the 200 and 600 grid lines (figure 2). CO_2 concentrations typically increased with increasing distance from shore. In comparison, CO_2 concentrations remained relatively constant along the 300 line (located between the 200 and 600 line) from 50 to 200 kilometers from shore. The coastal areas on the 200 and 600 line are near the mouths of large submarine canyons that may sustain large phytoplankton blooms by an enhanced macro- and micronutrient supply. Further analysis is needed to test the numerous ecological predictions of this hypothesis.

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A cross-site study of microbial ectoenzyme activities and regulation: Preliminary results from the Palmer Long-Term Ecological Research component

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The microbial loop is ubiquitous in marine and freshwater ecosystems (Hobbie 1994), but dissimilar biotic and abiotic factors regulate its components' activities in different habitats. We have commenced a cross-site project to investigate regulation of microbial ectoenzyme expression and bacterial processes in polar and subtropical marine habitats, sites represented, respectively, by the Palmer Long-Term Ecological Research (LTER) grid (Waters and Smith 1992), and the Hawaii Ocean Time-series (HOT) station ALOHA (A Long-Term Oligotrophic Habitat Assessment) (Karl and Lukas 1996).

Working from R/V *Polar Duke* in the Palmer LTER region, Marguerite Bay, and Tickle Channel from 11 January to 7 February 1997, we first described potential activities of the ectoenzymes α-glucosidase (AGase), ß-glucosidase (BGase), and leucine aminopeptidase (LAPase) in seawater from various depths at *in situ* temperatures. Fluorogenic substrate analogs were applied after Hoppe (1983), Somville and Billen (1983), and Christian and Karl (1995a), and fluorescence was determined in a Perkin-Elmer LS-5B spectrofluorometer. Activities are potential because substrate analogs were applied at saturating rather than trace concentrations.

Within a region of the LTER grid bounded by stations 200.000 to 600.200, surface AGase activities (figure 1*A*) were lowest at the center and seaward of a line approximately 75 kilometers (km) off the peninsula (mean 0.190 nanomoles per liter per day, SD=0.189, n=46). Higher activities at each end of the grid may reflect topographically steered upwelling. Enzyme activity peaked in Marguerite Bay where a phytoplankton bloom (diatoms and *Phaeocystis*) and highest oxygen (O_2) and lowest carbon dioxide (CO_2) levels were encountered (Carrillo and Karl, *Antarctic Journal*, in this issue). The pattern of BGase activities (figure 1*B*) across the grid was similar to that of BGase, except BGase activities were undetectable (<0.1 nanomoles per liter per day) in 29 of 53 surface samples. Across the grid, surface water BGase activities averaged 0.097 nanomoles per liter per day (SD=0.181, n=46). These data support the view that activities in the Antarctic Peninsula coastal zone may represent global minima (Christian and Karl 1995b). Christian and Karl (1994) also noted high BGase activities near sea ice in Marguerite Bay in 1991–1992. During the LTER *PD*97-01 cruise, activities were highest in Marguerite Bay and Tickle Channel; the latter was blocked by sea-ice.

Proteolytic activity is common in polar marine bacteria (Kriss 1963), and Christian and Karl (1995b) described high LAPase activities in the LTER grid. In the southern oceans, this may reflect a bacterial requirement for more dissolved organic matter (DOM) for growth at low temperatures (*sensu* Wiebe, Sheldon, and Pomeroy 1993). Activities peaked (>2,000 nanomoles per liter per day) along the 600 line (figure 2) and decreased with increasing latitude; elevated levels accompanied the bloom in Marguerite Bay and Tickle Passage (approximately 600 to approx-imately 1,800 nanomoles per liter per day, respectively). LAPase activity generally peaked at the sur-

