species such as *Ophiomages cristatus* were very high, up to 85.3 percent dry weight, suggesting that some antarctic brittle stars may be locally common but are not very nutritious prey. Ophiuroids examined thus far generally have mean caloric levels around 1 to 2 kilocalories per gram dry weight.

Richard L. Turner (Florida Institute of Technology) and J. H. Dearborn recently have completed a study of the organic and inorganic composition of postmetamorphic growth states of the viviparous subantarctic brittle star *Ophionotus hexactis*. Brood sizes range from 0 to 54 juveniles, with a mean of 24.5 juveniles. The composition of intraovarian juveniles was measured to estimate the contribution by the parent to postmetamorphic growth. Levels (percent dry weight) of lipid, protein, carbohydrate, and ash generally were unchanged. Contents (milligrams) of total organic matter and the three organic components showed large increases. Nutrient transfer probably involves nurse eggs and parental body fluids. Details are provided in a manuscript recently submitted for publication.

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References

Dearborn, J. H. 1977. Foods and feeding characteristics of antarctic asteroids and ophiuroids. In: *Adaptations within Antarctic Ecosystems* (Proceedings of the Third SCAR Symposium on Antarctic Biology, G. A. Llano, ed.). Smithsonian Institution, Washington, D.C. pp.293-326.

DeWitt, H. H. 1976. ARA *Islas Orcadas* cruise 5. *Antarctic Journal of the U.S.*, 11(2): 48-49.

DeWitt, H. H., and T. L. Hopkins. 1977. Aspects of the diet of the antarctic silverfish, *Pleuragramma antarcticum*. In: *Adaptations within Antarctic Ecosystems* (Proceedings of the Third SCAR Symposium on Antarctic Biology, G. A. Llano, ed.). Smithsonian Institution, Washington, D.C. pp. 557-567.

DeWitt, H. H., and J. D. McCleave. 1976. Ecology of fishes and echinoderms during ARA *Islas Orcadas* cruise 8. *Antarctic Journal of the U.S.*, 11(3): 182-184.

DeWitt, H. H., J. D. McCleave, and J. H. Dearborn. 1976. Ecological studies of fishes and echinoderms during ARA *Islas Orcadas* cruise 5. *Antarctic Journal of the U.S.*, 11(2): 49-53.

Lowe, E. F., and R. E. Crawford. 1976. Ecology of fishes and echinoderms: R/V *Hero* cruise 76-2 *Antarctic Journal of the U.S.*, 11(2): 53-55.

McCleave, J. D., J. H. Dearborn, and H. H. DeWitt. 1977. Ecology of benthic fishes and echinoderms along the Scotia Arc and the Antarctic Peninsula. *Antarctic Journal of the U.S.*, 12(4): 19-20.

Benthic marine biology, Ross Ice Shelf Project

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Benthic biology studies within the Ross Ice Shelf Project (RISP) took three successful directions during the 1977-78 season: (a) sampling under the Ross Ice Shelf at the primary drill site J-9, 82°22'S.168°38'W.; (b) comparative sampling along the ice front from the USCGC *Burton Island*; and (c) comparative studies using scuba (self-contained underwater breathing apparatus) diving at New Harbor and at other places in McMurdo Sound (see Lipps and DeLaca, 1977).

Our field teams' efforts were focused in these ways: DeLaca (5 November to 24 December 1977) and Showers (5 November 1977 to 11 February 1978), assisted by Lipps (21 November 1977 to 4 January 1978), worked at New Harbor; Lipps, Ronan (12 December 1977 to 4 January 1978), Clough, Raymond (29 November 1977 to 4 January 1978), and Bradford (20 December 1977 to 4 January 1978), assisted by DeLaca and Showers, worked at J-9; and Showers and Farmer (1 February to 28 February 1978) sampled from *Burton Island*.

We expected to find either a typical Antarctic fauna or a sparse but diverse fauna under the Ross Ice Shelf (see Lipps and DeLaca, 1977; Lipps *et al.*, 1977). Our work revealed neither. The sampling program was successfully completed at J-9 using television, baited traps and lines, and a specially designed sphincter sampler. Mysid shrimp, euphausiids, numerous amphipods (*Orchomene* spp), and an isopod (*Serolis*

*Deceased.

trilobitoides) (figure) were captured, or observed on the television.

