by controlling phosphorus (P) inputs. Management and research are based on the premise that P is the limiting factor in freshwater productivity and harmful algal bloom (HAB) formation (*2*, *3*). However, reducing P is no longer adequate for many lakes. Recent studies indicate algal proliferation in response to combined nitrogen (N) and P additions, or in some cases, the addition of only N (*4*–*8*). This shift in the freshwater nutrient management paradigm has important implications.

The toxic cyanobacterial genus *Microcystis* often dominates in nutrient-sensitive systems despite P-focused controls. Members of this genus cannot fix atmospheric N_2 (i.e., convert N_2 to ammonia), so they require combined N sources (such as ammonium, organic N, or nitrate) to support growth. Burgeoning usage of N fertilizers, urban and agricultural N wastes, and atmospheric N deposition have increased bioavailable N in receiving waters (*9*). This global pattern coincides with growing eutrophication issues, especially toxic, non–N_2-fixing cyanobacterial blooms, as exemplified by China's third-largest lake, Tai; in 2007, massive *Microcystis* blooms cut off drinking-water supplies to approximately 10 million local residents (*10*).

N occurs in gaseous forms, unlike P, and N is "lost" to the atmosphere through denitrification and other N sinks, whereas P is recycled internally (along with some N), perpetuating N-limitation (*8*). In-lake N_2 fixation does supply bioavailable N, but this input does not compensate for N loss (*8*, *11*). External N input is thus a key driver of eutrophication. Therefore, the "P-only" management paradigm should be amended to incorporate N-driven eutrophication and HAB abundances.

New nutrient reduction strategies should incorporate point and non-point sources, including N removal in wastewaters, optimization of fertilizer application, and erosion controls. This investment in joint P and N controls will counter the very high costs of HAB events and losses of freshwater resources in Toledo and worldwide.

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Bloom of the toxic, non–N_2-fixing cyanobacteria *Microcystis* spp. in eutrophic Lake Tai, China.

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Algal blooms: Proactive strategy

CYANOBACTERIAL HARMFUL algal blooms (CHABs) are increasing in severity on a worldwide basis. Combining nutrient-source control with post-bloom control is currently considered the best strategy for dealing with CHABs (*1*). However, huge investments in this strategy have proven ineffective in China, as demonstrated by yet another massive bloom last summer in Lake Tai despite over 100 billion RMB (more than US$16.25 billion) invested since 2007 (*2*). Further afield, four decades of strict phosphorus loading regulations have not prevented massive CHAB events in Lake Erie of the Laurentian Great Lakes of North America and the adjacent water bodies (*3*).

The current strategy apparently has limited effectiveness. Furthermore, nutrient-source control may not be feasible for many developing countries because of increasing population pressure and pollution, and elevated CO_2 influx into aquatic systems and climate change will intensify algal blooms (*4*). Once CHABs have occurred, even the most effective methods to date of removal of cyanobacteria and cyanotoxins cannot eliminate their adverse impacts on ecosystems and human health (*5*).

We firmly believe that the missing key component in the current strategy is proactive CHAB control. By implementing this approach over the past 15 years, we have achieved effective long-term prevention of CHABs in several severely eutrophic lakes and reservoirs in Eastern China (*6*), thus showing that this approach is entirely possible and practical. Our strategy also affords valuable time for the implementation of nutrient-source control.

Proactive CHAB control requires appropriate technical expertise aimed at inhibiting algal growth during the spring season, when cyanobacteria is vulnerable to foraging species. This would involve developing new tools to trace pre-bloom algal distribution so that proactive treatments only need to be implemented within algae concentrated areas and in a cost-effective manner. Continuous monitoring and assessment of water bodies would maximize treatment efficacy.

Moreover, supportive laws and government policies are necessary. In particular, governments from different jurisdictions should reallocate resources to where CHABs originate; implement an appropriate merit system for proactive CHAB prevention and other measures related to eco-service enhancement; and curtail counterproductive human practices such as illegal fishing by enhancing law enforcement and providing alternative livelihoods and social learning to affected communities.

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Ocean acidification foils chemical signals

THE CRUCIAL IMPORTANCE of chemical cues to reef resettlement was elegantly demonstrated by D. L. Dixson *et al.* ("Chemically mediated behavior of recruiting corals and fishes: A tipping point that may limit reef recovery," Research Article, 22 August, p. 892). Similarly, waterborne chemical signals (pheromones) and cues are essential for mediating marine species' behaviors, including those associated with mating, foraging, recruitment, and alarm (*1*).