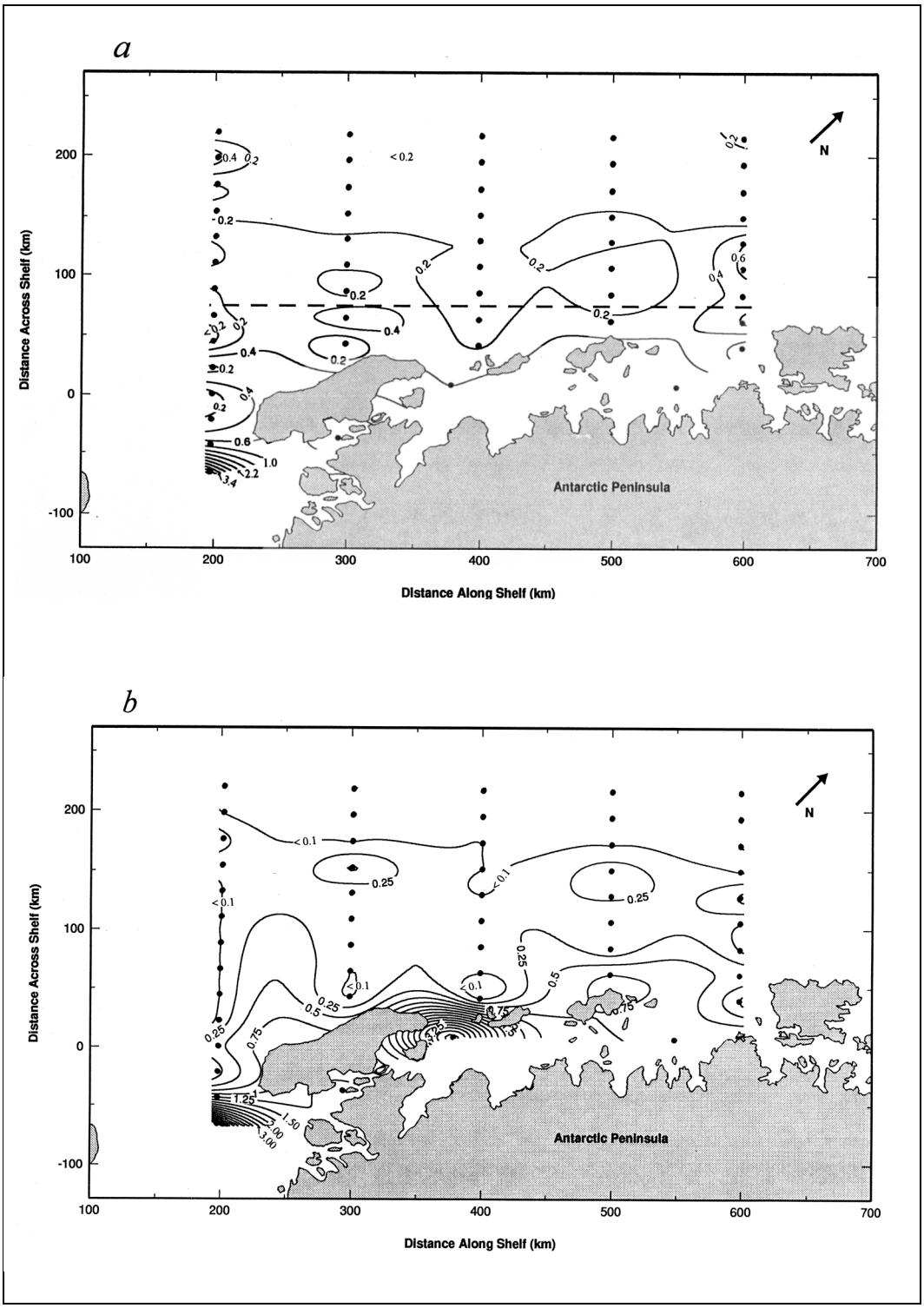

Figure 1. *A.* α-glucosidase, and *B.* ß-glucosidase activities across the surface of the LTER grid during *PD*97-01. Lowest AGase activities were recorded seaward of the dashed line on *A*. Solid circles indicate the positions where samples were collected. Contours are presented as nanomoles of substrate hydrolyzed per liter per day; contour intervals are *A*, 0.2 and *B*, 0.25.

face and decreased rapidly below the 13 percent light level (approximately 50 meters) (figure 3).

LAPase activities in 0.8-micrometer Nuclepore-filtered seawater with organic or inorganic nitrogen (N) [histidine, leucine, proline, tryptophan, phenylalanine, tyrosine, glycine, imidazole, ammonium (NH_4), nitrate (NO_3)] nutrient additions applied separately at 1 micromolar (μ*M*)—N were generally repressed only by phenylalanine and tyrosine through 48-hour incubations. That no other N-source consistently affected the activity of any of these enzymes or increased bacterial numbers, the latter determined through flow cytometry (Monger and Landry 1993) may in part result from low organic nutrient diversity (Griffiths, Caldwell, and Morita 1984); during RACER II, a mixture of 18 amino acids (Sigma AA-S-18) enhanced bacterial numbers by 8.5-fold over a 72-hour incubation (Bird personal communication). Inorganic N availability rarely limits bacterial production in the southern oceans, and concentrations applied here were below those generally found in this area.

