

other oceanic systems (Azam and Holm-Hansen 1973; Hanson and Wiebe 1977). However, the distribution of activity in the antarctic circumpolar deep water below the antarctic intermediate water shifted from "free floating" microbial populations to cells attached to particles larger than 3 micrometers. At these greater depths, more than 80 percent of the activity was on particles greater than 3 micrometers. This suggests that microbial activity occurs predominately on particles in deep antarctic waters. Under the Ross Ice Shelf, a large fraction of the metabolic activity (29 to 89 percent) was in the size fraction larger than 1 micrometer (Azam, Beers, Campbell, Carlucci, Holm-Hansen, Reid, and Karl 1979). In addition, most particles in the deep sea are relatively large and dominated by plankton skeletons and shells, and fecal pellets of zooplankton (Honjo 1980). Although there was a shift in the activity from "free floating" cells to those attached to particles in deep antarctic waters, the rates of mineralization are slow and turnover times are very long.

Microbial biomass and bacterial cell numbers were greatest in the antarctic intermediate water. Microbial biomass, estimated from adenosine triphosphate (ATP) was 20 to 30 nanograms per liter at the surface and increased to 50 to 100 nanograms per liter at between 50 and 100 meters. ATP concentrations remained near 5 nanograms per liter or less in waters below 200 meters. Unlike the distribution of microbial activity, most of the biomass (50 to 80 percent) in the surface layer was in the fraction larger than 3.0 micrometers. Bacterial cell numbers correlated with microbial biomass. In surface water cell counts were between 10,000 and 30,000 cells per liter and increased three times in the antarctic

intermediate water and polar frontal zone. Ribonucleic acid concentrations were highest (8 to 10 micrograms per liter) in surface waters. Concentrations were generally less than 3 micrograms per liter between 200 and 3,000 meters.

Another cruise on the R/V *Atlantis II* is scheduled for the 1980 austral winter in the Pacific sector of the southern ocean, with Daniel Pope as co-principal investigator. This work was supported in part by National Science Foundation grant DPP 78-21507.

## References

- Azam, F., and Holm-Hansen, O. 1973. Use of tritiated substrates in the study of heterotrophy in seawater. *Marine Biology*, 23, 191-196.
- Azam, F., Beers, J. R., Campbell, L., Carlucci, A. F., Holm-Hansen, O., Reid, F. M. H., and Karl, D. M. 1979. Occurrence and metabolic activity of organisms under the Ross Ice Shelf, Antarctic, at station J9. *Science*, 203, 451-453.
- Hanson, R. B., and Snyder, J. In press. Glucose exchanges in a salt-marsh estuary: Biological activity and chemical measurements. *Limnology and Oceanography*.
- Hanson, R. B., and Wiebe, W. J. 1977. Heterotrophic activity associated with particle size fractions in a spartina alterniflora loisel. Salt-marsh estuary Sapelo Island, Georgia in the continental shelf waters. *Journal of Marine Biology*, 42, 321-330.
- Honjo, S. 1980. Material fluxes and modes of sedimentation in mesopelagic and bathypelagic zones. *Journal of Marine Research*, 38(1), 53-97.
- Worley, S. J., and Nowlin, W. D., Jr. 1979. Oceanographic data collected aboard R/V *Melville* during January-February 1979 and AGS *Yelco* during April-May 1979 as a part of DRAKE 79 (Research Foundation Reference No. 79-7-T). College Station: Texas A & M University.

## Benthonic foraminifera collected by the R/V *Hero* near Adelaide, Anvers, and Brabant Islands, 1972-73

HAYDEE LENA

Florida Institute of Technology  
Department of Biological Sciences  
Melbourne, Florida 32901

During the 1972 and 1973 austral summers, the R/V *Hero* collected 32 bottom samples in the vicinity of Adelaide, Anvers, and Brabant Islands near the Antarctic Peninsula. The samples were obtained at depths ranging from 16 to 400 meters. Twenty-two of the samples collected were treated with Rose Bengal (Boltovskoy and Wright 1976) in order to study quantitatively the foraminifera that were alive when collected.

A total of 42 genera and 66 species were determined (see figure). Of the 66 species, 37 had specimens with protoplasm. Fifty percent of the species and 69 percent of the specimens were agglutinated; the rest were calcareous.

