unamended water led to slow decline in bacterial abundance, whereas growth was rapid in lighted controls. Using these results in combination with data derived from the radioisotope uptake experiments, we hope to determine whether the current notion that bacterial population size is determined by nutrient supply rate, and production by grazing loss rate, is applicable to antarctic bacteria.

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RACER: Fine-scale and mesoscale zooplankton studies during the spring bloom, 1989

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By comparison to other nearshore areas of the Antarctic Peninsula, the Gerlache Strait can support unusually large standing stocks of macrozooplankton, including krill (Hopkins 1985; Brinton and Townsend in press; Huntley and Escritor in press). Huntley and Brinton (in press) postulated that a persistent physical circulation mechanism might be responsible for retaining an abundant population of *Euphausia superba* larvae in the northern Gerlache Strait during summer and early fall. The best estimates of mesoscale circulation in the region, however, can be inferred only from geostrophic calculations based on coarse hydrographic sampling (Niiler, Amos, and Hu in press). Furthermore, the reproduction, development, and growth of zooplankton populations in the Gerlache Strait during spring has never been observed in detail.

Macrozooplankton studies during the 1989 Research on Antarctic Coastal Ecosystem Rates (RACER) were designed to address two key questions:

- Do abundant zooplankton populations accumulate in the Gerlache Strait purely as a result of physical circulation? or
- Do they originate there by virtue of high rates of local reproduction, development and survival in the spring?

To answer these questions effectively, our study required that physical oceanographic measurements be made in conjunction with our observations of macrozooplankton populations. Physical oceanography included assessment of watermass structure based on frequent and comparatively high-resolution hydrographic surveys throughout the northern Gerlache Strait and western Bransfield Strait (Amos, Jacobs, and Hu, *Antarctic Journal*, this issue), and direct measurements of upper water-column mesoscale circulation obtained from ARGOS-linked Lagrangian drifters (Niiler, Illeman, and Hu, *Antarctic Journal*, this issue).

Macrozooplankton studies were aimed at obtaining information on the vertical and horizontal distribution of species with the highest possible resolution in time and space. Two principal pieces of equipment were used: a "fast net" and a multiple opening and closing net and environmental sensing system (MOCNESS). The fast net is a 1-meter diameter, bridleless net capable of being towed at speeds of approximately 4 knots; our main purpose in using it was to attempt to obtain more representative catches of krill, which are well known to avoid slower sampling equipment. The fast net, using 1-millimeter mesh, was deployed at every "fast grid" zooplankton sampling station (figure 1) on each of the four fast grids from 30 October to 24 November 1989. The MOCNESS, with 1-square-meter mouth opening and 330-micron mesh nets, was also deployed at each of these stations at standard depth intervals, in meters, of 0–5, 5–15, 15–50, 50–90, 90–130, 130–170, 170–210, 210–250, and 250–290; one additional net fitted with 180-micron mesh was used for the 0–300 meter downcast. At the time-series station ("A"), which was visited for four 3-day periods during the cruise, MOCNESS was deployed at 6-hour intervals.

The MOCNESS was also used in two focussed studies at station A designed to resolve horizontal patchiness and fine-scale temporal variation in vertical distribution of macrozooplankton. In the horizontal patchiness study, the net was yo-yoed at the 15–50 meter depth interval over a total distance of approximately 1.5 kilometers, eight successive times over a 2-day interval, providing resolution at a scale of 150 meters. In the fine-scale temporal variation study, the net was towed at standard depths to 300 meters at 90-minute intervals over a 2-day period, providing a total of 32 "snapshots" of vertical distribution over a 48-hour period.

The 1989 zooplankton sampling program has provided us with a total of more than 1,200 samples which are now in the process of being analyzed. Ultimately, we intend comprehensive studies of at least the following species: the euphausiids *Euphausia superba*, *E. crystallorophias*, and *Thysanoessa macrura*, and the copepods *Calanoides acutus*, *Metridia gerlachei*, and *Rhincalanus gigas*; other species may also be analyzed depending on their relative importance. At present, however, a complete presentation of results is premature. In this article, we present some examples of recent analyses on the vertical distribution of *Calanoides acutus* during our high-resolution time series study at station A and the comparative night- and daytime abundance and vertical distribution of *Euphausia superba* at three selected stations from each of four successive fast grids.

