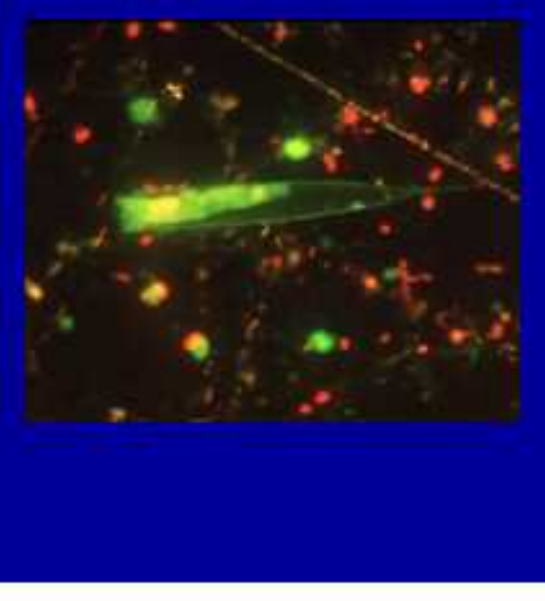

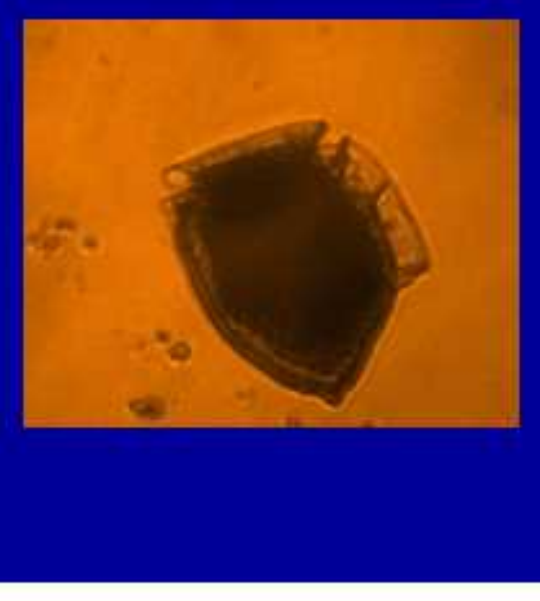

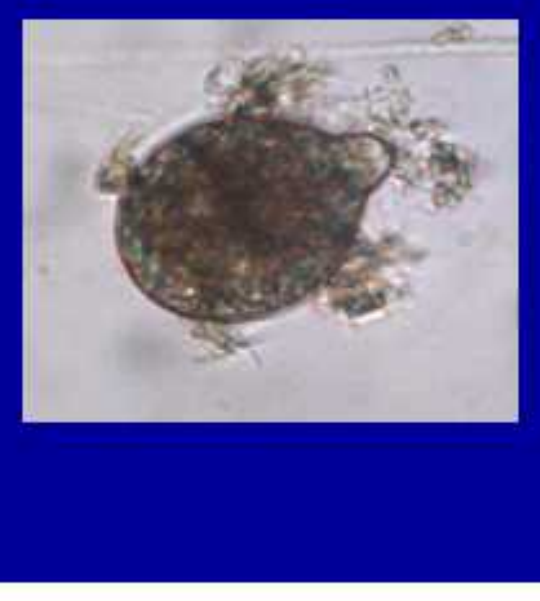

Microplankton growth and grazing processes in the coastal Gulf of Alaska (OS31D-68)

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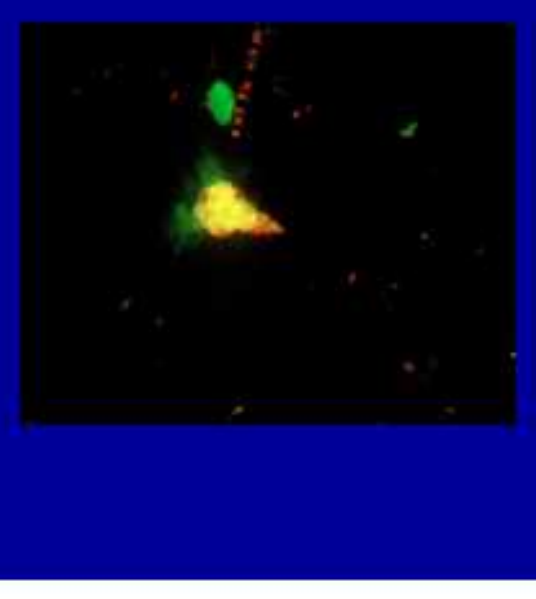
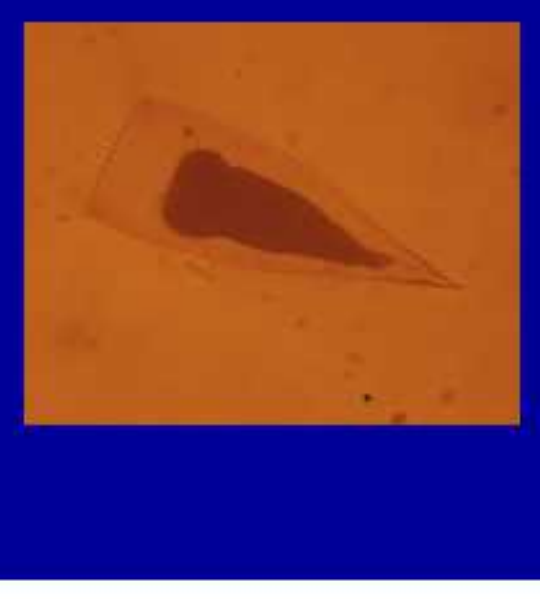




