Polar Biol (1987) 8:41–48

Polar Biology

Composition and Abundance of Zooplankton Under the Spring Sea-Ice of McMurdo Sound, Antarctica

Brian A. Foster

Department of Zoology, University of Auckland, Private Bag, Auckland, New Zealand

Received 28 November 1986; accepted 16 April 1987

Summary. Zooplankton was sampled through holes in the sea-ice of McMurdo Sound from 8 November to 10 December, 1985. Replicated vertical hauls were made to 100 and 300 m off Pram Point in the inner Sound, near the edge of the permanent McMurdo Ice Shelf. The zooplankton was sparse, averaging 2.5 mg/m^3 wet weight. The numbers of individual species varied between catches, depths, and occasions. Generally, small copepods, particularly *Oithona similis, Ctenocalanus citer* and *Oncaea curvata*, numerically dominated the catches, and higher densities of these were present in the shallower 100 m layer. Deeper hauls contained higher numbers of larger crustaceans, particularly copepods *Metridia gerlachei, Calanoides acutus* and *Euchaeta* spp., ostracod *Conchoecia belgicae* and euphausiid *Euphausia crystallorophias*. Pteropods *Limacina helicina* and *Clione limacina* were also consistently caught, but in equal densities in 100 m and 300 m hauls. Numerous other plankters were caught in low numbers, including amphipods, chaetognaths, medusae, radiolarians, and larval nemerteans, barnacles, shrimps, polychaetes and echinoderms. Comparative samples from 40 km further north, off Cape Royds and near the sea edge of the fast sea-ice in Wohlschlag Bay, and to 100 m deep, contained a similar species diversity to those near the McMurdo Ice Shelf, but always with higher densities of *L. helicina*. On the last sampling occasions, when microalgae were conspicuous under the ice off Cape Royds, there were increased densities of microcopepods and *Paralabidocera antarcticus*, indicating different ecosystem processes from the inner Sound location.

Introduction

Despite a long history of study of the marine biology of McMurdo Sound there is no published account of the species diversity and density of its zooplankton. It is known that zooplankton biomass in the Sound is low compared with further offshore Antarctic Ocean waters (Hicks 1974) and that it is dominated by copepods. Hicks (1974) reported, without amplification, that polychaetes, ostracods, euphausiids, amphipods, pteropods, tunicates, chaetognaths, ctenophores, medusae and various invertebrate larvae occur in the zooplankton under the ice there. This apparent low density but reasonable taxonomic diversity seems at odds with some earlier conceptions (Dell 1965; Knox 1970) that Antarctic zooplankton is characterised by an almost complete absence of benthic larval forms, and is poor in species but rich in individuals. Although the Antarctic marine fauna as a whole is rich in species (Knox and Lowry 1977), there is only restricted quantitative information on the diversity and abundance of zooplankton anywhere in the Antarctic Ocean, and mostly confined to larger euphausiids and copepods away from the Antarctic continent coast.

More and quantitative studies of the zooplankton community throughout the Antarctic Ocean are clearly desirable to characterise spatial and temporal variations (El-Sayed 1985). Studies by Chojnacki and Weglenska (1984) and Hopkins (1985) have investigated total zooplankton of coastal situations on the Antarctica Peninsula, and Fukuchi et al. (1985) give a preliminary account of under ice zooplankton in Lutzow-Holm Bay, but the Ross Sea zooplankton has received mostly taxonomic considerations. As part of the New Zealand Antarctic Research Programme 1985–86, the zooplankton under the land-fast sea ice of McMurdo Sound was sampled during November to early December 1985, firstly to quantify the composition of the zooplankton there, and secondly to provide information for assessment of plankton feeding by one of the cryopelagic ice fish that occurs there (Foster et al. 1987). Samples were collected through only the upper part of the water column, and thus represent only a part of the zooplankton (in space and time) McMurdo Sound.