The *Calanoides acutus* population, dominated by CV and CVI copepodites, was actively reproducing (Huntley and Lopez, *Antarctic Journal*, this issue). More than 80 percent of the CVI females were concentrated in the upper 50 meters, and did not appear to undergo diel vertical migration (figure 2), although to date we have only analyzed one series of 10 tows taken over the period from approximately midnight to noon. The CV copepodites (not shown) had approximately the same vertical distribution and, likewise, did not appear to undergo diel vertical migration. Drifter studies indicate that the residence time of waters near station A may be as high as 2.5 months (Niiler et al., *Antarctic Journal*, this issue). This observation, coupled with the high degree of consistency in the absolute abundances of *C. acutus* from our MOCNESS tows, suggests that the population was homogeneously distributed

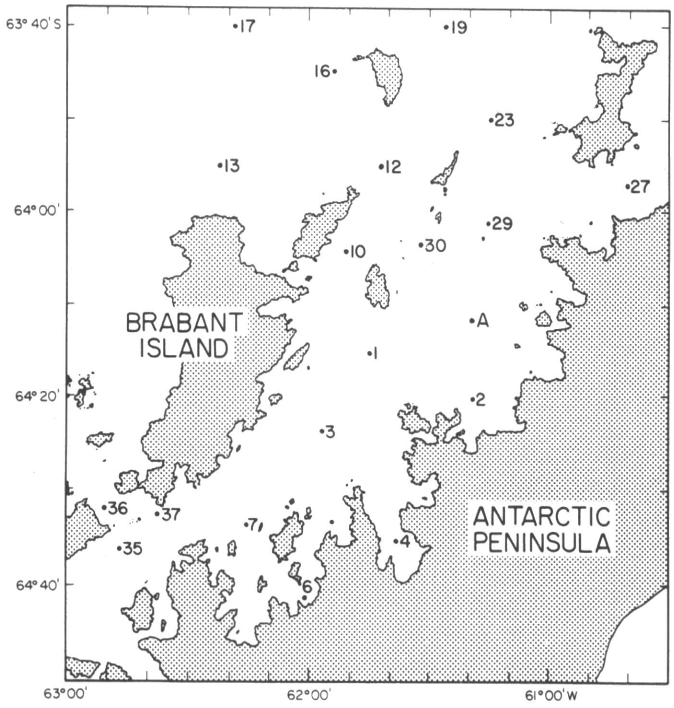

Figure 1. Locations of the 20 zooplankton stations sampled during the four consecutive fast grids conducted from 20 October through 24 November 1989. Station A is the time-series station, visited for four 3-day durations during the same time period.

