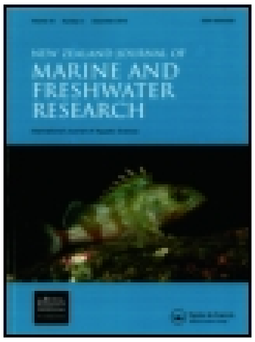

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Epibenthic communities on the Chatham Rise, New Zealand

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Abstract Samples of epibenthic macrofauna were collected using a small sledge trawl from 40 stations on the Chatham Rise (42°34′–44°47′S; 175°34′E–179°03′W) at water depths of 237–2039 m. 218 taxa were collected, predominantly echinoderms, crustaceans, and molluscs. Multivariate analysis based on 85 species indicated three epibenthic communities, the shallowest characterised mainly by crustaceans and two deeper water communities mainly characterised by echinoderms: (1) a community on predominantly sandy sediments on the crest and shallower flanks of the Rise at 237–602 m that included as characteristic species *Munida gracilis*, *Phylladiorhynchus pusillus*, *Campylonotus rathbunae*, *Pontophilus acutirostris*, and *Acutiserolis bromleyana* (Crustacea), *Amphiura lanceolata* (Ophiuroidea), *Cuspidaria fairchildi*, and *Euciroa galatheae* (Bivalvia); (2) a community associated with muddy sediments at 462–1693 m that included *Ypsilothuria bitentaculata* and *Pentadactyla longidentis* (Holothuroidea), *Brissopsis oldhami* (Echinoidea), and *Amphiophiura ornata* (Ophiuroidea); and (3) a community on muddy sediments at 799–2039 m that included *Ophiomusium lymani* (Ophiuroidea), *Porcellanaster ceruleus* (Asteroidea), *Gracilechinus multidentatus* (Echinoidea), and *Aeneator recens* (Gastropoda). Bathymetric range of the communities was not symmetrical on either side of the Rise; there was a marked submergence on the north side similar to the vertical displacement of the core of the Antarctic Intermediate Water.

Keywords New Zealand; Chatham Rise; bathyal benthos; epifauna; communities; Echinodermata; Crustacea; Mollusca

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INTRODUCTION

New Zealand has an extensive bathyal zone that includes a number of major plateaux and ridges (Carter 1980). A prominent feature of the New Zealand bathyal is the Chatham Rise, a broad ridge lying to the east of central New Zealand and extending for c. 1400 km to c. 168° W, east of the Chatham Islands. To the west of the Chatham Islands the Rise is generally flat-topped at depths of 200–400 m, but to the east the depth gradually increases to c. 3000 m (Thompson 1991). At the western end of the Rise is the Mernoo Gap, a narrow depression, deeper than 500 m, that separates the Rise from the New Zealand continental shelf. On the Rise lie four banks with depths of less than 250 m: Mernoo, Veryan, and Reserve Banks toward the western margin, and the smaller Matheson Bank nearer the Chatham Islands. On large-scale bathymetric charts the Rise appears smooth-topped, but more detailed mapping reveals considerable local relief (Mitchell & Cullen 1984). Surface sediments are in general relatively fine-grained, with terrigenous sediments giving way to pelagic sediments at c. 179° E (McDougall 1982; Mitchell et al. 1989). Located over the Rise is the Subtropical Convergence, a circumglobal front where subtropical and subantarctic surface waters meet (Heath 1985). The Rise is of economic importance, with major fisheries (Francis & Fisher 1979; Fenaughty & Uozumi 1989) and large deposits of potentially mineable phosphorite (Cullen 1987).

Earlier benthic studies of the Rise have dealt mainly with discrete elements of the fauna and have