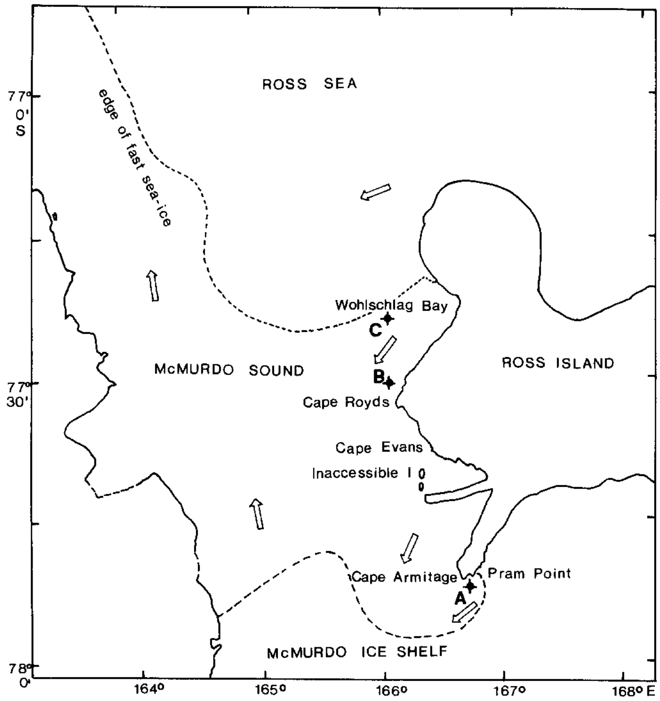

Fig. 1. Location of Stations A–C on the eastern side of McMurdo Sound. The ice edges are drawn from DMSP satellite images obtained for 4 occasions 12–30 November, courtesy U.S. NSF Representative at McMurdo. *Arrows* indicate suspected mean current flows (Heath 1977)

Materials and Methods

Samples were collected from three stations on the seasonally land-fast sea ice (Fig. 1):

Station A 77° 52'S, 166° 45'E, 1.5 km off Pram Point, near the edge of the permanent McMurdo Ice Shelf, through a hole bored by auger and covered by a heated hut for the duration of sampling, 4 November to 7 December 1985.

Station B 77° 31'S, 166° 6'E, 1 km north of Cape Royds through an enlarged seal hole initially, but later through a widening pressure crack, on five occasions between 6 November and 10 December.

Station C 77° 24'S, 166° 6'E, 12 km north of Cape Royds in Wolhschlag Bay, near the edge of the fast sea ice, through an enlarged seal hole on four occasions from 6 November to 3 December.

Samples were collected with a simple conical plankton net, 0.8 m mouth diameter (0.5 m^2), and 0.2 mm nylon mesh aperture. Vertical hauls were made from 100 m deep (filtering 50 m^3) at all stations, and from 300 m (150 m^3) on most occasions at Station A. Each haul was made at a rate of 0.3 ms^{-1}. Triplicated hauls were made on each occasion. All samples were collected between 09.00 and 12.00 h to minimise any latent diel effect. Fragments of ice were invariably collected into the sample as the net was pulled through the water surface. The ice was allowed to thaw in the hut at Station A, and on return to the laboratory at Scott Base for Stations B and C, and then the samples were fixed in 70% ethylalcohol or 4% formaldehyde in sea water. Complete samples were searched by microscopy in a counting tray. All copepods over 3 mm long and all other plankters were counted. The abundant smallest copepods were estimated from one tenth subsamples using the Stempel pipette technique.

After enumeration, whole samples were weighed after washing in an aspiration filtering cylinder, using weighed filter papers. Weights and numbers are expressed per volume of sea water filtered on the assumption of 100% efficiency of the net.

Results

Faunal Composition

A total of 102 samples were analysed, 75 from Station A, 15 from Station B and 12 from Station C. Not all of the taxa enumerated have been positively identified. For the purposes of this paper, the 28 taxa as listed in Table 1 are considered. The plankters ranged in size from 10–15 mm long euphausiids which were infrequently caught, to the always present smaller copepods *Oithona similis* and *Oncaea curvata* with body lengths of 0.5 mm. Net avoidance or escape could have occurred at either end of the size range, but this was not assessed.