Our cross-site study has so far shown that microbial populations at these sites respond differently to tyrosine. At station ALOHA, AGase and LAPase activities are strongly enhanced. Furthermore, although LAPase activities at ALOHA are considerably lower, greatest reductions in activity with depth at that site occur below approximately 125 meters.

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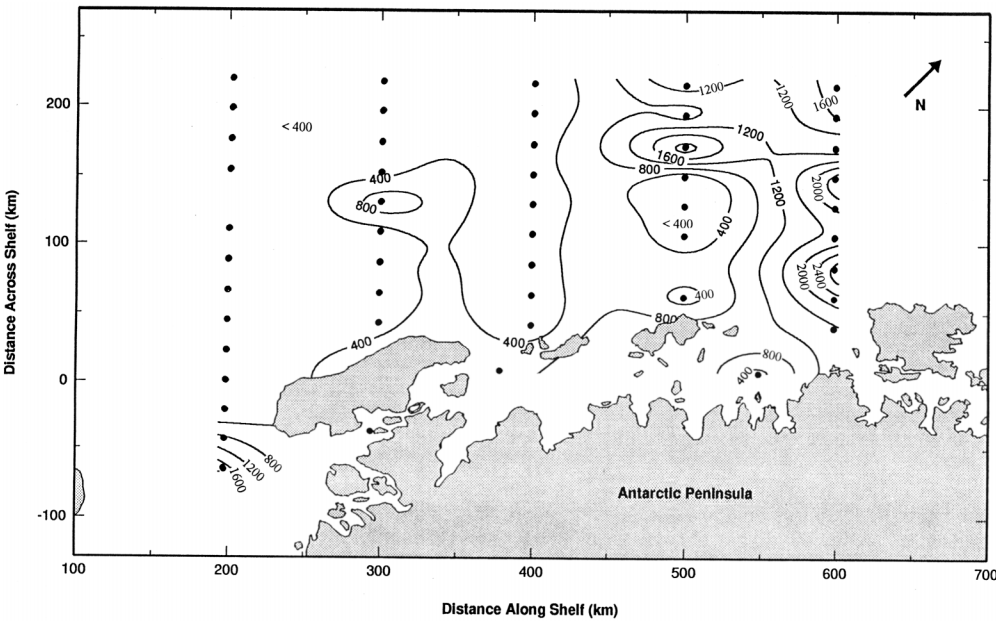

Figure 2. LAPase activities across the surface of the LTER grid during *PD*97-01. Solid circles indicate the positions where samples were collected. Contours are presented as nanomoles of substrate hydrolyzed per liter per day; contour interval is 400.