The most numerous agglutinated species were *Trochammina antarctica* (18 percent); *Reophax dentaliniformis* (13 percent); *R. subfusiformis* (13 percent); and in less quantity, *Saccammina atlantica* (6 percent) and *T. squamata, forma astrifica* (5 percent). The dominant calcareous species were *Cassidulinoides parkerianus* (7 percent), *Virgulina earlandi* (6 percent), and *Cassidulina subglobulosa* (4 percent).

The species with the largest sample distribution was *R. dentaliniformis*, present in 11 of the 22 samples analyzed (50 percent). In this sense, *R. dentaliniformis* was followed by: *T. antarctica* (45 percent), *S. atlantica* (41 percent), *V. earlandi* (41 percent), *R. subfusiformis* (41 percent), and *T. squamata, forma astrifica* (36 percent).

In general, the faunistic content of the three areas studied was similar and did not differ from that previously found northwest of the Antarctic Peninsula (Earland 1934; Finger 1977; Herb 1971; Lena 1975, in press; Stockton 1973).

The indexes of specific diversity for the three areas were determined from the Shannon-Wiener relationship. The

*Adercotryma glomerata* (Brady) = *Lituola glomerata* Brady, 1878. WP.  
*Ammodiscus gullmarensis* Höglund = *Ammodiscus planus* Höglund, 1947. WP.  
*Ammofluntina argentea* Echols, 1971.  
*Angulogerina angulosa* (Williamson) = *Uvigerina angulosa* Williamson, 1858. WP.  
*Astrammmina sphaerica* (Heron-Allen & Earland) = *Armoredella sphaerica* Heron-Allen & Earland, 1932. WP.  
*Astrononion antarcticus* Parr, 1950. WP.  
*Bolivina acerosa pacifica* Cushman & McCulloch, 1942. WP.  
*Cassidulina bora* Crespín, 1960. WP.  
*Cassidulina crassa* d'Orbigny, 1839.  
*Cassidulina crassa rossensis* (Kennett) = *Globocassidulina crassa* (d'Orbigny) rossensis Kennett, 1967.  
*Cassidulina subglobosa* Brady, 1881. WP.  
*Cassidulinoides parkerianus* (Brady) = *Cassidulina parkeriana* Brady, 1884. WP.  
*Cibicides aknerianus* (d'Orbigny) = *Rotalina akneriana* d'Orbigny, 1846.  
*Cornuspira involvens* (Reuss) = *Operculina involvens* Reuss, 1850. WP.  
*Cribrostomoides jeffreysii* (Williamson) = *Nonionina jeffreysii* Williamson, 1858. WP.  
*Discorbis peruvianus* (d'Orbigny) = *Rosalina peruviana* d'Orbigny, 1839. WP.  
*Elphidium macellum* (Fichtel & Moll) = *Nautilus macellum* Fichtel & Moll, 1798.  
*Epistominella exigua* (Brady) = *Pulvinulina exigua* Brady, 1884.  
*Glomospira charoides* (Jones & Parker) = *Trochammina souamata charoides* Jones & Parker, 1860.  
*Haplophragmoides parkerae* (Uchio) = *Recurvoidella parkerae*, Uchio, 1960. WP.  
*Hippocrepinella hirudinea* Heron-Allen & Earland, 1932. WP.  
*Lagena gracillima* (Seguenza) = *Amphorina gracillima* Seguenza, 1862.  
*Lagena heronalleni* Earland, 1934.  
*Lagena striata* (d'Orbigny) = *Oolina striata* d'Orbigny, 1839.  
*Miliammina arenacea* (Chapman) = *Miliolina oblonga* (Montagu) var. *arenacea* Chapman, 1916. WP.  
*Miliammina lata* Heron-Allen & Earland, 1930.  
*Nodosaria calomorpha* Reuss, 1866.  
*Nonion offine* (Reuss) = *Nonionina offinis* Reuss, 1851. WP.  
*Nonionella bradyi* (Chapman) = *Nonionina scapha* var. *bradyi* Chapman, 1916. WP.  
*Nonionella iridea* Heron-Allen & Earland, 1932. WP.  
*Oolina caudigera* (Wiesner) = *Lagena* (*Entosolenia*) *globosa* var. *caudigera* Wiesner, 1931.  
*Oolina ovalis* (Reuss) = *Lagena globosa* var. *ovalis* Reuss, 1870.

**Species collected. Those designated WP (with protoplasm) were alive when collected.**

indexes ranged from 0.48 to 3.46 (Anvers Island), 1.00 to 2.92 (Adelaide Island), and 1.79 to 2.35 (Brabant Island). The higher values correspond to depths ranging from 80 to 150 meters, and the lower values, to depths ranging from 20 to 30 meters.

