Large Phaeodaria in the Twilight Zone: Their Roles in the Carbon and Silica Cycles

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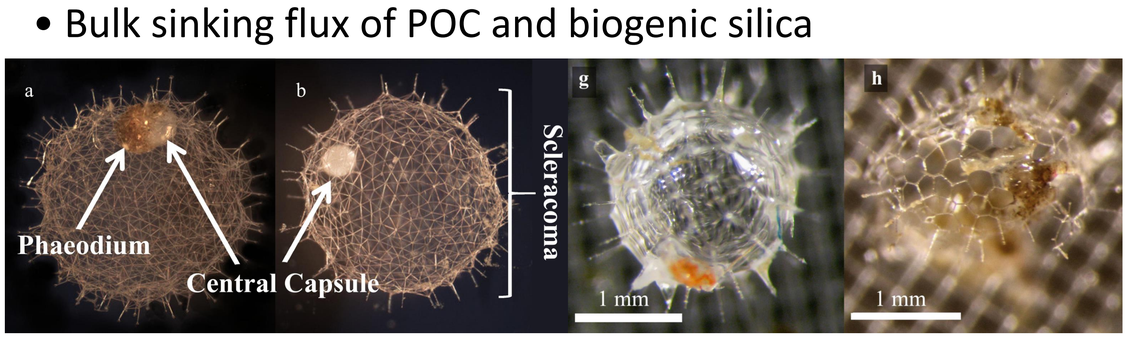
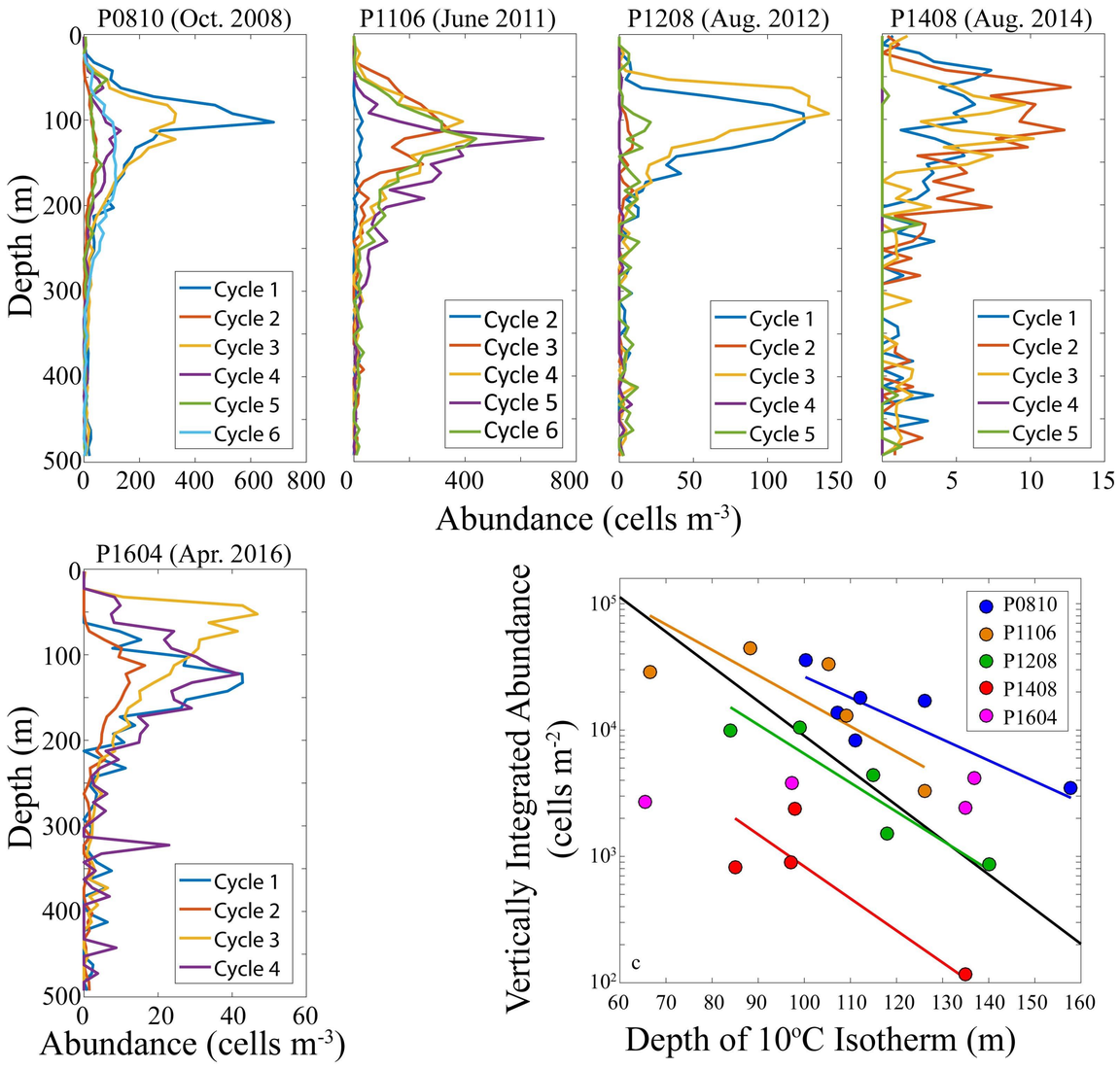
Introduction - Advances in *in situ* imaging allow enumeration of abundant populations of large rhizarians (including Phaeodaria) that compose a substantial proportion of total mesozooplankton biovolume. Large Phaeodaria (>600-µm) are abundant plankton with hollow siliceous tests (called scleracoma). Using a quasi-Lagrangian sampling scheme on five process cruises of the California Current Ecosystem Long-Term Ecological Research Program (CCE LTER) we quantified:

- Abundance and vertical distribution of Aulosphaeridae (~2-mm diameter phaeodarian)
- Vertical flux (sinking mortality) of Aulosphaeridae at base of euphotic zone, 100 m, and 150 m depth
- Silica content of Aulosphaeridae and other phaeodarians
- Bulk sinking flux of POC and biogenic silica



Aulosphaeridae Abundance – Inter-cruise variability was high, with average concentrations at the depth of maximum abundance ranging from <10 to >300 cells m^{-3}. Vertical profiles showed that these organisms were consistently most abundant at 100-150 m depth. Abundance was negatively correlated with the depth of the 10°C isotherm (where Aulosphaeridae typically resided).



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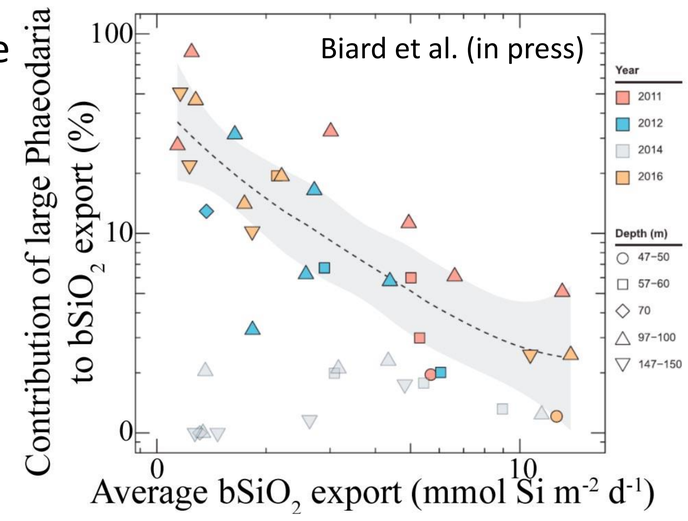
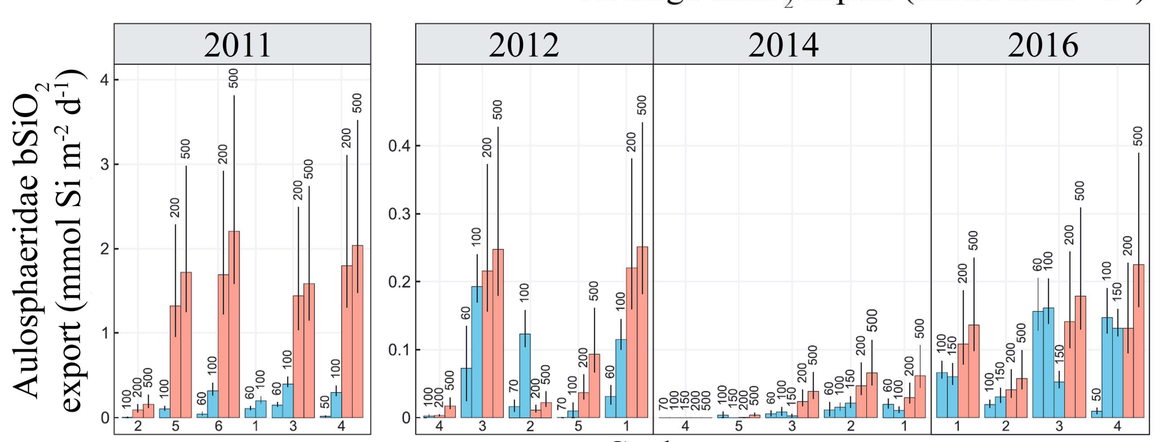
Silica Cycle – Aulosphaeridae contained ~8 µg Si $cell^{-1}$ (Castanellidae, an abundant ~600-µm phaeodaerian contained ~10 µg Si $cell^{-1}$). Together, these families contributed on average 10% of total $bSiO_2$ export from the euphotic zone. Their proportional contributions increased in oligotrophic regions and at deeper depths, where they could at times dominate $bSiO_2$ flux.