Responses to these chemical signals and cues are in danger of global disruption by the effect of rising atmospheric CO_2 levels on aquatic pH. At current rates, ocean pH will drop from the current and historic pH of 8.15 to 8.25 to about 7.8 or below by 2100 (*2*). Quite apart from effects on calcification, reduced pH has the capability to affect both the signaling (semiochemical) molecules themselves and their interaction with chemosensory receptor proteins. The interaction of semiochemical ligands with chemosensory receptors changes with pH, through the number, type, and alignment of intermolecular forces (e.g., hydrogen bonding, electrostatic potential, and hydrophilic/hydrophobic regions) on both ligand and chemosensory receptor (*3*, *4*). Examples of the pH-affected semiochemicals are pheromones and cues, including peptides, nucleosides, thiols, and organic acids in nereid polychaete worms, *Aplysia* sea hares, crustaceans, and fish (*3*).

The current rate of oceanic pH decline is occurring faster than chemosensory systems can evolve; today's systems have evolved over 50 million years under relatively constant pH (*2*). Every marine species, at every trophic level, is potentially affected by disruption of chemical cues and signals, including responses to predator odors [e.g., (*5*)], sexual reproduction, sperm attraction, fertilization, social interactions, feeding, and larval settlement (*1*). Studies into not only the effects of disruption but also the mechanisms of action and resulting predictive ecological models are urgently needed. We risk widespread ecosystem damage by this additional silent danger from rising anthropogenic CO_2 levels.

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TECHNICAL COMMENT ABSTRACTS

Comment on "Oxytocin-mediated GABA inhibition during delivery attenuates autism pathogenesis in rodent offspring"

Victorio Bambini-Junior, Gustavo Della Flora Nunes, Tomasz Schneider, Carmem Gottfried

■ Tyzio *et al.* (Reports, 7 February 2014, p. 675) reported that bumetanide restored the impaired oxytocin-mediated γ-aminobutyric acid (GABA) excitatory-inhibitory shift during delivery in animal models of autism, ameliorating some autistic-like characteristics in the offspring. However, standard practices in the study of these models, such as the use of sex-dimorphic or males-only analyses and implementation of tests measuring social behavior, are lacking to definitely associate their findings to autism.

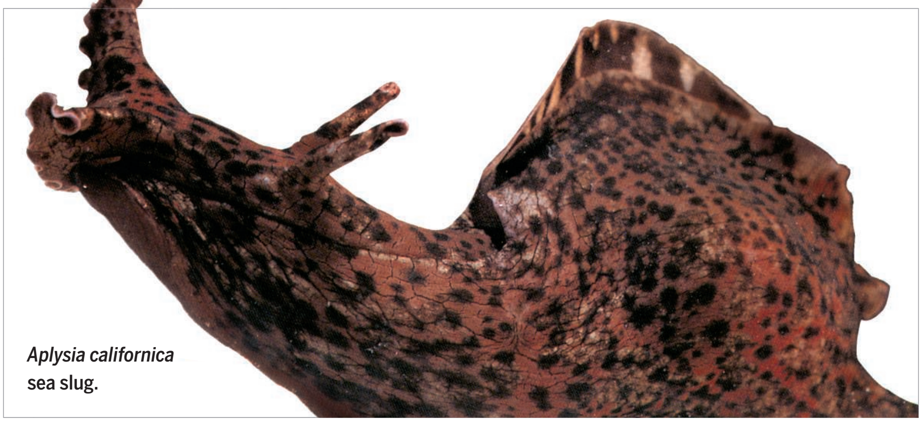
Full text at http://dx.doi.org/10.1126/science.1255679

Response to Comment on "Oxytocin-mediated GABA inhibition during delivery attenuates autism pathogenesis in rodent offspring"

Sanaz Eftekhari, Amene Shahrokhi, Vera Tsintsadze, Romain Nardou, Corinne Brouchoud, Magali Conesa, Nail Burnashev, Diana C. Ferrari, Yehezkel Ben-Ari

■ Bambini-Junior *et al.* questioned whether our treatment in two rodent models of autism has a long-lasting effect into adulthood. In response, we show that bumetanide treatment around delivery attenuates autistic behavioral features in adult offspring. Therefore, the polarity of γ-aminobutyric acid (GABA) actions during delivery exerts long-lasting priming actions after birth.

Full text at http://dx.doi.org/10.1126/science.1256009



Aplysia californica sea slug.

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