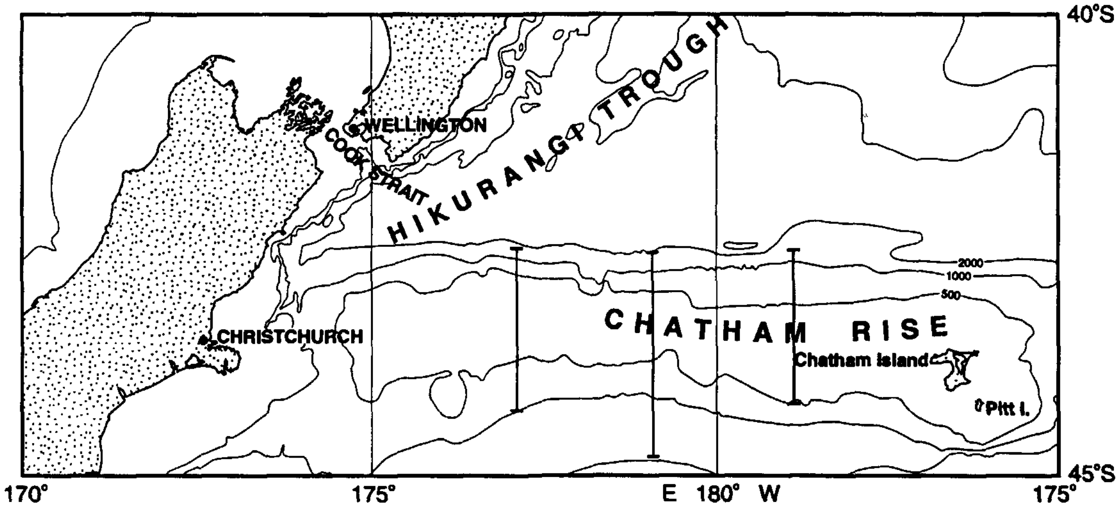

Fig. 1 Locality diagram showing transects.

been largely systematic in approach (e.g., Fell 1960; Knox 1960) although Hurley (1961) provides some observations on benthic structure. Dawson (1984) and Probert et al. (1997) examined effects of mining and trawling on benthos of the Rise. Probert & McKnight (1993) and Probert et al. (1996) noted relatively higher macrobenthic biomass and faunal densities on the southern side of the Rise, which they suggest may be the result of the enhanced organic flux associated with the Subtropical Convergence. As part of a multidisciplinary study of the Chatham Rise region the following contribution examines epibenthic communities on the Rise, mainly between 177°E and 179°W.

MATERIALS AND METHODS

Twenty-four epibenthic samples were taken with a small sledge-trawl on the Chatham Rise during September 1989 (V-prefixed stations in Table 1). Stations were sited along three north-south transects: a western transect at 177°E, a central transect at 179°E, and an eastern transect at 179°W (Fig. 1). Positions of the V stations are those in Probert & McKnight (1993), except that weather conditions prevented sampling at the southern end of the eastern transect (>568 m) and three off-transect stations were added: V361 (30 km west of the central transect), and stations V393 and V394 (65 and 117 km west of the western transect, respectively). (These three stations are considered below as belonging to the central and western transects.) A further 16 samples were taken during September 1993 (W stations in Table 1) on the central transect. Transect positions are shown in Fig. 1 and sample sites detailed in Table 1. In total, 24 of the stations were on the central transect, 10 on the western and six on the eastern. The trawl was similar to that described by McDougall (1973), with a width of 1.2 m and a height of 0.45 m. The outer bag, c. 2 m long, had a mesh of 15 mm knot to knot, with a finer mesh of 7 mm knot to knot lining the distal half of the net. At each site the trawl was towed for 20 min at c. 0.5 m s^{-1}. Most samples retained some fine sediment and all were washed on a 1-mm mesh then preserved. In the laboratory the animals were sorted to major taxa and identified, if possible to species. Polychaetes were relatively uncommon in the samples and most were assigned only to family. A total of 85 taxa present in two or more samples was used in the subsequent analyses. The smaller and infaunal species were largely excluded from the subsequent analyses as they were likely to have been sampled inconsistently by the trawl. The presence/absence data were subject to numerical classification and ordination analyses. Classification was performed using the Czekanowski coefficient and by group-average sorting (Lance & Williams 1967). Ordination was carried out using multidimensional scaling (MDS) (Field et al. 1982). Community scores for species were calculated as in Grange (1979), but modified to exclude the bioindex value. Thus the community score for a species in a site group is the percentage occurrence within the group multiplied by the proportion of total sites where the species is present. Sediment samples taken from a small dredge also used at some of the sampling sites (Table 1) were analysed for grain-size in the size categories: gravel (>2.00 mm), sand (2.00–0.062 mm), silt (4–62 µm), and clay (<4 µm), and expressed as percentage weight.

RESULTS

A total of 218 taxa was recognised from the entire collection, including a considerable number of as yet undescribed species. The best represented major taxa were Echinodermata (52 spp.), Crustacea (44 spp.), and Mollusca (36 spp.). Table 2 shows the species used in multivariate analysis.

The main feature of the dendrogram (Fig. 2) is a central cluster of 20 stations, here called Group

Table 1 Station positions, water depth, and community grouping.