Introduction:

The pelagic microbiota in the coastal Gulf of Alaska is a diverse and abundant community that is dependent on chemical-physical ocean properties favorable for growth. These chemical-physical properties, in turn, are dependent on the dynamic weather and climate in the north Pacific, which interact with a complex geology and sub-surface geomorphology. Therefore, an intimate relationship is shared between climate and coastal Gulf of Alaska biology. The Gulf of Alaska Northeast Pacific GLOBEC program's mission is to gain an understanding of climate-driven variations in the planktonic food web, and how these variations influence distribution and recruitment success of the pink salmon, *Oncorhynchus gorbuscha*.

Three process cruises were conducted in 2001. Each cruise represented a different season and occupied four sites (Prince William Sound, inner, mid, and outer shelf) to examine a diversity of chemical-physical conditions in the coastal Gulf of Alaska. Scientific objectives for this study were:

1. Determine cross-shelf variability in chlorophyll concentration and phytoplankton size structure;
2. Measure phytoplankton cell division rates and identify growth-limiting factors;
3. Measure microzooplankton grazing on the < 200 μm phytoplankton.

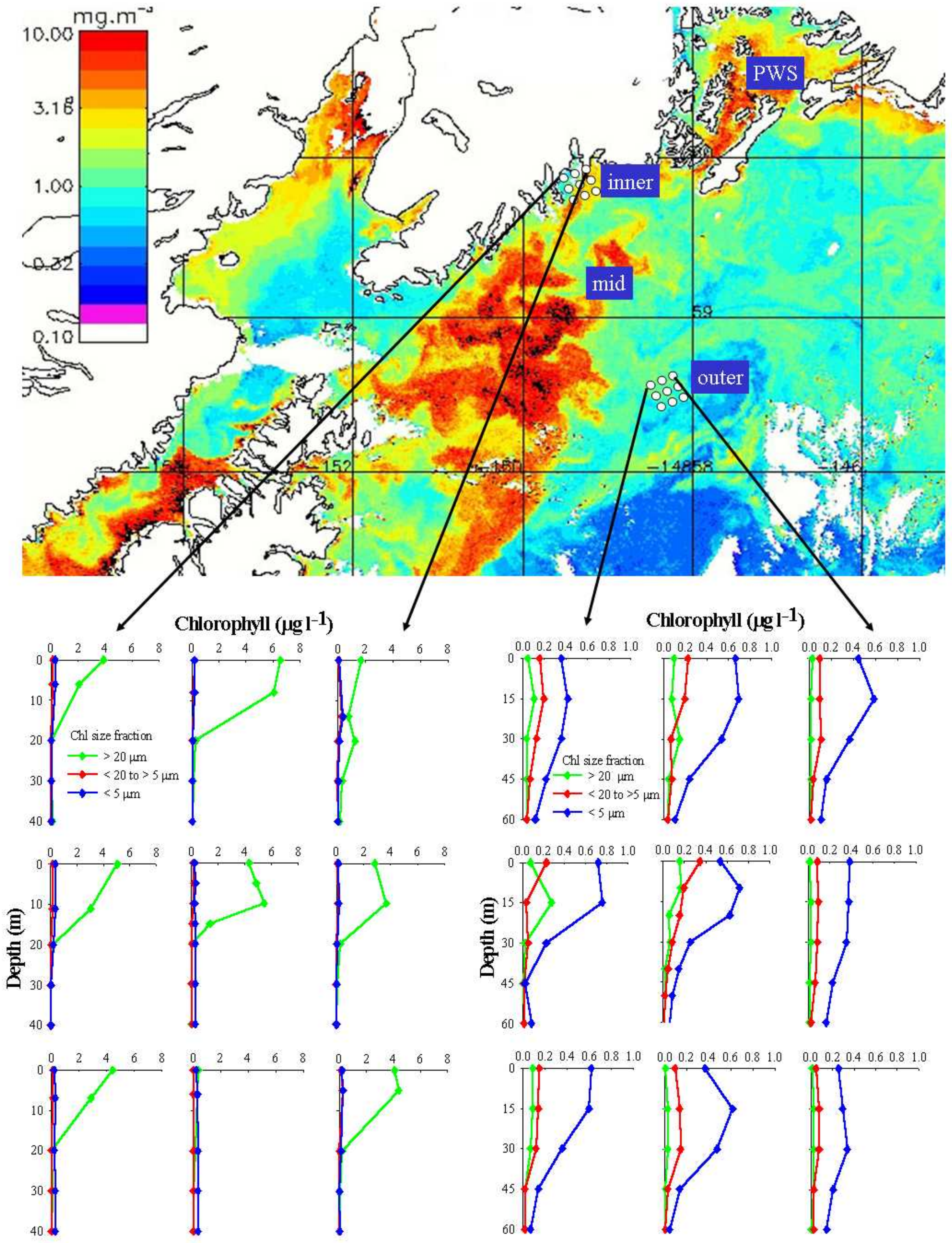


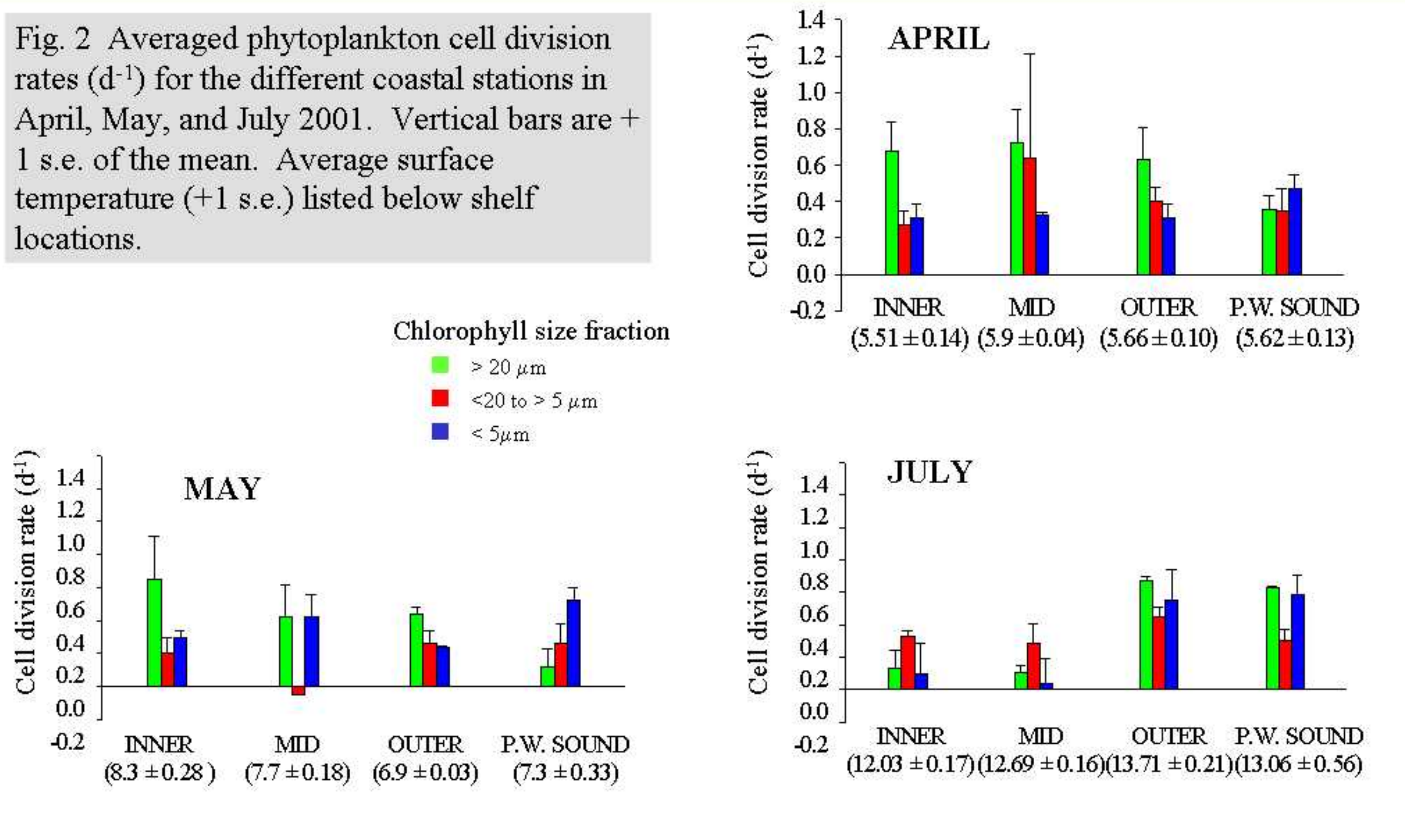
Fig. 1 SeaWiFS image of the coastal Gulf of Alaska, 12 May 2001 showing core sites. White circle plots represent 20 km^2 grids that were occupied to assess spatial variability of chlorophyll across the shelf. Black arrows point to chlorophyll depth profiles of three size classes generated from grid stations. Chlorophyll profiles are meant to overlap white circle grids, matching the upper left plot to upper left circle. Chlorophyll concentration in μg l^{-1}, depth in meters (note axis change between locations). SeaWiFS image provided by University of Maine, School of Marine Sciences.