I thank A. A. Hernandez for his assistance in collecting the material used for this study.

## References

Boltovskoy, E., and Wright, R. 1976. *Recent foraminifera*. The Hague: W. Junk b.v. Publishers.  
 Earland, A. 1934. Foraminifera, 3. The Falklands sector of the Antarctic (excluding South Georgia). *Discovery Reports*, 10, 1-208.

*Parafissurina dorbignyana* (Wiesner) = *Ellipsolagena dorbignyana* Wiesner, 1931. WP.  
*Parafissurina marginata* (Wiesner) = *Ellipsolagena marginata* Wiesner, 1931.  
*Parafissurina ovata* (Wiesner) = *Ellipsolagena ovata* Wiesner, 1931.  
*Patellina corrugata* Williamson, 1858.  
*Planispirinoides bucculentus* (Brady) = *Miliolina bucculenta* Brady, 1884.  
*Psammosphaera fusca* Schulze, 1875. WP.  
*Pseudobolivina antarctica* Wiesner, 1931. WP.  
*Pseudonodosaria rotundata* (Reuss) forma *elliptica* (Reuss) = *Glandulina elliptica* Reuss, 1863.  
*Pullenia sphaeroides* (d'Orbigny) = *Nonionina sphaeroides* d'Orbigny, 1826. WP.  
*Pullenia subcarinata* (d'Orbigny) = *Nonionina subcarinata* d'Orbigny, 1839. WP.  
*Pyrgo depressa* (d'Orbigny) = *Biloculina depressa* d'Orbigny, 1826. WP.  
*Pyrgo ringens* (Lamarck) = *Miliolites* (*ringens*) *subglobosa* Lamarck, 1804. WP.  
*Recurvoides contortus* Earland, 1933.  
*Reophax arcticus* Brady, 1881. WP.  
*Reophax dentaliniformis* Brady, 1884. WP.  
*Reophax fusiformis* (Williamson) = *Proteonina fusiformis* Williamson, 1858. WP.  
*Reophax oblicuus* Hada, 1957. WP.  
*Reophax pilulifera* Brady, 1884. WP.  
*Reophax subfusiformis* Earland, 1933. WP.  
*Saccammina atlantica* (Cushman) = *Proteonina atlantica* Cushman, 1944. WP.  
*Spiroplectammina bififormis* (Parker & Jones) = *Textularia agglutinans* var. *bififormis* Parker & Jones, 1865.  
*Trochammina antarctica* Parr, 1950. WP.  
*Trochammina discorbis* Earland, 1934.  
*Trochammina inconspicua* Echols, 1971.  
*Trochammina quadricamerata* Echols, 1971.  
*Trochammina squamata* Jones & Parker, forma *astrifica* Rhumbler, 1938. WP.  
*Trochammina wiesneri* Parr, 1950. WP.  
*Turritellevella laevigata* Earland, 1933.  
*Turritellevella shoneana* (Siddall) = *Trochammina shoneana* Siddall, 1878.  
*Valvulina conica* Earland, 1934.  
*Virgulina earlandi* (Parr) = *Bolivina earlandi* Parr, 1950. WP.  
*Virgulina fusiformis* (Williamson) = *Bulimina pupoides* var. *fusiformis* Williamson, 1858.  
*Webbinelloidea irregularis* (Wiesner) = *Thurammina irregularis* Wiesner, 1931.

Finger, K. L. 1977. Foraminiferal species obtained by R/V *Hero* from Deception Island, 1971-1976. *Antarctic Journal of the U.S.*, 12(4), 37-39.

Herb, R. 1971. Distribution of recent benthonic foraminifera in the Drake Passage. In G. A. Llano and I. E. Wallen (Eds.), *Biology of antarctic seas*, Antarctic Research Series (Vol. 17). Washington, D.C.: American Geophysical Union.

Lena, H. 1975. Foraminíferos bentónicos del área de Isla Elefante (Antártida). *Physis* (Secc. A), 34(89), 405-431.

Lena, H. In press. Foraminíferos bentónicos del noreste de la Península Antártica. *Physis*.

Stockton, W. L. 1973. Distribution of benthic foraminifera at Arthur Harbor, Anvers Island. *Antarctic Journal of the U.S.*, 8(6), 348-350.