Station no.	Latitude (S)	Longitude (E or W)	Depth (m)	Group designation
V361†	43° 30.6′	178° 38.11′E	345	A
V363†	44° 15.22′	178° 58.53′W	560–568	A
V365†	43° 44.92′	179° 00.35′W	399	A
V366†	43° 29.69′	178° 59.55′W	499	A
V367†	43° 14.31′	179° 02.18′W	471	A
V368†	42° 49.87′	179° 00.45′E	1040	B
V369†	43° 05.67′	178° 59.94′E	399	A
V370†	42° 41.70′	179° 03.42′W	1024	B
V371†	42° 59.39′	179° 03.30′W	533	A
V372†	43° 20.22′	178° 58.88′E	415–409	A
V373†	43° 35.48′	178° 59.50′E	385	A
V374†	43° 51.19′	178° 58.81′E	480	A
V375	44° 05.97′	179° 01.08′E	815	C
V376	44° 20.29′	179° 00.34′E	1239	C
V385	44° 19.81′	176° 59.90′E	1086	C
V386	44° 05.25′	177° 00.05′E	665	B
V387	43° 49.62′	176° 59.82′E	498–497	A
V388	43° 34.83′	176° 59.91′E	331–328	A
V389	43° 20.02′	176° 59.83′E	237	A
V390	43° 05.00′	177° 00.00′E	330	A
V391	42° 49.97′	176° 59.91′E	476	A
V392	42° 34.32′	176° 59.70′E	1390	B
V393	42° 54.89′	176° 12.53′E	538	A
V394	43° 01.49′	175° 34.25′E	396	A
W247	44° 47.4′	178° 59.8′E	1932–1963	C
W248	44° 36.0′	178° 55.6′E	1442–1463	C
W249	44° 18.9′	179° 00.0′E	1200–1230	C
W250	44° 05.4′	179° 00.0′E	799–815	C
W251	43° 50.0′	178° 59.5′E	469–462	B
W252	43° 37.7′	178° 59.8′E	400–428	A
W255	44° 40.9′	179° 01.2′E	1600–1706	C
W257	43° 22.5′	179° 00.0′E	400–390	A
W258	42° 57.9′	178° 59.8′E	602–499	A
W259	42° 54.1′	179° 00.2′E	812–715	B
W260	42° 57.0′	179° 00.0′E	665–625	B
W261	42° 47.2′	178° 59.6′E	1212–1126	B
W262	42° 44.0′	179° 00.2′E	1410–1281	B
W263	42° 41.0′	179° 00.3′E	1660–1693	B
W265	42° 38.3′	178° 59.9′E	2039–1687	C
W273	42° 39.0′	178° 57.2′E	1915–1491	C

†Sediment particle size analyses available.

Table 2 Occurrence of species used for multivariate analysis with community scores (> 20). (E, endemic; +, present; – absent; G, ovigerous or gonads appear ripe.) (Also recorded as G were the crustaceans *Acanthophyra pelagica*, *Prionocrangon curvicaulis*, and *Nectocarcinus antarcticus*.)

	Community group			
Taxa	A	B	C	
Cnidaria				
Flabellum knoxi	+	+	+	
Edwardsia sp.	+	–	+	
Polychaeta				
Hyalinoecia tubicola	29	+	+	
Aphrodita talpa	43	+	+	
Crustacea				
Acutiserolis bromleyana	51	+	+	G
Pontophilus acutirostris	55 E	–	–	G
Notopandulus magnoculus	41	+	–	G
Campylonotus rathbunae	70 E	–	–	G
Prionocrangon curvirostris	+	+	+	
Metacrangon knoxi	+	–	–	
Pasiphaea notosivado	+	+	–	G
Euphausiid sp.	+	–	+	
Nephrops challengeri	20 E	–	–	
Polychelid sp.	+	–	–	
Munida gracilis	81	+	+	G
Gastroptychus novaezealandiae	+	–	–	G
Phylladiorhynchus pusillus	55	+	–	G
Carcinoplax victorienesis	31	+	–	G
Trichopeltarion fantasticum	+	+	–	
Mollusca				
Dentalium zealandicum	+	–	–	
Dentalium sp.	–	–	20 E	
Poroleda lanceolata	+	–	–	
Neilo wairoana delli	+	–	–	
?*Anomia* sp.	+	–	–	
Cuspidaria fairchildi	55	–	+	
Cuspidaria morelandi	+	–	–	
Euciroa galatheae	50	–	+	
Falsilunatia powelli	+	24	+	
Waihaoa knoxi	+	+	+	
Baryspira novaezealandica benthicola	+	+	–	
Waipaoa marwicki	–	20 E	–	
Surculina expeditionis	20 E	–	–	
Fusitriton cancellatus	–	+	+	
Otukaia blacki	–	–	20 E	
Aeneator recens	–	–	30 E	
Retusa pachys	+	+	+	
Echinodermata				
Psilaster acuminatus	+	+	+	
Plutonaster knoxi	+	+	+	
Plutonaster fragilis	–	–	+	
Porcellanaster ceruleus	–	–	42 E	
Benthopecten pikei	–	+	27	
Pectinaster mimicus	–	+	23	
Pseudarchaster garricki	+	+	+	
Ceramaster lennoxkingi	–	–	+	
Pillsburiaster aoteanus	+	–	+	