Methods:

•Dilution experiments (Landry and Hasset, 1982; Landry, 1993) were conducted aboard the RV *Alpha Helix* at four locations in the coastal Gulf of Alaska in April, May, and July 2001. In order to satisfy the assumptions of the dilution method, inorganic nutrients were added during the May and July cruises. Nitrate ($NaNO_3$) and phosphate (Na_2HPO_4) were added to reach target concentrations of 5 μM nitrate and 0.3 μM phosphate.

•Chlorophyll for vertical profiles and dilution experiments was size-fractioned and analyzed fluorometrically using methods of Parsons *et al*. (1984).

Fig. 2 Averaged phytoplankton cell division rates (d^{-1}) for the different coastal stations in April, May, and July 2001. Vertical bars are + 1 s.e. of the mean. Average surface temperature (+1 s.e.) listed below shelf locations.



Results:

•Chlorophyll concentrations and size fractions showed extreme variability on small spatial and temporal scales across the shelf (Fig. 1). In general, large cells dominated inshore waters, whereas small cells dominated offshore waters.

•Highest phytoplankton growth rates were seen in cells > 20 μm (Fig. 2). Across all size fractions, phytoplankton growth rates were moderate (0.45, 0.29, and 0.37 d^{-1} for > 20, 20 to 5, and < 5 μm cells, respectively). Within a given month, growth rates varied among shelf locations for all size fractions.

•Biomass of large heterotrophic and mixotrophic dinoflagellates lagged behind high diatom biomass in April (Fig. 3), but was high during and after periods of high diatom biomass later in the season.

•Within a given cruise, there were large differences in the degree of nutrient limitation depending on location, with > 20 μm cells consistently showing the greatest nutrient limitation (Fig. 5).

•Microzooplankton grazing was high in relation to phytoplankton growth, especially for the < 20 μm size fractions (Fig. 6). Microzooplankton grazing was significant on > 20 μm cells, but during this study, only rarely exceeded phytoplankton growth in this size fraction when nutrient limitation was not a co-factor.