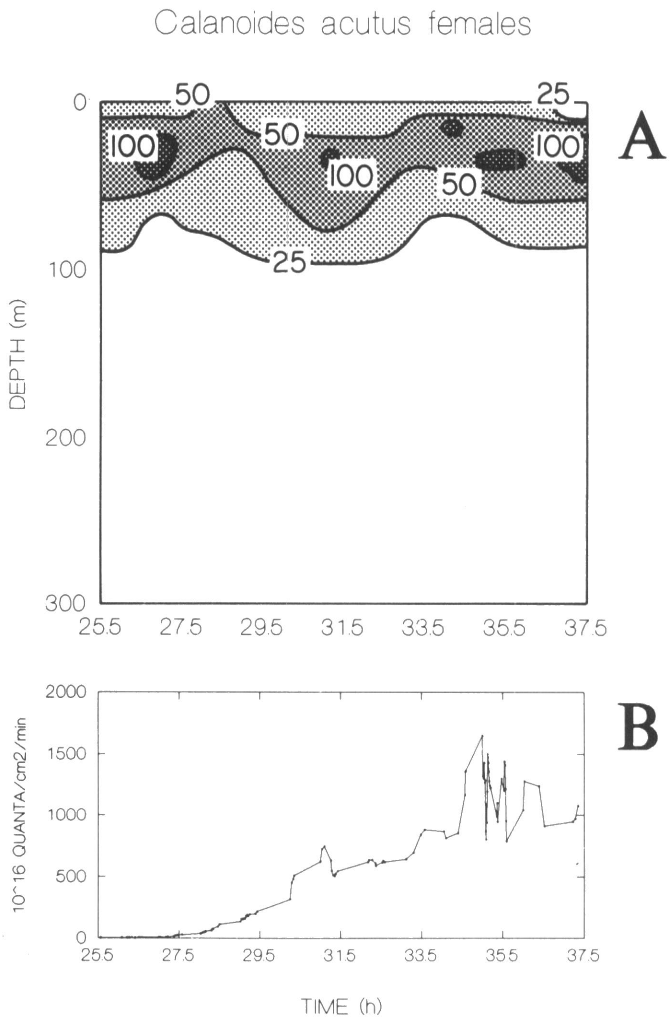

Figure 2. A. *Calanoides acutus* adult females: Vertical distribution at station A, based on a series of ten MOCNESS tows at 9 nine depth intervals taken between 0130 hours (hour 22.5 of the 48-hour time series) and 1430 hour on 21 November 1989. Contours (percentage of the total population) show that the majority of individuals were in the 15–50 depth interval. B. Ambient surface light intensity (PAR), in 10^{16} quanta per square centimeter per minute, over the same time period. (m denotes meter. cm^2/min denotes square centimeters per minute. h denotes hour.)

in the horizontal on scales of at least 1–2 kilometers (tow distance) and that it may have remained there for several months.

For *Euphausia superba*, we have analyzed samples from selected stations in the Bransfield Strait and in the western, central, and northeastern Gerlache Strait (station A). From this preliminary analysis it appears that, throughout the study region, the population consisted mainly (>90 percent) of immature krill 25–33 millimeters in total body length. There were also small juveniles (18–24 millimeters) and large subadults (35–39 millimeters) occurring particularly in eastern and northern areas near the Antarctic Peninsula. Immature males were common and small mature males were sometimes found. There were substantial numbers of females (30–36 millimeters) with developing ovaries. Few had attached spermatophores. We have not encountered ripe females, but the population structure seems to portend a local reproductive stock of small abundant, probably first-time spawners. Our analysis will examine details of body length and maturity progressions during the course of the November bloom.

Krill were most abundant in the eastern and northern part of the Gerlache Strait where it joins the Bransfield Strait. They were fewest in the area of strong northward flow in the western Gerlache. Small dense swarms were frequent, with abundances up to at least 2×10^5 individuals per square meter at station A and up to 6,000 grams net weight per cubic meter throughout the upper 50 meters. *Euphausia superba* were almost entirely above 50 meters depth, day and night, with individuals dispersed to 200 meters in some day and night MOCNESS tows.

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RACER: Egg production of *Calanoides acutus* during the spring bloom, 1989

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The copepod *Calanoides acutus* (Giesbrecht) is a dominant member of the zooplankton community in waters south of the Antarctic Convergence. Its annual spawning period has been inferred from a combination of observations, including the appearance of females with developed ovaries and the later appearance of copepodite stages in the plankton (Andrews 1966; Voronina 1970). Egg production rates have been recorded on one occasion apparently late in the reproductive season (Huntley and Escritor in press), but the onset of annual spawning has never been observed. *Calanoides acutus* is predominantly herbivorous (Hopkins 1985), and the initiation of its fecundity may be directly linked to the availability of abundant phytoplankton food.

With this background in mind, we asked the following questions:

- When does *Calanoides acutus'* egg production begin in relation of the timing of the annual spring bloom of phytoplankton?
- Once egg production has begun, is the rate of spawning linked to the amount of available food and, if so, what is the relationship?
- How much individual variability is there in egg production rates?

Calanoides acutus was collected at 16 stations during the fast grid conducted 22–24 November with a 1-meter, 333-micromesh net towed in the upper 100 meters. All active females were sorted and placed individually in 250-milliliter plastic beakers with 500-micromesh bottoms, and suspended in 500-milliliter plastic jars containing surface water from the station where they were collected. These were incubated for approximately 24 hours at ±1 °C of ambient seasurface temperature in the dark. After incubation, individual clutches of eggs were preserved separately in approximately 2 percent formalin in seawater, and females were frozen at −20 °C. Egg production rates of more than 700 individual females were measured in this manner.

To determine the feeding period required for egg production to resume at different food concentrations in pre-starved females, copepods collected at station A on 8 November were stocked in filtered surface seawater as above, at 5 females per jar. After 3 days, when egg production ceased, groups of 5