(*continued*)

Table 2 (*continued*)

Taxa	Community group A	B	C	
Hippasteria trojana	–	–	20 E	
Crossaster japonicus	21	–	+	
Zoroaster spinulosus	+	–	20 E	
Ophiomyxid sp.	+	–	20 E	
Ophiacantha vilis	37	–	+	
Ophiacantha yaldwyni	+	–	–	
Ophiophthalmus relictus	–	+	32	
Amphiura lanceolata	63	+	–	G
Amphiura sp.	–	–	+	
Amphioplus pegasus	+	–	–	
Ophiactis hirta	+	–	–	
Ophiactis abyssicola	–	–	23 E	
Ophiochiton lentus	–	20 E	–	
Ophiura irrorata	42	+	–	
Ophiura ooplax	+	–	–	
Amphiophiura ornata	–	30 E	–	
Ophiomisidium irene	+	+	–	
Ophiozonella stellamaris	+	+	+	
Ophiozonella stellata	–	20 E	–	
Ophiomusium lymani	–	+	49	
Ophiernus sp.	–	–	20 E	
Goniocidaris parasol	23	+	–	
Phormosoma bursarium	+	+	+	
Caenopedina otagoensis	–	–	20 E	
Gracilechinus multidentatus	–	–	30 E	G
Urechinus antipodeanus	–	–	20 E	
Hemiaster expergitus gibbosus	+	+	+	
Brissopsis oldhami	32	34	+	
Echinocardium lymani	31 E	–	–	
Paramaretia peloria	21	–	+	
Spatangus multispinus	+	+	–	
Spatangus lutkeni	+	+	–	
Heterothyone alba	+	–	+	
Pentadactyla longidentis	+	41	+	
Ypsilothuria bitentaculata	+	49	+	
Echinocucumis hispida	35 E	–	–	
Paracaudina chilensis	43	+	–	
Bathyplotes natans	+	+	+	
Holothurian sp. E	+	+	+	
Holothurian sp. F	+	–	–	

A, occupying a water depth range of 237–602 m and two groupings each of 10 stations: Group B at depths of 462–1693 m and Group C at 799–2039 m. The two smaller clusters are less discrete and subdivide at a similarity level lower than that required to recognise the integrity of the large grouping (<0.25). The three groups were less well defined in the MDS plot and, in the absence of clear alternatives, the groups referred to above were adopted for further examination.

Community A comprised 20 stations from the crest and shallower flanks of the Rise, in water depths of 237–602 m, and was present on all three transects (Table 1). Sediment particle size analyses, available for 10 stations, indicated predominantly muddy sands; mean percent weights were: clay 8% (SD 4.1), silt 20% (6.2), sand 68% (7.1), and gravel 4% (8.0). Sixty-three species were recorded, of which 19 were "endemic", 13 shared with Community B, 11 with Community C, and 20 with both. Community scores for the species ranged from 81.0 to 1.7. Eight species had a score of 50.0 or more, and a further 10 a score between 50.0 and 25.0. Twenty-three species had a score of 20.0 or

