We are grateful to a number of taxonomists for aid in the identification of prey organisms. Most recently these include James A. Blake, Battelle New England Marine Research Laboratory (Polychaeta), Frank D. Ferrari, Smithsonian Oceanographic Sorting Center (Copepoda), Joseph Rosewater, U.S. National Museum of Natural History (Mollusca), Les E. Watling, University of Maine at Orono (various crustaceans), and Judith E. Winston, American Museum of Natural History (Bryozoa). We thank David B. Fratt, Gordon F. Hendler, and William E. Zamer for technical assistance and continued collaborative efforts.

This work was supported by National Science Foundation grant DPP 79-21537.

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Lipid composition of antarctic midwater invertebrates

S. B. Reinhardt *and* E. S. Van Vleet

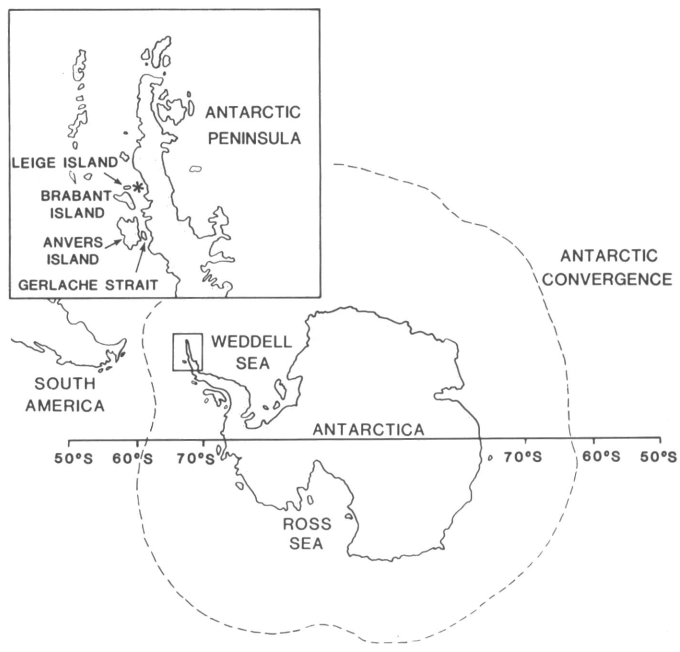
University of South Florida
Department of Marine Science
St. Petersburg, Florida 33701

Total lipid, hydrocarbon, wax ester, triacylglycerol, and phospholipid contents were determined by gas-liquid chromatography and combined gas chromatography/mass spectrometry for 16 major macrozooplankton biomass species of a midwater community in the East Wind Drift system. Samples for this study were collected by T.L. Hopkins and B.H. Robison during March and April of 1983 in basins (depths of 800–1,200 meters) of the Croker Passage off the Antarctic Peninsula (figure) using a discrete depth Tucker trawl. Principal biomass species included: *Euphausia superba, Salpa thompsoni, Metridia gerlachei, Calanoides acutus,* and *Euchaeta antarctica.* Before this study, the lipid composition of a comprehensive sample of an antarctic midwater community had not been analyzed.

Total extractable lipid content, expressed as percent of dry weight, ranged from 0.5 percent in the coelenterate *Diphyes antarctica* to 59.7 percent in the euphausiid *Thysanoessa macrura* (table 1). Species with high lipid levels (greater than 40 percent) included: the amphipod *Eurythenes gryllus;* the copepod *Calanoides acutus;* and the euphausiid *Thysanoessa macrura.* These organisms were caught at depths greater than 230 meters. In general, total lipid levels in this study were similar to values reported for more temperate species. *Antarctomysis ohlinii* (16.8 percent) did not have a significantly higher lipid content than the 9–13 percent reported for temperate and subtropical mysids (Linford 1965; Morris and Hopkins 1983). Lipid levels in the antarctic chaetognath *Sagitta gazellae* (17.4 percent) were similar to the 19 percent found in the bipolar species *Eukrohnia hamata* by Lee in 1975, and less than the 30 percent measured in temperate species (Blumer, Mullin, and Thomas 1964). Lipid levels in antarctic copepods *Calanoides acutus* (45 percent) and *Metridia gerlachei* (21.4 percent) were lower than the 50–64 percent detected in arctic copepods (Lee 1975), but within the 12–47 percent range found in temperate and subtropical species (Sargent and Lee 1975; Lee, Nevenzel, and Paffenhofer 1971). The 59.7 percent lipid in *Thysanoessa macrura,* however, exceeded the 23–40 percent range found for the temperate species *T. raschii* (Sargent and Lee 1975).