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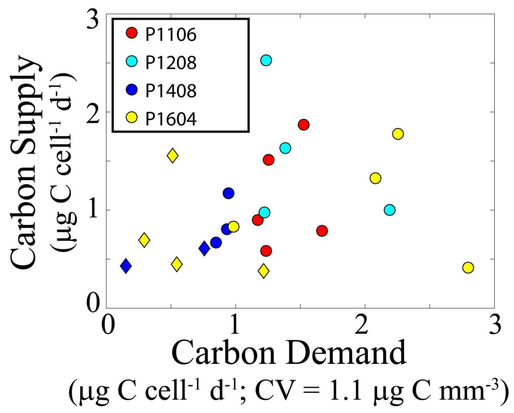
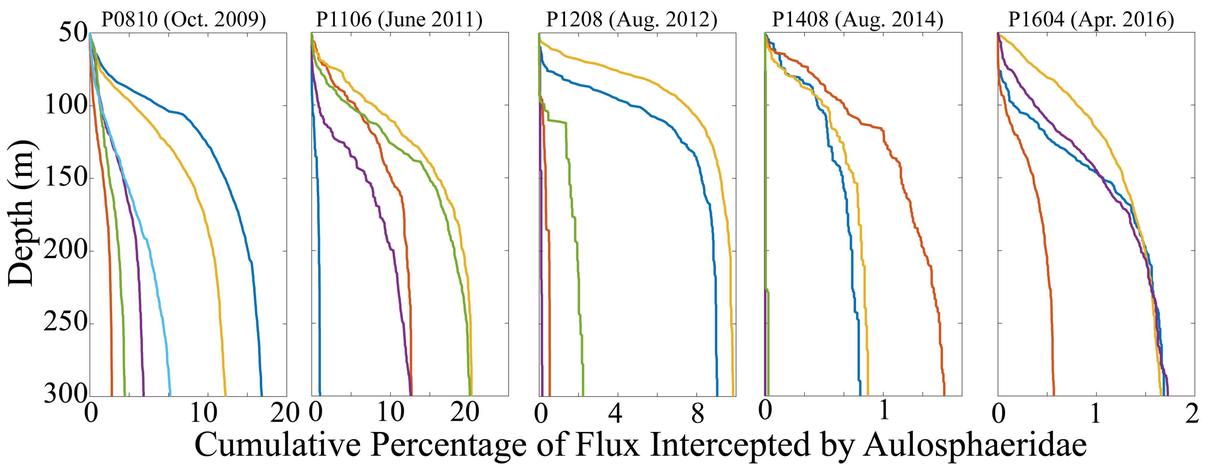
Carbon Cycle - Average turnover times with respect to sinking were 4.7 to 10.9 d, equating to minimum *in situ* population growth rates of ~0.1 to 0.2 d^{-1}. Using simultaneous measurements of sinking organic carbon and the inferred flux of prey protists to non-motile phaeodarian cells, we find that Aulosphaeridae derive most of their nutrition from sinking particles and could only meet their carbon demand if their carbon:volume ratios were ~1 µg C mm^{-3}. This value is substantially lower than previously used in global estimates of rhizarian biomass, but is reasonable for organisms that use large siliceous tests to inflate their cross-sectional area without a concomitant increase in biomass. Based on the cross-sectional area of cells determined from vertical profiles, we found thata single phaeodarian family (Aulosphaeridae) alone can intercept >20% of sinking particles produced in the euphotic zone before these particles reach a depth of 300 m.





Stukel et al. (accepted)

For more information, see:

•Stukel, M. R., T. Biard, J. W. Krause, M. Ohman (accepted). Giant Phaeodaria in the twilight zone: Their role in the carbon cycle. Limnology and Oceanography.

•Biard, T., J. Krause, M. R. Stukel, M. Ohman (in press). The significance of giant phaeodarians (Rhizaria) to biogenic silica export in the California Current Ecosystem. Global Biogeochemical Cycles. doi: 10.1029/2018GB005877

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