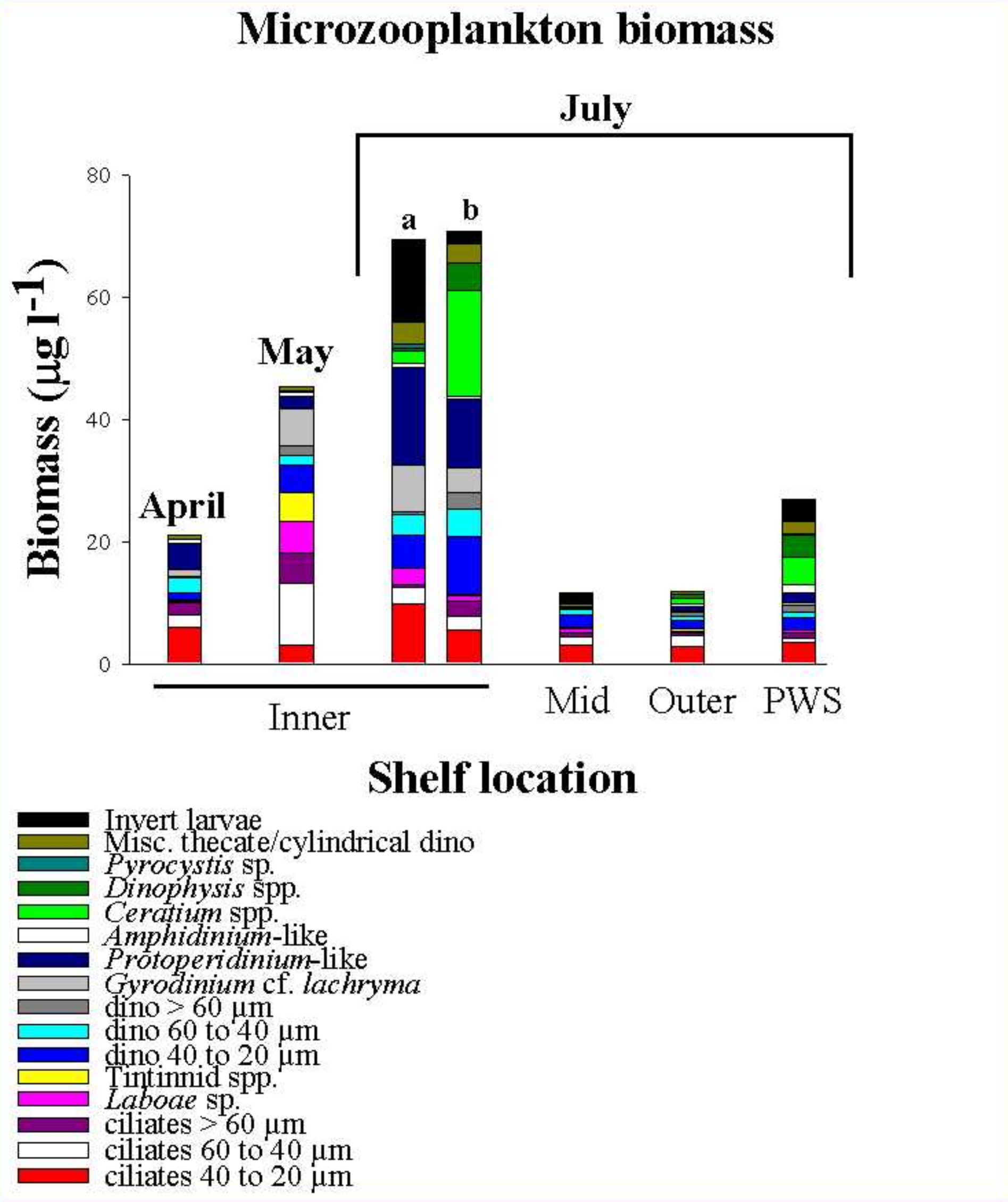


Fig. 3 Contribution of different microzooplankton taxa to total initial biomass of selected dilution experiments. Estimates were calculated by averaging replicate counts from each experiment. In all cases, >200 cells were counted and digitized. **a** and **b** represent inner shelf stations in July, where **b** was sampled 15 days later than **a**. Dino: dinoflagellates.

