

Interactive comment on “Reality checks on microbial food web interactions in dilution experiments: Responses to the comments of Dolan and McKeon” by M. R. Landry and A. Calbet

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Authors Final Comments: Reality checks on microbial food web interactions in dilution experiments: Responses to the comments of Dolan and McKeon

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Given the relatively modest discussion that has been generated by Dolan and McKeon (2004), it seems counter-productive to respond at length with what will now be the 4th level of comments and responses to the original paper by Calbet and Landry (2004). We offer, however, some final thoughts on lingering issues.

First, Dolan’s (2005) response is notable for what it does not say. For instance, we (Landry and Calbet 2004) challenged several inaccurate points that Dolan and McKeon (2004) made to support their contention that dilution experiments gave systematically

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biased estimates of microzooplankton grazing (e.g., “there would be little left” for carbon export; that an insignificant slope is a dilution “failure”; Gallegos’ (1989) contradictory results showing food-saturated underestimates). The lack of response on these issues suggests they are not in dispute. Dolan (2005) did, however, rebut our use of FLB grazing probes to ascertain net dilution effects on protistan grazing, suggesting that the experiments were tainted by added nutrients. We note that these experiments were conducted in the HNLC equatorial Pacific, which shows no significant differences in 24-h phytoplankton growth responses between nutrient and no nutrient treatments (e.g., Landry et al. 1995). Lastly, the latest Dolan comment misinterprets our point on flagellate dilution dynamics as being about their clearance rates. What we said, using flagellates and ciliates as contrasting examples, is that, in the truncated food webs of dilution experiments, there are important differences in population responses between smaller grazers (flagellates) whose food and predatory environments are both impacted by dilution versus larger protistan grazers (ciliates) which only experience the negative effects of food dilution.

The remaining comments on our paper are not really about points of accuracy or fact as much as different experiences, perspectives and opinions on what is known about ocean ecosystems. Are there significant structural and functional differences in the micro-herbivore assemblages of coastal and open-ocean ecosystems, specifically with regard to the ratio of herbivorous ciliates to flagellates (the latter including dinoflagellates)? Based on our experience in major biomes of the Pacific Ocean, we certainly believe that that is the case, and would also likely be so on a global areal basis. We can readily appreciate, however, that the situation may look murkier in the North Atlantic, in seasonal ice zones or in other systems that experience open-ocean blooms more typical of coastal sites. It would be worth the effort to look at this question more carefully and critically, given the very different sampling and preservation strategies that have been used in the literature assessments of community composition and their implications for optimal quantification of the major groups of protistan grazers. Since mixotrophs likely play an increasing role as grazers of pico-sized phytoplankton in

nutrient-deficient regions of the open oceans, it would also be important to include them explicitly in such an analysis. One would not expect an accurate accounting of flagellate grazing potential if we ignored this potentially important, but often cryptic, component of the grazing community.

Do we have an adequate understanding of rates and patterns in ocean productivity and export fluxes? After more than a decade of intensive JGOFS (Joint Global Ocean Flux Studies) process and time-series studies, the situation is not nearly as bleak as McManus (2005) suggests. As just one example, we know from 16 years of approximately monthly data from the Hawaii Ocean Time-series Program that 14C-particulate production averages 15 moles C m⁻² y⁻¹ and is about half of gross production (Karl et al. 2002). Total export is 1.2 moles C m⁻² y⁻¹, or 7% of 14C production, based on the combination of particulate and dissolved fluxes of organic carbon and the active transport of migrating zooplankton (Lomas et al. 2003). This amount of export flux also agrees with inferences from biogeochemical mass balances and trace-gas proxies of new production (Emerson et al. 1996). Such rigorously constrained rates anchor our understanding of open-ocean oligotrophic systems as being not only consistent with high microzooplankton grazing, but demanding an efficient grazer return of recycled nutrients to sustain >90% of daily primary production. Similarly, while one might argue the utility of data from isolated dilution experiments, a large fraction of those results have come as part of integrated experimental studies in JGOFS Process and related projects, and their interpretations are both constrained by and generally consistent with contemporaneous estimates of production, export, mesozooplankton grazing and nutrient cycling (e.g., Landry et al. 1997, 2001). In the equatorial Pacific, for instance, balanced growth and grazing estimates of ~1 cell division d⁻¹ for *Prochlorococcus* and other pico-phytoplankton (Landry et al. 2003, Le Borgne and Landry 2003) are entirely consistent with diel patterns of cell cycle properties and in situ abundances (Vaulot and Marie 1999) and beam transmissometry estimates of particle density (Neveux et al. 2003). In other words, there is a good correspondence between rate estimates from these bottle incubations and entirely independent assessments of growth and mortality

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processes from non-manipulative observational techniques.

The above having been said, dilution experiments are not an end to themselves, but hopefully just a crude beginning to quantifying microzooplankton grazing rates and relationships in the oceans. We clearly need more and better information on the abundances, energetics and rate capabilities of different micro-herbivore groups both to enhance our measurement capabilities and to understand the results more clearly in the context of ocean phenomena and dynamics.

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