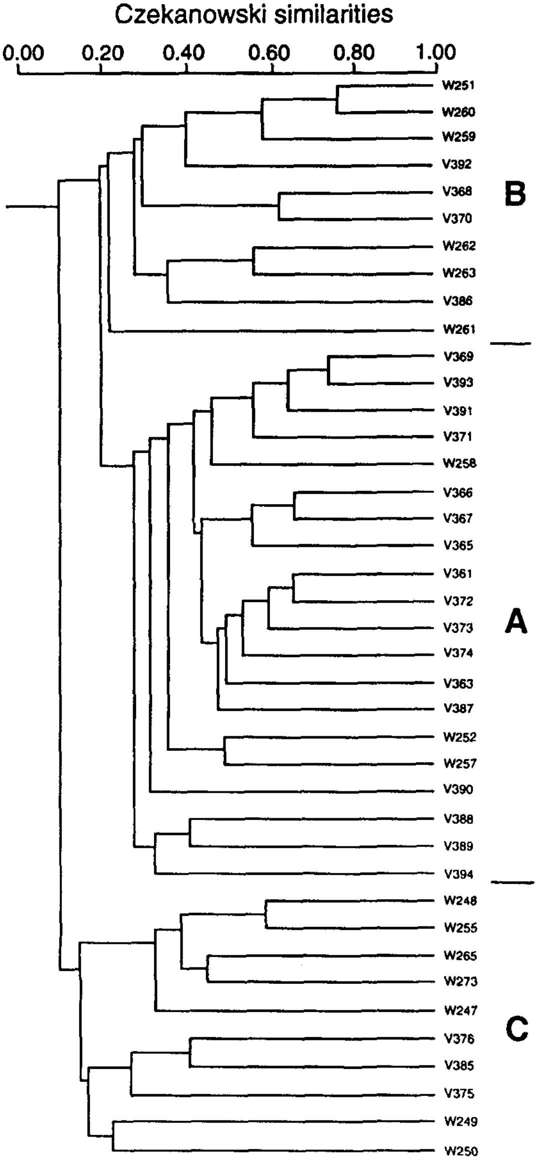

Fig. 2 Dendrogram of stations.

more (Table 2). These comprised 8 crustaceans, 4 echinoids, 3 ophiuroids, 2 bivalves, 2 polychaetes, 2 holothurians, 1 asteroid, and 1 gastropod. Mobile crustaceans were noticeable among the high-scoring characteristic species.

Community B was recorded from 10 stations on both flanks of the Rise (Table 1). To the north it was present at eight sites on all three transects, at 625–1693 m, and to the south at two sites on the western and central transects at 462–665 m. Sediment particle size analyses, available for only two stations, indicated sandy mud; mean percent weights were: clay 29% (SD 6.0), silt 35% (7.2), and sand 36% (13.1). Forty-two species were recorded of which four were endemic, 13 shared with Community A, five with Community C, and 20 with both. Community scores for the species ranged from 49.0 to 0.5, and eight species had a score of >20.0 (Table 2). These comprised 3 ophiuroids, 2 holothurians, 2 gastropods, and 1 "irregular" echinoid. None would be considered as highly mobile.

Community C occurred at 10 stations at water depths of 799–2039 m, predominantly at southern stations of the central transect (Table 1). In particular it was recorded on the central (nine stations) and western (one station) transects, and spanned depth ranges of 799–1963 m to the south of the Rise (eight stations) and 1491–2039 m to the north (two stations). No sediment data were available. Forty-nine species were present, 13 were endemic, 11 shared with Community A, five with Community B, and 20 with both. Community scores ranged from 49.2 to 0.5. Sixteen species had a score of >20.0, including 5 ophiuroids, 5 asteroids, 3 echinoids, 2 gastropods, and 1 scaphopod. Highly mobile species were absent.

DISCUSSION

In recent years there have been a considerable number of studies on communities of the continental slope and deeper oceanic regions, sufficient for the production of several comprehensive compilations (e.g., Menzies et al. 1973; Rowe 1983; Gage & Tyler 1991). Studies outside New Zealand have progressed to the recognition of large-scale, widespread communities, the detailed examination of bathymetric distributions, and the spatial distribution of individual species. There is, however, a dearth of comparable studies for the New Zealand continental margins. The present contribution must be viewed as a preliminary study and there is as yet little scope to correlate these results with those from elsewhere. To date there has been no widespread survey of epifaunal communities of the New Zealand slope, nor even those of the shelf. The only extensive study of local benthic communities is that of McKnight (1969), which relates primarily to infaunal shelf communities. Nevertheless, from a comparative viewpoint, this is of some relevance here. Some taxa that are probably shallow burrowers were commonly collected by the sledge-trawl used in the present study and were included in the analysis. Thus in characterising the communities there may be some overlap between the "infaunal" and "epifaunal" elements, although for some species these designations are somewhat arbitrary.

