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Tidal zone ecology at Palmer Station

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The presence of ice in the antarctic marine environment has been studied extensively. Ice reduces the intensity of light entering the water, causes large seasonal variations in the salinity of the water, denudes the near shore zone, and limits the vertical migration of plants and animals. While studying tidal zone ecology at Palmer Station in 1970 under the direction of Dr. Joel W. Hedgpeth, the author observed the effect of many of these phenomena on the ecology of Arthur Harbor.

Anchor ice (bottom-forming ice) formed on June 2 and lifted on June 10, 1970, as observed during scuba dives. Oceanographic and biological implications of anchor ice have been discussed by Dayton *et al.* (1969). The limit of anchor ice formation in Arthur Harbor was very sharp and occurred to a depth of 2.85 meters below mean sea level (fig. 1), in marked contrast to the 33 meters depth that Dayton *et al.* (1969) found in McMurdo Sound. The anchor ice had a negligible effect on the biota; when it lifted on June 10, its unconsolidated nature prevented extensive tearing and lifting of plants and animals.

Large icebergs entering Arthur Harbor often become grounded. Generally they remain for several days, but a stay of 2 to 3 weeks is not uncommon. A grounded berg crushes and churns the substrate as it oscillates owing to the effects of the tide, wind, and waves. Fig. 2 shows a typical mud buttom after the passage of a grounded berg. Note the large number of broken shells of the bivalve *Laternula elliptica* and the algal fragments. The destruction of the substrate and its fauna is extensive, and in most cases few of the larger benthic invertebrates survive.

Observations made during almost 200 scuba dives suggest that the movement of brash ice may be indirectly related to the distribution of at least four species of ctenophores in the surface waters (fig. 3). No ctenophores were observed in Arthur Harbor before June 2. During dives below the brash ice on this date, densities of 0.5 per cubic meter were observed. (All densities are approximate and were estimated from photographs.) No ctenophores were observed in ice-free areas. On June 3, wind-blown brash ice entered the harbor. Ctenophore densities of 25 to 50 individuals per cubic meter of water were found. The greatest densities occurred from the water-ice interface to a depth of 1.5 meters. In an area approximately 50 meters upwind from this point, there was no brash ice and no ctenophores.

Densities were always lower beneath fast ice in comparison to those under the brash ice, even when the two adjoined. On June 16, the following densities were observed: 5 per cubic meter beneath fast ice, and 70 per cubic meter beneath brash ice. The sudden appearance of ctenophores in June remains unexplained.

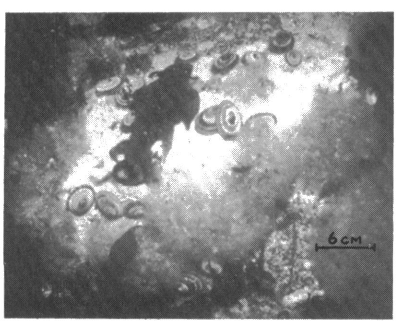

Figure 1. Anchor ice formation. Note limpets, *Patinigera polaris,* and alga, *Iridaea* sp.

Figure 2. Mud bottom, 15 meters below water's surface, after an iceberg had grounded. Note shells and algal fragments.

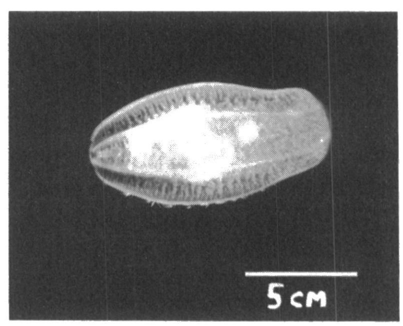

Figure 3. An individual of the most abundant species of ctenophores observed in Arthur Harbor.

Studies of life between tidemarks initiated by Hedgpeth (1969) and continued by Stout and Shabica (1970) were intensified during the 1970 austral winter by Shabica (1971). Six tide pools, 0.6 to 1.46 meters above zero tide level, were observed monthly to better understand how plants and animals tolerate the extreme environmental stresses in this transitional zone between land and sea. During the coldest part of the winter, thick layers of shore ice and snow (up to 1.75 meters) were found to blanket the pools. The tide pools were connected to the subtidal by ice tunnels originating at their seaward edges. These heavily protected tunnels allowed sea water to circulate freely in the pools at high tide. The lowest water temperature recorded for a tide pool was −1.97°C. The ice covering thus prevents exposure of the tide pools to air temperatures of as low as −25°C. and prevents grinding and crushing by brash ice.

In the tide pools, major variations were seen in winter in the algal population. A marked reduction in the size and number of individuals per algal species was noted; and no species of filamentous green algae, noted by Hedgpeth (1969), were seen. Nonetheless, fructification of one species, *Iridaea,* was observed throughout the winter; this observation agrees with the observations of Zaneveld (1968) that many algae tolerate the stresses of the environment. The protection afforded the algae by the ice thus permits their wintering over between tidemarks.

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Benthic studies in the Antarctic

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Palmer Station (Anvers Island). The soft-bottom benthos at Palmer Station was sampled with a 0.07-square-meter Van Veen grab, January and February 1971. Five replicate grabs were obtained at each of 12 stations in Arthur Harbor. Depths ranged from 4 to 75 meters. One station outside of Arthur Harbor at depths between 400 and 700 meters also was occupied.

All grab samples were sieved through a 0.5-millimeter screen, and the fraction remaining on the screen was preserved in 10 percent formalin in seawater. Sediment samples were obtained for particle size analysis.

The Van Veen grab collected quantitatively in the silt-clay substrate. Densities of the epifaunal isopod *Serolis polita* and the deep burrowing lamellibranch *Laternula elliptica* obtained by scuba diving corresponded well with densities calculated from grab samples.

Black mud with a hydrogen sulfide odor was noticed at several stations. It was due to decaying algae broken from the rocky shore and collected in depressions left from grounded icebergs. Partially decayed algae covered with large numbers of amphipods were brought up at one station.

Samples sorted to date indicate a high diversity of species and higher taxa, and high faunal density and biomass. All the samples will be sorted and identified at Oregon State University.

Numerical community analysis will be applied to the data. The variations of benthos between and within stations will be studied. Community characteristics (diversity, dominance, etc.) will be measured and compared to those for benthos in other parts of the world.

Few quantitative studies of the soft-bottom benthos of the Antarctic have been made. It is hoped that the effect of a cold but stable environment on the evolution of benthic community structure can be determined and related to the time-stability hypothesis of species diversity.

Deception Island (South Shetland Islands). On January 18 and 19, 1971, a benthic survey was conducted to determine the effects of the volcanic eruptions of December 1967, February 1969, and October 1970 on the benthic invertebrates of Deception Island. I was interested in which areas were affected by volcanic activity and if repopulation had begun.

Twenty 0.07-square-meter Van Veen grabs were obtained from 10 stations in Port Foster. The samples were washed through a 0.5-millimeter screen, and the fraction that remained was preserved in 10-percent formalin in seawater. A 0.5-millimeter screen was used because many of the organisms repopulating Port Foster since the October 1970 eruption would pass through a larger screen.

The substrate of stations close to the site of the 1970 eruption consisted mostly of volcanic ash and