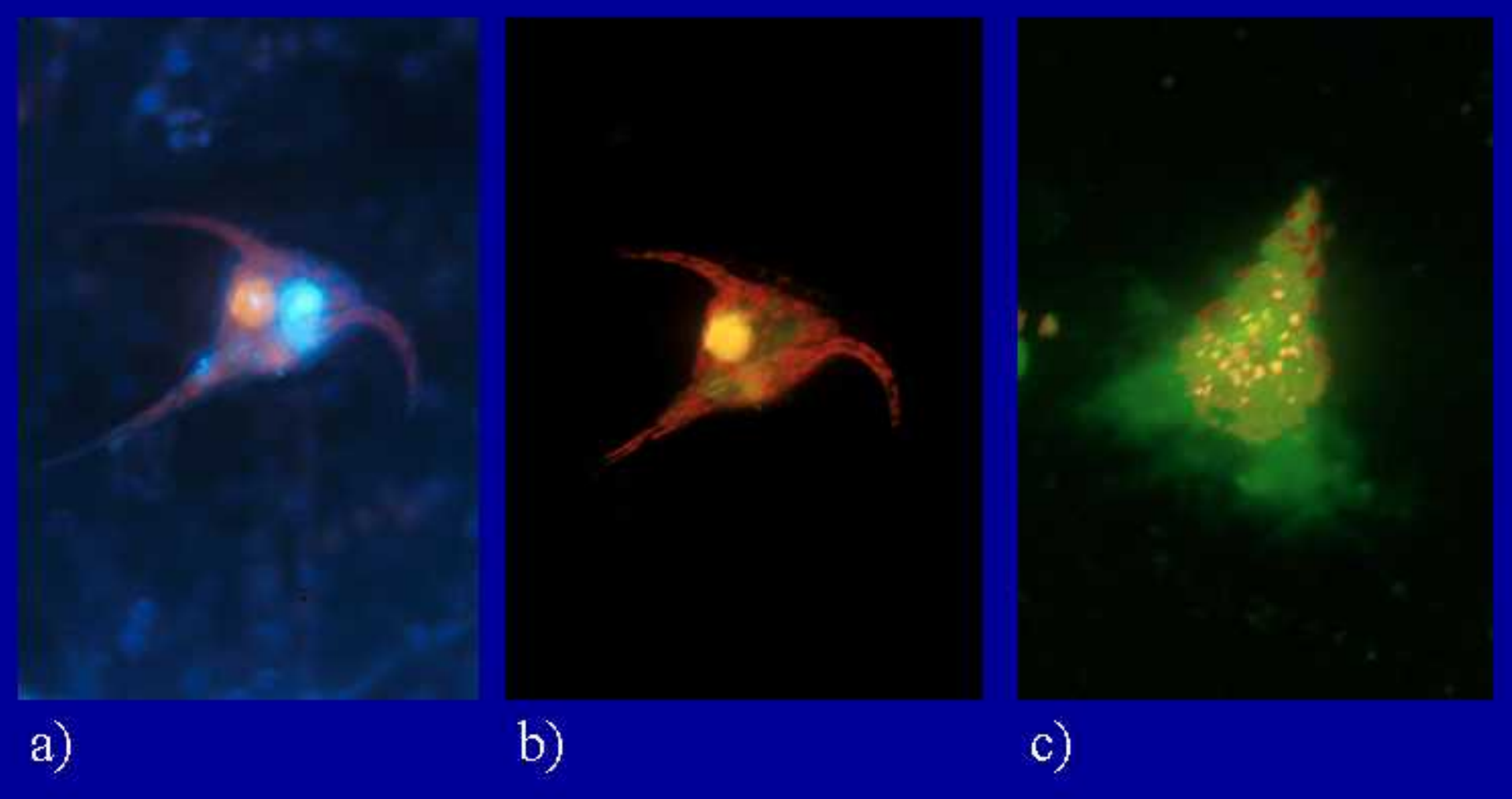
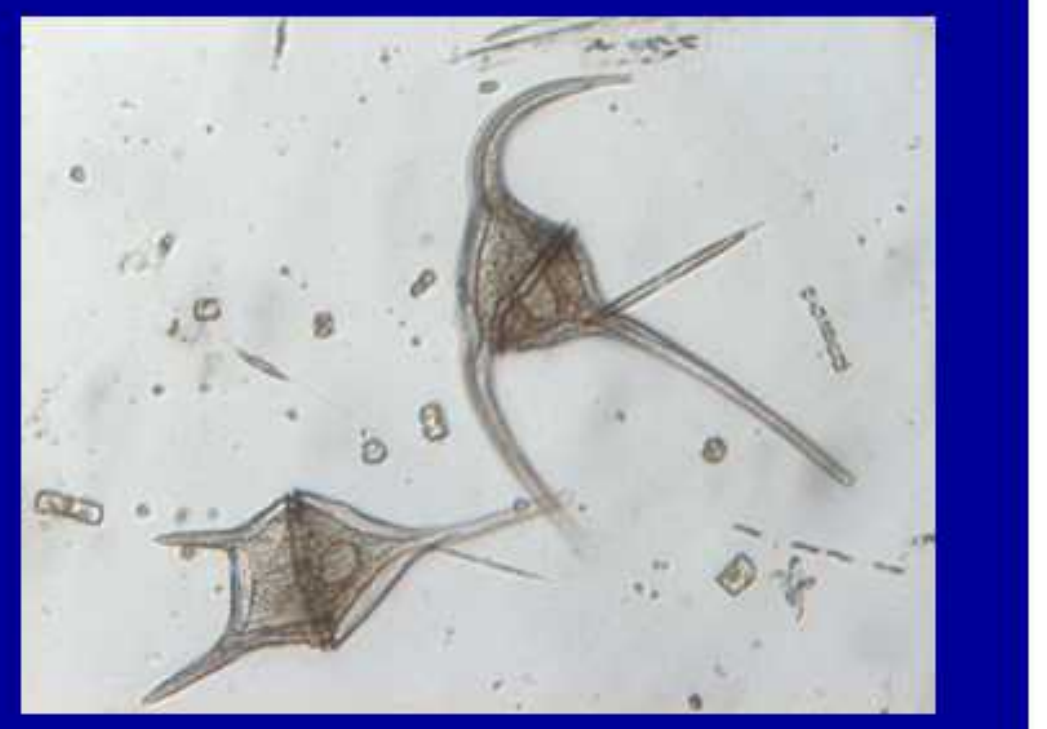


Fig. 4a-h Photos of large microzooplankton encountered during July at nutrient-poor, low chlorophyll locations. Figs. a-b is the mixotrophic dinoflagellate *Ceratium* cf. *tripos* under (a) UV excitation, and (b) blue excitation, showing the nucleus (a, blue dot) and ingested prey (a-b, orange dot). Fig. C is a mixotrophic Strombidiid ciliate under blue excitation. Figs. d-h are an assortment of large microzooplankton found on the inner shelf and Prince William Sound during July when diatom biomass was low.



