Bacterial ice nucleating activity associated with a winter phytoplankton assemblage in Lake Erie

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Sea ice supports diverse and productive assemblages of planktonic microbes in polar waters. In contrast to sea ice, freshwater ice is believed devoid of the network of channels and pores used by marine plankton as microhabitat. In cases where planktonic assemblages are associated with ice cover on lakes, their recruitment is often attributed to atmospheric deposition. Here we document ice nucleation activity associated with assemblages of filamentous diatoms sampled from ice-covered Lake Erie, one of the Laurentian Great Lakes. The ability to promote ice formation offers a previously undescribed mechanism by which these non-motile phytoplankton can attach themselves to overlying ice and, thereby, maintain a favourable position in the photic zone. We attribute the ice nucleation activity to bacteria; Scanning Electron Microscopy (SEM) revealed associations of bacterial epiphytes with the dominant diatoms of the phytoplankton assemblage and bacteria isolated from the phytoplankton showed high temperatures of ice crystallization (T_c) of up to -3°C. Ice nucleation active (INA) isolates were identified as belonging to the genus *Pseudomonas*, many strains of which are characterized as INA and serve as plant pathogens. Whereas INA bacteria have been isolated from lakes and streams, their presence in these environments is attributed primarily to environmental runoff and atmospheric deposition as rain or snow consistent with their proposed role as biological ice nuclei in clouds. In turn, non-agricultural niches such as lakes and streams are viewed primarily in the context of reservoirs for eventual dissemination of the plant pathogens. Far from a passive existence in the aquatic milieu, the INA microbes associated with winter diatom assemblages in the Laurentian Great Lakes may possess both a role in promoting the formation of ice cover during winter and in promoting blooms of filamentous diatoms under ice in Lake Erie and other large lakes.

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