Within the Ross Sea, the greatest diversity of brachiopods occurs on the seaward edge of the shelf. This diversity is believed due to an ecotone effect caused by the junction of two different water masses at this location. Significant associations (using the chi-square test) between different brachiopod species occur in the Ross Sea only between *Crania lecointei—Compsothyris racovitzae* and *Magellania fragilis—Macandrevia vanhoffeni.* I believe these species occur together commonly only because of quite different feeding behavior.

My studies have clearly shown that brachiopods are a significant and abundant element of the marine benthos in the southern oceans. The large number of specimens available in this study has permitted close examination of species structure and its relationship to systematics in various brachiopod species.

Reference

Campbell, K. S. W. 1965. Australian Permian terebratuloids. *Bureau of Mineral Resources. Geology and Geophysics Bulletin* no. 68. 113 p.

General Physiology of the Echinoderm Body Wall with Special Reference to Asteroids and Echinoids

ARTHUR C. GIESE

Department of Biological Sciences
Stanford University

As earlier observations had suggested that the body wall of the antarctic sea star *Perknaster fuscus antarcticus* had much more protein than that of the temperate species *Pisaster ochraceus* and *Patiria miniata,* a study of the biochemistry of the body walls of antarctic and temperate-zone sea stars was initiated to determine whether this high protein level was characteristic of antarctic species or whether it was a peculiarity of only one of the species examined by chance. Conversely, it was desirable to sample other temperate sea stars to determine whether some might not have a high protein level in the body wall comparable to that in *Perknaster.* It was of interest also to determine the oxygen consumption rate for both temperate and antarctic sea stars as a measure of the metabolic acitivity of the body wall.

These objectives have been fulfilled in part. It was found that the high protein level (38.3% of the dry weight) of *Perknaster* was unusual among antarctic sea stars: in *Diplasterias brucei* it was found to be 29.7%; in *Cuenotaster involutus,* 31.1%; and in *Odontaster validus,* 21.7%. In the body wall of all of these sea stars, the lipid levels were found to be about 5% and the total carbohydrate about 1%. In the temperate sea stars, the protein level for the body wall varied from 9.7% of the dry weight in *Astropecten californicus* to 34.2% in *Dermasterias imbricata* and *Pycnopodia helianthoides.* In most of the other temperate sea stars, the values were closer to those in *Astropecten* than to *Dermasterias—e.g.,* in *Pisaster ochraceus,* the common ochre star, 14.1%; *Pisaster giganteus,* 18.6%; *Pisaster brevispinus,* 13.5%; and *Patiria miniata,* the common sea bat, 12.8%. Only in *Orthasterias kohleri* do the values approximate those in *Dermasterias* and *Pycnopodia* (22.2%). In the body wall of most of these species, the lipid level per unit dry weight was much lower than in the antarctic stars—around 2%, reaching 4.3% in *Pycnopodia.* The carbohydrate level (in this case, glycogen-like material) was always less than 1%, and usually about half that amount.

Measurements of the oxygen consumption of these antarctic sea stars were planned for *Eltanin* Cruise 38, but the ship never reached the area of the continental shelf where the species are found, and none were caught.

The oxygen consumption of the body wall of the following six temperate sea stars was determined with Warburg respirometry: *Pisaster ochraceus, Patiria miniata, Pycnopodia helianthoides, Dermasterias imbricata, Orthasterias kohleri,* and *Astropecten californicus.* It ranged from 15 to 35 μl/gram wet weight/hour, the rate for *Pycnopodia* being the highest and that for *Patiria* and *Astropecten* the lowest. However, on the basis of protein level, *Astropecten* has the highest rate while *Dermasterias* has the lowest.

The possible reason for the low oxygen consumption in the high-protein body wall of *Dermasterias* may be a result of much inert protein, possibly connective tissue. The construction of the body wall in *Dermasterias* was therefore studied histologically and compared with that of *Patiria.* Preliminary examination of the material indicates that *Dermasterias* has much more connective tissue in the body wall than *Patiria.*

Oxygen consumption compared for *Patiria* (low protein) and *Dermasterias* (high protein) on the basis of DNA level of the body wall proved to be quite similar, much more so than on the basis of protein level. If DNA is taken to measure the cell content of the tissue, this finding suggests that the oxygen consumption of the body wall is related to the number of cells present, not the protein, much of which is extracellular in the high-protein type of body wall.