Community A is essentially the *Serolis bromleyana–Spatangus multispinus* community described by Hurley (1961) from the Chatham Rise at depths of 403–604 m. Of the 38 species listed by Hurley (1961), 11 are represented in the characteristic species of the present data; only one species is represented in Community B, and two in Community C. More species would have been represented in both lists if dead molluscs were listed for the present data. Characteristic species, besides the two nominate species, were *Campylonotus rathbunae*, *Nassarius ephamillus*, *Micantapex paregonius*, *Falsilunatia powelli*, *Fusitriton retiolus*, *Cominella alertae*, *Columbarium mariae*, *Neilo australis*?, *Ophiura irrorata*, and probably, *Hyalinoecia tubicola*.

None of these species appears restricted to the Chatham Rise, but the extent of their respective distributions is mostly poorly known. Some of the species encountered in this study are known to be widely distributed at bathyal depths around New Zealand, although Dawson (1982) does identify some biogeographic differences of major bathyal regions of New Zealand. Other species taken in this study occur worldwide. For instance, *Ophiomusium lymani*, a highly characteristic species of Community C, and *Hyalinoecia tubicola* are both global continental margin species (Menzies et al. 1973).

Dawson (1984), in discussing observations from underwater television, noted the mosaic nature of the larger visible fauna of the Chatham Rise. The spatial scale of the present study is much coarser and finer detail is not resolvable. Certainly trawl samples could contain elements of dissimilar infaunal and epifaunal communities, though this is not apparent in our data, which are generally to the west of the area studied by Dawson. Dell (1956: 198) also remarked on the patchiness of benthos from the Chatham Rise at depths of up to 600 m.

Depth ranges of communities

Of interest are the depth ranges of Communities B and C on either side of the Rise. Community B is present to the north at 625–1693 m, and to the south at 462–665 m. Community C is present at 1491–2039 m to the north and 799–1963 m to the south. Heath (1968) reported on hydrological stations, sampled in April, in the region of the present study. North of the Rise at 42°20′S (Stations D611, D612), interpolated mean temperatures at 500 and 1000 m were 9.5 and 6.1°C respectively, whereas south of the Rise at 45° S (Station D605), the corresponding temperatures were 6.6 and 3.9°C. The core of the Antarctic Intermediate Water is at a depth of c. 750 m south of the Rise and at c. 1000 m to the north (Ridgway et al. 1979). Gradual submergence of bathyal and abyssal faunas at lower latitudes is well known (Ekman 1953; Menzies et al. 1973). At the Chatham Rise, however, there appears to be an abrupt displacement possibly because of the coincidence of the Subtropical Convergence and bathymetry. Carney et al. (1983) indicated that globally a distinction between bathyal and abyssal zones commonly occurs at about the 4°C isotherm. This would roughly correspond to the division of Communities B and C on the north and south sides of the Rise. Community C may represent an abyssal fauna, given the inclusion of such echinoderms as *Ophiomusium lymani*, *Porcellanaster*, and *Urechinus* (Menzies et al. 1973), but further sampling and/or analysis of archived data will be necessary to describe zonation of deep-sea faunas in the New Zealand region.

The causes of vertical zonation of the deep-sea benthos are, however, still largely unclear (Carney et al. 1983). It has often been assumed that temperature is paramount (e.g., Ekman 1953), but such a relationship is largely untested. At least some of the observed zonation may reflect changes in trophic strategies along a gradient in food and hydrodynamic energy. On the Atlantic continental margin of the United States there is a mixture of suspension and carnivore/scavengers on the upper slope, carnivores/scavengers alone on the middle slope, and a mixture of suspension and deposit feeders on the lower slope (Gage & Tyler 1991). From the percentage occurrence of major taxonomic groups in historic data, Dawson (1984) estimated the representation of trophic groups on the Chatham Rise (bathymetric range not specified) to be: carnivores 46.9%, deposit feeders 34.6%, and suspension feeders 18.5%. Although the present data do not permit a thorough analysis of trophic groups, they indicate that the communities may differ in this regard. Prominent among the characteristic species of Community A are mobile crustaceans, likely to be scavengers or carnivores, whereas the two deeper communities lack highly mobile characteristic species, but include more obvious deposit-feeding components. The coarser sediments on the crest of the Rise indicate that Community A is subject to more energetic hydrodynamic conditions than the deeper communities where the finer sediment would be expected to favour deposit feeding. Distribution of infaunal biomass indicates that organic flux to the benthos is higher on the south side of the Rise than on the north side (Probert & McKnight 1993). If zonation of epifaunal communities was strongly influenced by organic flux, one might expect a higher flux to the south to enable Community B to penetrate to a greater depth there, rather than the reverse being the case.

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