d) *Ceratium* cf. *tripos* and *C.* cf. *lineatum* (Inner shelf, July)

e) *Protoperidinium* sp. (PWS, July)

f) *Gyrodinium* cf. *lachryma* ingesting large diatom (Inner shelf, July)

g) The large ciliate *Tiarina fusus* (PWS, July)

h) A large oligotrich ciliate, possibly *Strombidium* sp. (PWS, July)

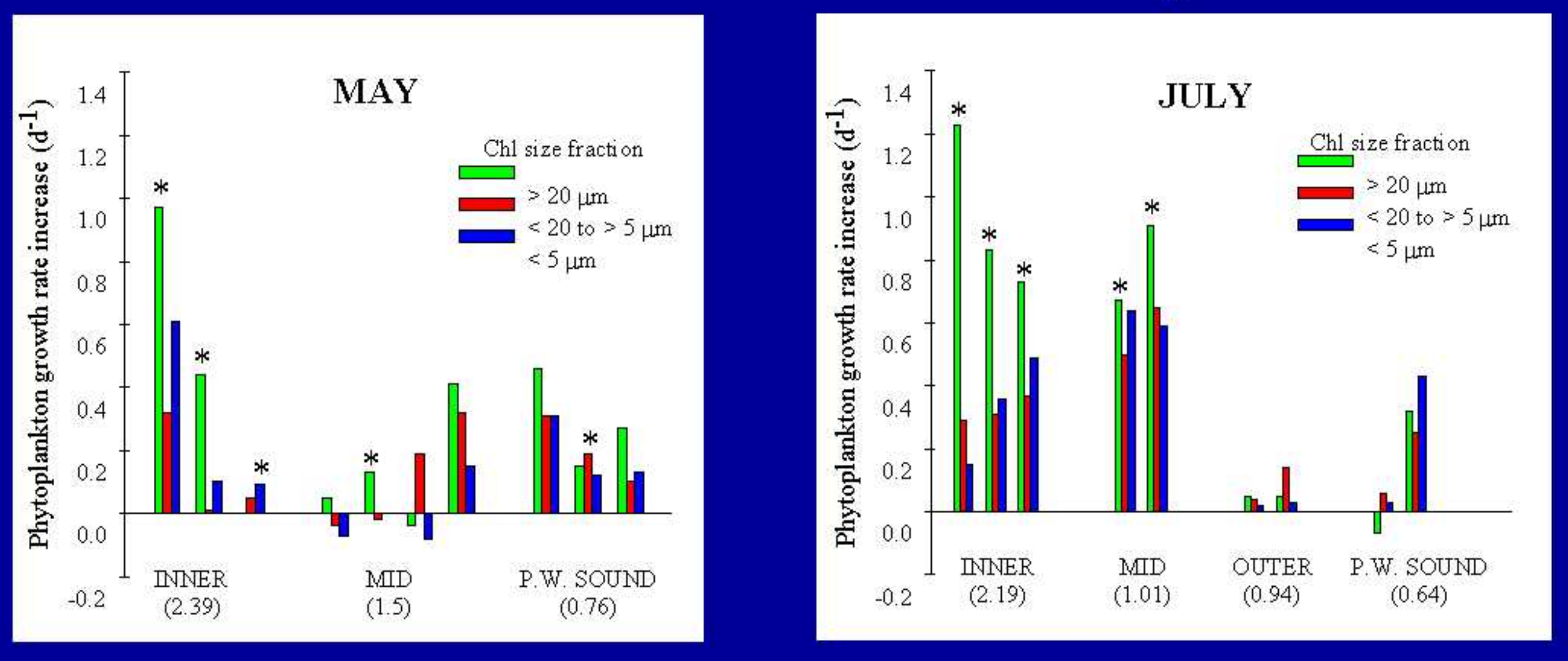


Fig. 5 The ***increase*** in phytoplankton cell division rate due to nutrient additions at different coastal locations for May and July 2001. Each group of vertical bars represents a separate experiment and date. Vertical bars with * over the top represent bloom stations (defined as locations where chlorophyll exceeded 1 μg l^{-1}) .