No larvae of euphausiids were collected, although a few eggs of appropriate size for *E. crystallorophias* were present in the samples from Stations B and C on the last two sampling occasions. Copepod nauplii were rare in the samples; late stage copepodites were present and were not distinguished from adults for these analyses.

The taxa are arranged in Table 1 in rank order of the frequency of their representation in the 33 samples taken

Table 1. Frequency of capture of taxa as a percentage of occurrence in all hauls, to 100 m at all stations and to 300 m at Station A. (1) copepods; (2) pteropod molluscs; (3) larval forms; (4) crustaceans other than copepods; (5) gelatinous zooplankton; (6) foraminiferan; (7) present at end of period only. The decapod crustacean larvae are probably of *Chorismus antarcticus,* the ctenophores mostly juvenile *Beroe* sp. (occasional large specimens excluded), and siphonophores enumerated from nectocalyces of mostly *Pyrostephos vanhoeffeni*

	Station A		Station B	Station C
	300 m	100 m	100 m	100 m
No. of samples	34	39	15	12
Oithona similis (1)	100	100	100	100
Ctenocalanus citer (1)	100	100	100	100
Oncaea curvata (1)	100	100	100	0
Stephus longipes (1)	100	60	40	0
Metridia gerlachei (1)	100	92	53	0
Limacina helicina (2)	100	92	100	100
Calanoides acutus (1)	100	87	60	8
Clione limacina (2)	100	85	87	75
polychaete larvae (3)	100	69	20	16
Conchoecia belgicae (4)	100	67	13	25
siphonophores (5)	97	51	0	0
Calanus propinquus (1)	94	49	0	17
Euchaeta spp. (1)	91	67	13	0
Oikopleura sp. (5)	88	69	0	0
Euphausia crystallorophias (4)	88	3	0	16
hydromedusae (5)	76	31	13	0
nemertean larvae (3)	68	62	7	75
Sagitta spp. (5)	53	21	33	0
Hyperiella dilatata (4)	53	10	27	8
Orchomene rossi (4)	32	0	47	25
Globigerina pachyderma (6, 7)	32	31	73	75
decapod crustacean larvae (3)	21	0	47	16
ctenophores (5)	18	23	27	0
asteroid larvae (3)	12	15	7	8
Eusirus antarcticus (4)	12	10	0	0
cirripede larvae (3)	9	10	0	0
ascidian larvae (3)	3	0	0	0
Paralabidocera antarctica (1, 7)	0	3	60	50

Table 2. Numerical abundance of zooplankters standardised to numbers per 1000 m³, calculated from total numbers caught in triplicate samples on 11 occasions (11 Nov. to 7 Dec.) at Station A, arranged in order of abundance in the 300 m hauls. Total volume of water filtered was 4950 m³ in the 300 m hauls, and 1650 m³ in the 100 m hauls

	0–300 m	0–100 m
Oithona similis	48579	78181
Ctenocalanus citer	14650	23349
Oncaea curvata	7943	12902
Metridia gerlachei	2970	691
Stephus longipes	941	1553
Calanoides acutus	273	94
polychaete larvae	201	51
Conchoecia belgicae	164	36
Limacina helicina	70	104
Clione limacina	62	81
nemertean larvae	57	12
Calanus propinquus	31	20
Oikopleura sp.	28	73
Euphausia crystallorophias	23	1
hydromedusae	13	7
Globigerina pachyderma	9	19
Sagitta sp.	7	5
Euchaeta spp.	7	2
Hyperiella dilatata	6	2
Orchomene rossi	3	0
ctenophores	3	18
decapod crustacean larvae	2	0
asteroid larvae	1	4
Eusirus antarcticus	1	3
cirripede larvae	1	2
ascidian larvae	1	1
Paralabidocera antarctica	0	1

over the full 300 m of water column at Station A. Differences occur in the order when only the 100 m samples are considered, most notably in the case of *Euphausia crystallorophias* which was taken infrequently in the shallower hauls. Other taxa more frequently taken in deeper hauls are *Stephus longipes*, *Orchomene rossi* and shrimp larvae. In Table 2, instead of frequency of capture, the density of plankters in the 100 m and 300 m samples,