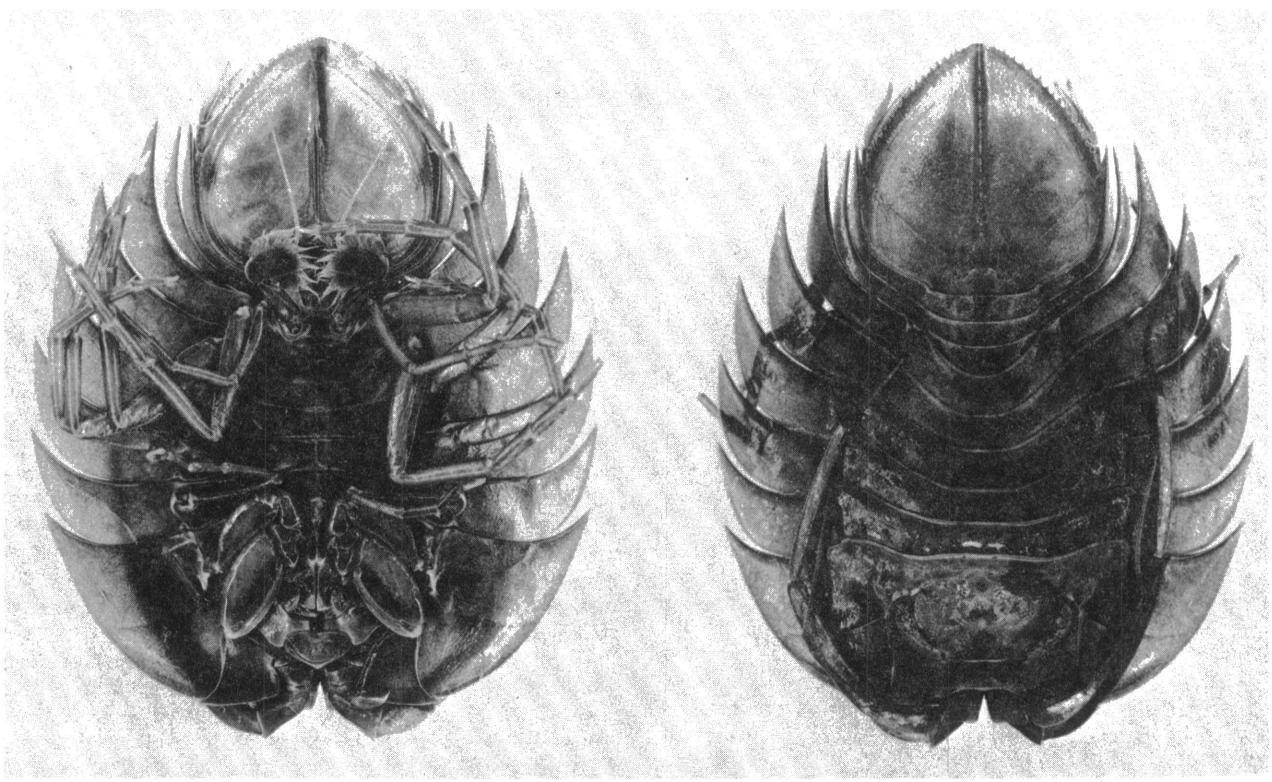
Seven hours of television videotape showed the activities of the amphipods as they swam in and around the baited traps. During one television run, the camera was placed by Clough in one end of a trap to observe what went on during the trapping operation. As the trap and camera reached the bottom, 400 to 500 amphipods quickly collected in and about the trap from the nearby area where, possibly, they were attracted by seal meat bait left lying on the bottom. When the trap was lifted, several hundred amphipods fell out. When the trap entered the ice hole, the animals became frantic and another 100 or so escaped. Some of these may have been observed later (on the television) swimming near the bottom of the ice. A total of 260 amphipods were caught during several trapping runs. Of the amphipods retrieved, about 30 percent were carrying eggs or brooding up to as many as 69 young. The eggs were approximately 0.1 millimeter in diameter, and the adults were approximately 3 centimeters long. Examination of stomach contents indicated that most of the animals probably had nothing in their stomachs when they first entered the traps, but they later ate seal meat bait. Bottom photographs taken by Stanley Jacobs and Peter Bruchhausen of Lamont-Dougherty Geological Observatory revealed two species of fish.

Bottom samples representing an area of about 1/3 square meter were collected (see Ronan *et al.*, 1978). There were no living animals in the mud, but dead shells of an ostracode, a bivalve, snails, foraminifera, and what may be small worm tubes were found.

The evidence completely analyzed to date suggests that life under the shelf at the drill site, some 400 kilometers from the open ocean, is neither very abundant nor particularly diverse. It seems to be even less so than it is in very deep sea areas where food is also scarce. At the drill site, the parts of the food chain represented by infaunal detritus feeders seem to be missing. Large animals such as the crustaceans and fish are present in small numbers, but there are no smaller animals as would be found in most other areas of the world's oceans. There are bacteria, so it is surprising that the infauna is missing. It is possible that the samples were inadequate or that the area at the drill site is unusual and not representative of the entire bottom under the Ice Shelf.

USCGC *Burton Island* was utilized to collect material from the Ross Sea near the Barrier and along Victoria Land to provide a basis for comparison with material from J-9. Forty-two stations were occupied, with sampling done by Smith-MacIntyre Grab, Blake Trawl, and fish traps. This material revealed more or less typical antarctic assemblages quite different from what we found under the ice shelf.

Comparative work in McMurdo Sound using scuba was done during 80 man-dives. Comparisons were made between the eastern side of the sound, which receives south-trending nutrient-rich water, and areas on the western side of the sound, which are bathed with nutrient-poor, north-trending water (Dayton and Oliver, 1977) that may originate from under the Ross Ice Shelf. This work focused on microscopic and small organisms, especially foraminifera. The trophic strategies of benthic foraminifera also were studied.