It is conjectured that, on the basis of protein level, the body wall of a sea star like *Perknaster* with high protein level would probably have a lower oxygen consumption than a star like *Odontaster* with considerably lower protein level, but that on the basis of DNA level, they would be similar.

In conclusion, it appears that the antarctic sea stars are variable with respect to protein level in the body wall, but so are temperate forms. The antarctic species appear to store slightly more nutrient than the temperate stars. Sea stars with much connective tissue in the body wall have a lower oxygen consumption per unit protein level than do those with little connective tissue. The oxygen consumption of the body wall is similar in sea stars with and without much connective tissue in the wall when measured on the basis of the DNA levels in the body wall.

Microbiology of Sea Ice

JOHN BUNT

Institute of Marine Sciences
University of Miami

During 1968, the analysis of field data and materials collected at McMurdo Sound during 1967 and in the Weddell Sea during IWSOE–1968 was completed. The raw data on hydrology, intensity and spectral composition of submarine radiation, and parameters relating to the microalgal flora of the sea ice were assembled in a technical report issued by the Institute of Marine Sciences (Bunt *and* Lee, 1969). A manuscript concerned largely with the reliability of C^{14}-uptake measurements in the laboratory as a means of predicting ultimate yields of cell carbon in the sea ice has been submitted for publication (Bunt *and* Lee, submitted). The account also provides the first documentation of the development of the ice microflora onwards from midwinter.

In the course of the field programs, algal and protozoan enrichment cultures were established, and a great deal of effort since then has been expended on the separation of pure cultures for more detailed study. The success of this endeavor may be measured by the fact that we now have in unialgal and, in some cases, axenic conditions, several green flagellates, two chrysomonads, one cryptomonad, and a number of diatoms including one centric form. Some of this material has been made available for studies of taxonomy and ultrastructure to Dr. R. O. Fournier of Dalhousie University. In addition, an elucidation of gross food needs has added to the collection one ameba, some colorless microflagellates, and several ciliates. One of these organisms has been used for comparative studies of temperature requirements for growth, demonstrating marked psychrophily and inability of the organisms to survive at temperatures above 10°C. A detailed account, supported by a companion document dealing with the taxonomy of the ciliates including one new genus recognized and described by Dr. T. Fenchel, has been prepared for publication. Preserved samples from the ice have been sent to Dr. G. Hasle at Texas A&M University for taxonomic study.

Contribution No. 1095, Institute of Marine and Atmospheric Sciences, University of Miami.

References

Bunt, J. S. *and* C. C. Lee. 1969. *Observations Within and Beneath Antarctic Sea Ice in McMurdo Sound and the Weddell Sea, 1967-1968.* University of Miami. Institute of Marine Sciences, Report 69-1.

Bunt, J. S. *and* C. C. Lee. Seasonal primary production within antarctic sea ice. Submitted to the *Journal of Marine Research.*

Ecological Studies of Antarctic Marine Phytoplankton

SAYED Z. EL-SAYED

Department of Oceanography
Texas A&M University

Folio 10 of the *Antarctic Map Folio Series,* published recently by the American Geographical Society, summarizes our present knowledge of marine plant life in antarctic and subantarctic waters. In this Folio, the author discusses the distribution and abundance of the phytoplankton standing crop (in terms of chlorophyll *a*) and primary productivity (in terms of C^{14} uptake), on the basis of collections made at different depths during 18 cruises in the Atlantic and Pacific sectors of the southern oceans. Seasonal and year-to-year variations in productivity parameters are also discussed, and data are presented on the concentrations of nutrient salts (phosphates, silicates, nitrates, and nitrites) and particulate and dissolved organic carbon. Contributions to the Folio by other authors include texts and plates showing the circumpolar distribution of selected species of diatoms (G. Hasle) and dinoflagellates (E. Balech). Ecology and distribution of benthic marine algae are discussed by M. Neushul and J. S. Zaneveld.

Since publication of Folio 10, additional data have been compiled on phytoplankton dynamics in the region south of Australia and New Zealand during *Eltanin* Cruises 35, 36, and 38. Of special interest during Cruise 38 was the success in measuring the photosynthetic activities of phytoplankton by means of *in situ* experiments (using C^{14} as a tracer) at all the stations occupied in the antarctic, subantarctic, and convergence regions (see photograph). These productivity experiments were conducted simultaneously with "simulated *in situ*" experiments using a deck incubator. Also of special significance on Cruise 38 were studies of the day-to-day variability in phytoplankton standing crop, primary production, dissolved