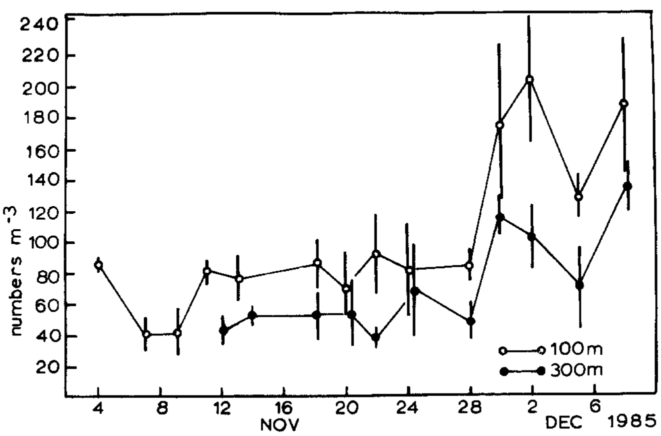

Fig. 2. Density of smaller copepods (*Ctenocalanus citer* + *Oithona similis* + *Oncaea curvata*) at Station A in shallow and deep hauls during the sampling period

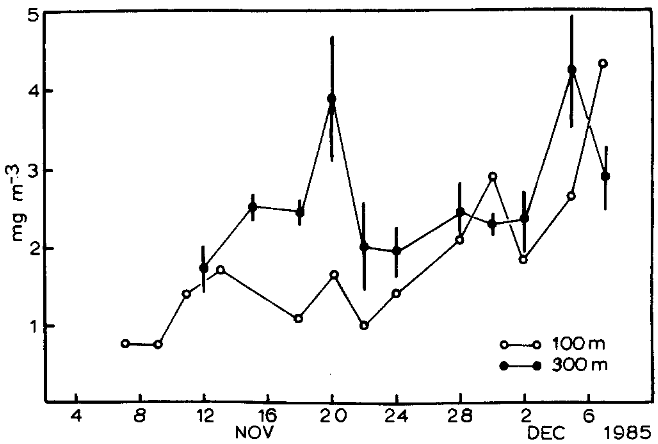

Fig. 3. Biomass of total plankton in shallow and deep hauls at Station A, standardised to mg/m³. Shallow samples were combined for weighing

integrated over the same 33 samples, are compared, showing some minor differences in order of abundance.

The information given in Tables 1 and 2 represent accumulative interpretations of the zooplankton composition during November and early December in the upper layer of the water column. It confirms that copepods are the commonest component, with small copepods *Oithona similis*, *Ctenocalanus citer* and *Oncaea curvata* being particularly common, four or five orders of magnitude more than the larger amphipod and euphausiid crustaceans.

Temporal Variation and Vertical Distribution

The density of the three smallest copepods at Station A are expressed as a function of time in Fig. 2. Comparison of the density in the 100 m and 300 m hauls reveals higher concentrations of these microcopepods in the shallow samples on most occasions, and a marked increase in density during early December.

Comparing the biomass of the whole samples (Fig. 3) indicates that the always volumetrically larger catches in the deeper hauls also represented greater unit density. This was due to contributions from plankters other than the microcopepods, and a bimodality of relatively high biomass (about 4 mg m^{-3}) from this source occurred on or about 20 November and 5 December. By the latter part of the sampling period, the increasing density of microcopepods in the shallower hauls made the standardised biomasses of both hauls equivalent.

