Procedures for *in situ* observations of krill schools in the southern ocean

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Only a few observations of euphausiids are reported in the literature (Fenwick 1978; Kils 1979; Pavlov 1969; Ragulin 1969). In this article I describe the procedures we used to locate and observe schools of the antarctic krill, *Euphausia superba*, under water with scuba in the austral summer of 1982.

On three cruises of the R/V *Hero* in January and February 1982, divers were deployed in the Gerlache Straits, the Bransfield Straits, Charlotte Bay, the Drake Passage outside Livingston Island, and near Elephant Island. The *Hero* found numerous aggregations of *E. superba*, usually by echo sounder but also by watching for krill predators—primarily humpback whales, *Megaptera novaeangliae*, and Wilson's storm petrel, *Oceanites oceanicus*. These aggregations were sampled with a midwater trawl, but most were too deep for direct observations by divers, who were limited to 20 meters depth.

Our research team of five divers made 12 separate dives in deep-water locations that appeared promising for krill observations. We sighted krill on only six of these dives. Of the six, three took place between 1600 and 1700, and one was at midnight; our use of lights for these dives clearly altered the krill's behavior. Krill were sighted on a fifth dive, made at 1400 in the Drake Passage near Livingston Island, but they were most abundant below 20 meters and were difficult to see from above. The most productive dive was in Crocker Passage on 17 February between 0500 and 0730. The water was exceptionally clear, with 30 meters horizontal visibility, the sea was flat, and the weather was clear and windless. Immense schools of *E. superba* surrounded the *Hero* in the surface waters, and we made most of our behavioral observations on this occasion.

Both our research team and the *Hero's* crew kept constant watch for krill aggregations. Divers were on 24-hour standby, with dry suit diving equipment fully readied. Using dry suits of noncompressible material, with large passive exhaust valves for buoyancy control, and underwear of thick polypropylene for insulation, divers could stay in water of 0°–1°C for 2½ hours. When krill were located, a surface drogue was thrown from the ship to mark the site. Divers left the *Hero* in a rubber boat and were under water within 20–30 minutes. Speed was important both because the krill schools moved horizontally quite rapidly and because research time aboard the *Hero* was shared by four research groups.

We used bluewater diving techniques modified after Hamner (1975, 1979). Divers entered the water from a 16-foot (4.7-meter) rubber boat and swam on the surface along a slack buoyant line tethered from the boat to a float 20 meters away. A vertical, 30-meter down-line, weighted with a 2-kilogram weight and knotted at 10 and 20 meters, was tied to the float. Each research diver attached a 20-meter safety line to the down-line, as described by Hamner (1975). One safety diver watched depth limits and diving time and kept the research divers' safety lines untangled. If the divers did not see a school of krill or if the school moved away, the divers would swim horizontally, towing the down-line and the surface float with their safety lines. The boat operator would follow the tethered float, keeping slack in the line to avoid straining the lines under water. In this way the divers maintained continuous line contact with their surface support, of vital importance in open-ocean diving. Safety precautions are even more important in Antarctica because of the intense cold, rapid weather changes, and the necessity of immediate rescue in an emergency.

We could approach within 1 meter of schooling krill by swimming slowly toward the school from the side. Approach from above caused avoidance in response to the diver's silhouette; from below, rising exhaust bubbles from the diver's regulator would scatter the school. At distances of 1 to 2 meters divers can readily collect data on density, orientation, swimming speed, size and shape of schools, interactions of individuals within the schools, feeding, molting, excretion, and reaction to predators. *In situ* information of this type is critical to an understanding of the biology of *E. superba*.

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