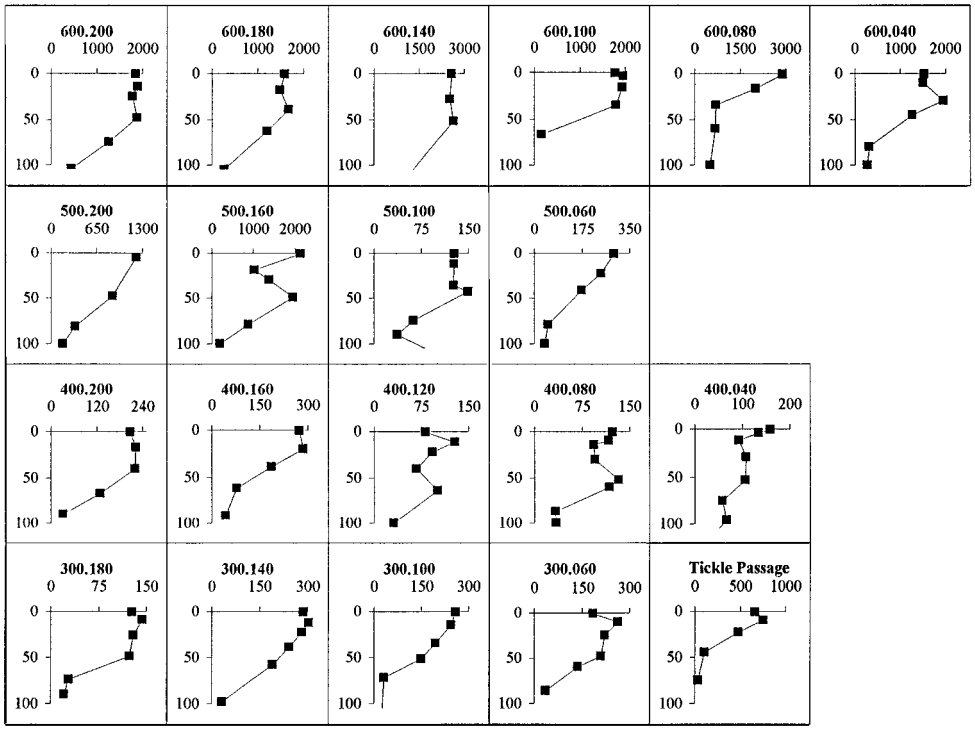

Figure 3. LAPase activities often fell by one order of magnitude at the 13 percent light level (approximately 50 m). x-axis is nanomoles of substrate hydrolyzed per liter per day. Station numbers are in bold.

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Palmer LTER: Stable interannual successional patterns of phytoplankton communities in the coastal waters off Palmer Station, Antarctica

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Over the austral spring/summer periods from November 1991 through January 1994, water column profiles were obtained at the Long-Term Ecological Research (LTER) program station B (Sta B in figure 1) for concurrent determinations of physical and biological parameters related to phytoplankton dynamics. A Seabird® CTD (SEACAT SBE 19-03) was profiled free-fall from surface to near bottom from a Mark V Zodiac®. The instrument samples at a rate of 2 hertz. At a lowering rate of approximately 5 meters per second, approximately four samples per meter were retrieved. Along with the physical measurements, 615 discrete water column samples were collected for pigment determination in 5-liter GoFlo bottles within a few hours of solar noon. Samples were transported in dark bottles within 30 minutes of collection to Palmer Station (figure 1) for analyses. A more detailed description of the sampling strategy is given by Moline and Prézelin (1996, 1997).

Aliquots of all whole-water samples were analyzed for the algal pigments using reverse-phase high-performance liquid chromatography procedures of Wright et al. (1991). Specific details of the sample processing and pigment identification are described elsewhere (Moline and Prézelin 1996; Claustre, Moline, and Prézelin 1997). Pigment data were used to estimate phytoplankton standing crop (chlorophyll-*a*) and as chemotaxonomic markers to differentiate between algal groups. The four taxonomic groups that dominated the phytoplankton communities in the study area over the 3 years were diatoms, prymnesiophytes, cryptophytes, and chlorophytes. From the class-specific accessory pigments and the total chlorophyll-*a*, the percentage contribution of each taxonomic group to the overall biomass was calculated using multiple regression techniques (Everitt et al. 1990; Claustre et al. 1997). This approach indicated that the dominant accessory pigments (fucoxanthin, alloxanthin, 19'-hexanoyloxyfucoxathin (HF) + 19'-butanoyloxyfucoxathin (BF) and chlorophyll-

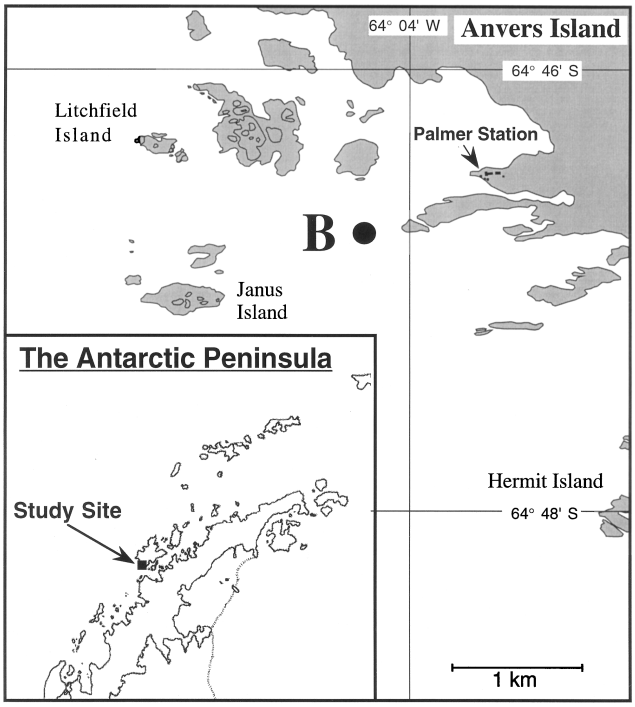

Figure 1. Location of LTER sampling station B (64°46.45'S 64°03.27'W) with respect to Palmer Station and the Antarctic Peninsula (inset). (km denotes kilometer.)