***Serolis trilobitoides* (Eights) captured in traps baited with seal meat at the RISP drill site, J-9. (Right, dorsal view; left, ventral view. The specimen, the only isopod captured, is 7 centimeters in total length.)**

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References

Dayton, P. K., and J. S. Oliver. 1977. Antarctic soft-bottom benthos in oligotrophic and eutrophic environments. *Science*, 197(4298): 55-58.

Lipps, J. H., and T. E. DeLaca. 1977. Ross Ice Shelf Project—benthic biology, 1976-1977. *Antarctic Journal of the U.S.*, 12(4): 32-33.

Lipps, J. H., W. N. Krebs, and N. K. Temnikow. 1977. Microbiota under antarctic ice shelves. *Nature*, 265(5591): 232-233.

Ronan, T. E., Jr., J. H. Lipps, and T. E. DeLaca. 1978. Sediments and life under the Ross Ice Shelf (J-9), Antarctica. *Antarctic Journal of the U.S.*, 13(4): 141-142.

Sediments and life under the Ross Ice Shelf (J-9), Antarctica

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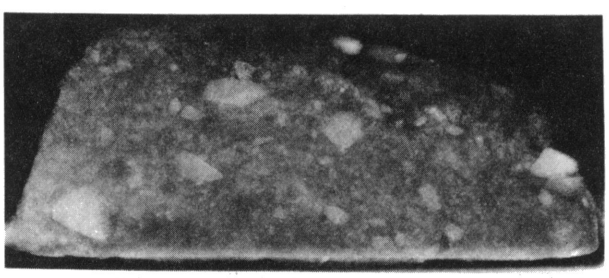
Although the general biology of the antarctic seas is relatively well known from a descriptive view, little is known about life under the permanent ice shelves (Lipps *et al.*, 1977). If life does exist far under an ice shelf, the sediments would be of great interest because they afford food and shelter for benthic organisms and contain a record of the biota through geologic time. Our plan as participants in the 1977-78 Ross Ice Shelf Project (RISP) was to obtain bulk samples of bottom sediment for biological study at the Ross Ice Shelf (J-9) (82°22'S, 168°38'W.), a remote drill site located some 450 kilometers from McMurdo Sound. Our bottom sampling equipment consisted of a modified cylindrical sphincter corer (Burke, 1968) with an internal diameter of 22.5 centimeters, for use in an ice hole with a predicted working diameter of 25 centimeters. A remote television camera (with surface monitor and videotape recorder) was used in conjunction with our corer to study the sea floor at the drill site. Ten successful coring runs with our sampler yielded about 1/3 square meter of bottom sediment cored to a mean depth of 10 centimeters. Because this portion of the ice shelf moves northeastward at a rate of about 1 meter per day (Zumberge, 1971), we sampled along a track about 12 meters in length.

Although our results are biased by the limited number of samples collected and the restricted area from which they were gathered, we believe the J-9 sea floor to be unusual in several respects:

1. Although the sediment may be reworked, there appears to be no Pleistocene or Recent sediment at the drill site; fossil diatoms and foraminifera indicate a deposit of mid-Miocene age (Webb and Brady, 1978). The rich assemblage of planktonic and benthic microfossils in the sediment suggests that a thick ice cover was absent at the site during the Miocene.

2. Bottom photographs under the sea ice in the McMurdo area, and elsewhere in the world ocean (Heezen and Hollister, 1971), show much evidence of biological activity on the sea floor in the form of animal tracks, trails, and burrows. In contrast, videotapes of the J-9 sea floor show a depositional interface carpeted with indurated clay fragments and cobbles but devoid of biological activity and epifaunal organisms.

3. Even more unusual was the absence of biological mixing of the sediment cores. X-radiography (figure) of vertical sections of four sphincter cores showed no burrow structures or indications of a remnant bioturbate texture, suggesting that bottom fauna has been absent from the drill site since the deposition of the sediment (Ronan and Lipps, 1978). The biological processing of 0.15 square meter of sediment thus far has revealed only a few dead foraminifera tests and several isolated shells of an ostracod, bivalve, and gastropod along with a problematic worm tube. Micro-organisms, however, are not absent from our sediments. Azam *et al.*, (1978) have shown that there are bacteria and probably other microbes in the sediment, but their numbers are low, perhaps fewer than in nutrient-poor areas of the deep sea.



X-radiograph of a vertical sediment slice from RISP sphincter core 5-2. The sediment has the texture of glacial till, with indurated clay fragments and striated pebbles scattered throughout the core material. Living animals and biogenic sedimentary structures are absent from the X-ray photo.

To understand the geological history of the sediments and the biological environment under the Ross Ice Shelf, we plan to secure additional samples from the drill site and to core other localities distant from J-9. We shall not have a good understanding of the habitability of the sediments until we know a great deal more about its organic matter and associated micro-organisms, which we call detritus, and its importance as a food for sediment-dwelling organisms. We also plan further study of our sediments using high-resolution gas chromatography and mass spectrometry to examine the

*Deceased.