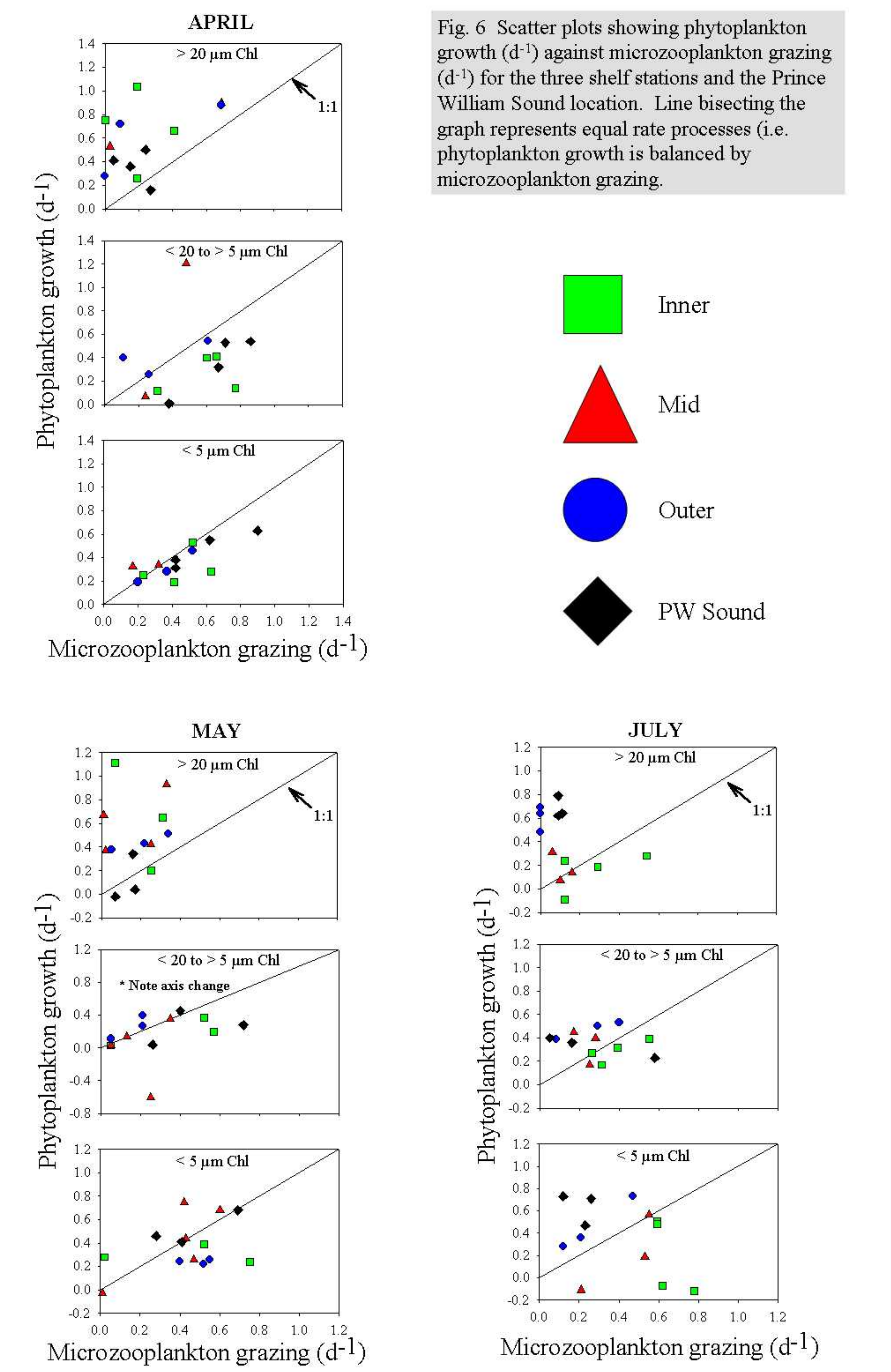


Fig. 6 Scatter plots showing phytoplankton growth (d^{-1}) against microzooplankton grazing (d^{-1}) for the three shelf stations and the Prince William Sound location. Line bisecting the graph represents equal rate processes (i.e. phytoplankton growth is balanced by microzooplankton grazing.

Summary:

Climate-forced, salinity-driven stratification of inshore waters allowed high concentrations of chlorophyll to develop, especially for large cells. Mesoscale features and turbulent flow associated with the Alaska Coastal Current may have contributed observed patchiness of this biomass. Phytoplankton growth rates were moderate, and most phytoplankton growth was consumed by microzooplankton, especially for size fractions < 20 μm. Equally important in regulating phytoplankton growth was availability of inorganic nutrients, where apparent pulses of nutrient additions gave rise to dramatic responses of phytoplankton on short time scales. Accumulation of large cells appears to be regulated by nutrient limitation, and to some degree, microzooplankton grazing. Large (>60 μm) dinoflagellates and ciliates were abundant during and after periods of high diatom biomass. The high abundance of large microzooplankton after diatom biomass diminished may suggest the possibility of a mixotrophic and detritus-based food web. Thus, physical responses of the Gulf of Alaska to climate and weather alter chemical properties in complex ways, which affect microbiota in similar fashions.

Acknowledgments:

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