Hydrocarbons generally comprised less than 1 percent of the total lipids in all species studied. Two types were analyzed: aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH's). No PAH compounds were detected in any of the organisms analyzed in this study. These compounds may be transported too quickly to the sea floor to allow incorporation into the mesopelagic food web.

Aliphatic hydrocarbons, measurable in all samples, ranged from less than 0.01 percent of the total lipids in several samples to 4 percent in *Calanoides acutus.* The ratio of odd carbon chain-length (O) alkane abundances to even chain-length (E) abundances was calculated. Seventy-four percent of the antarctic invertebrates studied had O/E values less than one, indicating a



Antarctic midwater sampling site ("*" denotes area sampled).

Table 1. Lipids of antarctic invertebrate zooplankton and micronekton from the Croker Passage

Sample	Total lipid (expressed as percentage of dry weight)	Hydrocarbons (expressed as percentage of total lipids)	Wax esters (expressed as percentage of total lipids)	Triglycerides (expressed as percentage of total lipids)	Phospholipids (expressed as percentage of total lipids)
Amphipoda					
Cyphocaris richardi	20.5	<0.1	11.4	71.3	17.3
Eurythenes gryllus	55.2	0.3	19.4	68.8	11.5
Eusirus (perdentatus?)	21.5	0.3	22.2	60.9	16.6
Parandania boecki	19.4	0.1	32.8	45.8	21.3
Parathemisto gaudichaudi	18.5	< BL[a]	8.9	57.6	33.5
Copepoda					
Calanoides acutus	45.0	4.0	64.4	14.5	17.1
Metridia gerlachei	21.4	< BL	51.9	19.4	28.7
Rhincalanus gigas	8.1	< BL	<BL	<BL	—[b]
Polychaeta					
Tomopteris carpenteri	8.4	0.4	13.0	17.2	69.4
Chaetognatha					
Sagitta gazellae	17.4	0.2	2.6	28.4	68.8
Coelenterata					
Atolla wyvillei	1.1	0.2	47.5	22.2	30.1
Diphyes antarctica	0.5	<1.0	15.8	27.1	56.1
Tunicata					
Salpa thompsoni	24.3	<0.1	2.4	55.2	42.4
Mysidaceae					
Antarctomysis ohlinii	16.8	0.4	20.3	56.0	23.3
Euphausiacea					
Euphausia superba H82	6.4	0.8	47.2	40.9	11.1
Euphausia superba H83	25.6	<0.1	7.4	63.7	28.9
Euphausia superba 4.0–4.6 centimeters	28.4	<0.1	3.4	60.8	35.8
Euphausia superba 3.4–3.6 centimeters	23.8	<0.1	20.5	53.1	26.4
Thysanoessa macrura	59.7	0.7	50.1	11.7	37.5
Other					
Mixed plankton	41.7	0.1	60.2	23.0	16.7

[a] Less than blank.
[b] Not detected.

predominance of even chain-length alkanes (table 2). Hydrocarbons isolated from the vast majority of marine organisms are primarily odd chain-length alkanes. In an earlier study (P.M. Williams unpublished data), even carbon-chain hydrocarbons predominated in the lipids of *Euphausia crystallorophias*, *Pleuragramma antarcticum*, and *Dissostychus mawsoni* from McMurdo Sound. In the present study, all five euphausiid samples had O/E values less than one. The mysid *Antarctomysis ohlinii*, both coelenterate species, the chaetognath *Sagitta gazellae*, the polychaete *Tomopteris carpenteri*, two of the three copepod species, and four of the five amphipod species studied also had an even carbon-chain alkane predominance.

