Modeling the concentration of exuded dimethylsulphoniopropionate (DMSP) in the boundary layer – a response

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Our recent paper (Fredrickson and Strom, 2009) explored the signaling function of DMSP, a molecule that plays key physiological and ecological roles in marine microbial communities. Specifically, we tested the feeding deterrent properties of DMSP with both laboratory cultures and field communities of diverse heterotrophic protist grazers. As part of our exploration, we used a simple model to suggest that deterrent concentrations of DMSP could be produced in the phycosphere of a DMSP-producing algal cell upon release of a minute fraction (0.1%) of the cell's DMSP content. Breckels et al. (submitted) modified our model to include diffusive losses from the phycosphere, and found DMSP concentrations up to 10^6-fold lower than our estimates.

The fundamental difference between our approach and that of Breckels et al. is that we posited release over short time scales – consistent with active transport – whereas the model of Breckels et al. assumed an equivalent amount of release over a full day. Because diffusion effects scale to time, the difference between the two model estimates is largely a function of the nearly 10^5 seconds in a day. To quantify the effect of diffusive losses on short-term release of DMSP, we used Breckels et al.'s equation 2 and data (their Table 2) on the DMSP content and

size of the dinoflagellate *Heterocapsa pygmaea*. We assessed DMSP concentration at the outer edge of a 5-µm thick phycosphere assuming release of 0.1% of cellular DMSP contents over a 2-s period. This yielded concentrations of 6.2×10^5 pmol L^{-1}, as compared with the 14.4 pmol L^{-1} calculated by Breckels et al. assuming release over 24 hr. Modeling release from the algal cell surface rather than from a point source at the cell's center reduces the path length for diffusion by nearly a factor of 2 and will correspondingly further increase modeled phycosphere DMSP concentrations.

Therefore, diffusive losses to a release lasting a few seconds are minor, and we argue that the much lower DMSP concentration estimates of Breckels et al. demonstrate not that our model was inadequate, but that that the mechanisms of cellular release of this biologically important molecule are poorly understood. This makes assessment of DMSP's small-scale patch concentrations and its role in chemical signaling very difficult. Wolfe et al. (2002) presented evidence that algal DMSP cleavage can occur in response to physical or mechanical cues, and microalgae use specific membrane transporters for active efflux of diverse molecules (Croot *et al.*, 2003; Chin *et al.*, 2004; Milligan *et al.*, 2004), which can occur in response to environmental triggers. Does active efflux also occur for DMSP? What are the triggers? Do factors such as cell surface organic layers reduce the diffusion rates of small molecules? How do other organisms react to patches of infochemicals, and what is the "information content"? Technical advances in imaging solute release by single cells, combined with burgeoning knowledge of cell surface transporters from the genomes of marine protists, promise to provide answers to some of these fascinating questions. There is much to be done; let's get to work!

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