



The effect of Fe and Cu on growth and domoic acid production by *Pseudo-nitzschia multiseriis* and *Pseudo-nitzschia australis*

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ABSTRACT: Toxicogenic pennate diatoms of the genus *Pseudo-nitzschia* produce domoic acid (DA), the neurotoxin linked to amnesic shellfish poisoning. We investigated how Fe and Cu affect growth and DA production by *P. multiseriis* and *P. australis* clones isolated from Monterey Bay, California. Growth rates of these species could be inhibited by both Fe limitation (pFe 20.5, $\mu = 50\% \mu_{max}$) and Cu toxicity (pCu 10.5, $\mu = 5-30-50\% \mu_{max}$). The rate of DA production during the exponential phase was a significant inverse function of cellular growth rates ($P < 0.02$). Voltammetric measurements of dissolved DA-equivalents in short-term experiments indicated that the cellular production of DA increased from ~ 5 amol DA cell⁻¹ h⁻¹ under optimal growth conditions to ~ 40 amol DA cell⁻¹ h⁻¹ under Fe-deficient conditions and ~ 105 amol DA cell⁻¹ h⁻¹ under Cu-stressed conditions. The DA was released to the medium under metal stress conditions, with intracellular DA concentrations decreasing relative to nonstressed cells. Fe uptake rates by *P. multiseriis* were slow compared to other marine diatoms in the absence of dissolved DA but were enhanced threefold ($P < 0.03$) by adding DA to the medium. DA addition also partially alleviated toxic Cu conditions. Our findings suggest that DA production during exponential growth of these two toxicogenic *Pseudo-nitzschia* species is directly induced by Fe-deficient or Cu stress conditions and that 95% of this DA is actively released into the medium. Changing trace metal conditions in coastal waters therefore may have a profound effect upon intracellular DA concentrations and thereby influence the toxic effect of these harmful bloom events.

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