Lipid composition was used to identify food web interactions. Total lipid content, total hydrocarbon levels, and pristane content provided the best information. For example, all samples from depths greater than 900 meters had high lipid levels, except *Parandania boecki* (19.4 percent), suggesting that this amphipod occupied an ecological niche different from other deep-dwelling species. Concurrent gut content analyses showed that *P. boecki* fed on coelenterates (*Atolla* and *Periphylla*) which were very low in lipids, possibly accounting for the low lipid content of this amphipod. High total hydrocarbon concentrations suggested a predator-prey relationship between *Thysanoessa macrura* and *Calanoides acutus*. High pristane contents in both species allowed prediction of predator-prey relationships for *T. macrura/C. acutus* and for *Eurythenes gryllus/Atolla wyvillei*. These feeding relationships were confirmed by gut content analyses.

This work was supported by National Science Foundation grant DPP 80-23961.

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Table 2. Hydrocarbons of antarctic mesopelagic invertebrates

Sample	Branched hydrocarbons (expressed as a percentage of total hydrocarbons)	Saturated hydrocarbons (expressed as a percentage of total hydrocarbons)	Monounsaturated hydrocarbons (expressed as a percentage of total hydrocarbons)	Saturated-to-unsaturated ratio of hydrocarbons	Odd-to-even ratio of hydrocarbons
Amphipoda					
Cyphocaris richardi	65.2	1.2	1.4	0.9	0.3
Eurythenes gryllus	67.9	2.6	1.9	1.3	0.1
Eusirus (perdentatus?)	4.2	8.6	69.4	0.1	1.0
Parandania boecki	69.1	7.2	2.1	3.5	1.0
Parathemisto gaudichaudi	—[a]	—	—	1.1	0.3
Copepoda					
Calanoides acutus	73.2	<0.1	0.7	0.1	1.5
Metridia gerlachei	—	—	—	0.4	0.1
Rhincalanus gigas	—	—	—	∞[b]	0.4
Polychaeta					
Tomopteris carpenteri	1.7	15.9	0.5	34.9	0.7
Chaetognatha					
Sagitta gazellae	3.5	29.4	6.3	4.7	0.1
Coelenterata					
Atolla wyvillei	50.4	13.8	2.4	5.8	0.3
Diphyes antarctica	0.0	17.8	0.6	27.7	0.4
Tunicata					
Salpa thompsoni	8.8	62.3	16.2	3.9	1.8
Mysidaceae					
Antarctomysis ohlinii	29.1	7.4	23.1	0.3	3.6
Euphausiacea					
Euphausia superba H82	<0.1	10.2	0.2	67.7	0.8
Euphausia superba H83	60.1	28.7	2.2	12.9	0.6
Euphausia superba 4.0–4.6 centimeters	2.0	18.0	2.0	9.0	0.1
Euphausia superba 3.4–3.6 centimeters	0.0	14.9	3.3	4.5	0.1
Thysanoessa macrura	61.8	0.3	4.4	0.1	0.6

[a] Not detected.

[b] No unsaturated hydrocarbons detected (division by zero).

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Acoustic assessment of the distribution and abundance of micronekton and nekton in the Scotia Sea, March 1984

M. C. Macaulay, K. L. Daly, *and* O. A. Mathisen

College of Ocean and Fisheries Science
University of Washington
Seattle, Washington 98105

We used hydroacoustic methods to survey and assess the abundance and distribution of micronekton and nekton in the Scotia Sea. We made real-time observations to detect regions of biological interest and to coordinate net catches (Brinton, *Antarctic Journal*, this issue; Wormuth et al., *Antarctic Journal*, this issue). We used three frequencies to provide the basis for discriminating between sizes and identities of many target organisms. The analyzed acoustic data will be used to provide net-independent estimates of abundance and to estimate net avoidance, particularly by larger krill. These observations will be used to relate the abundance and distribution of target organisms to the physical, chemical, and biological observations of the other projects aboard R/V *Melville*.

We made acoustic observations in open water aboard the R/V *Melville*, both underway and at fixed stations. Sampling aboard