Densities of some of the taxa relative to depth of haul and through the sampling time are shown in Figs. 4–7. Some taxa were represented frequently enough in the samples to provide useful variation estimates among the replicates. Of these, it is clear that the copepods *Metridia gerlachei* and *Calanoides acutus* (Fig. 4) were not only caught in larger numbers in the deeper hauls but actually occurred more densely at deeper layers in the water column. In contrast, the pteropod molluscs *Limacina helicina* (subspecies *antarctica*) and *Clione limacina*

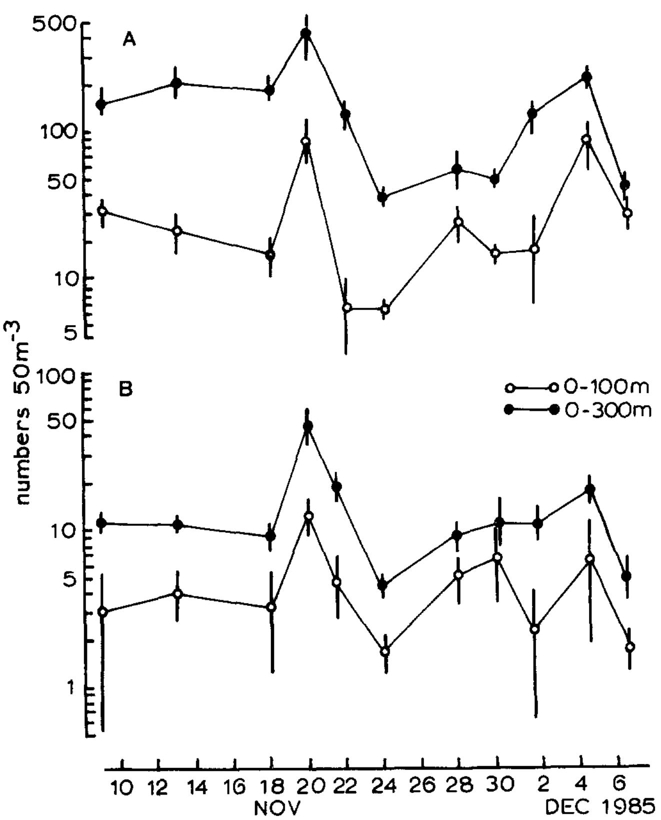

Fig. 4. Density of A *Metridia gerlachei* and B *Calanoides acutus* caught in shallow and deep hauls at Station A

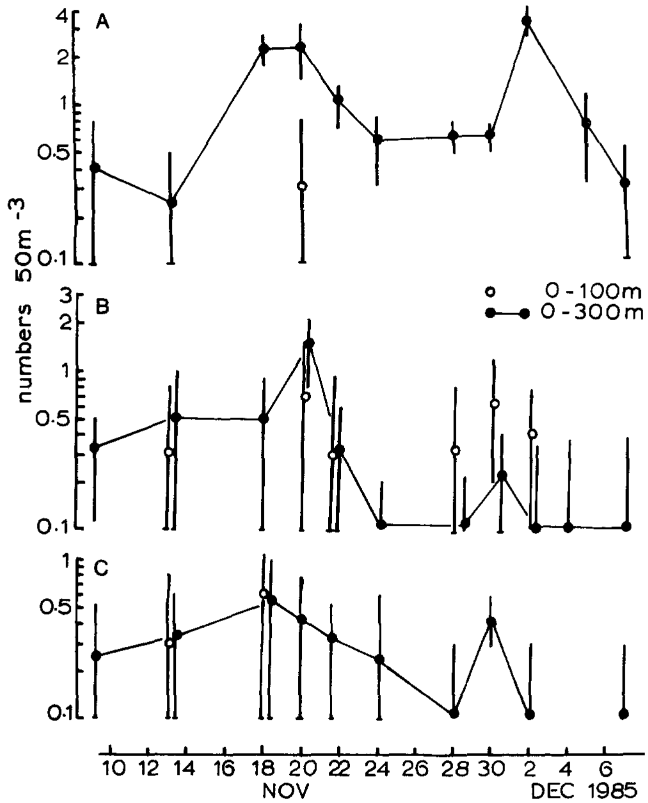

Fig. 6. Density of A *Euphausia crystallorophias*, B chaetognaths, and C *Hyperiella dilatata* caught in shallow and deep hauls at Station A

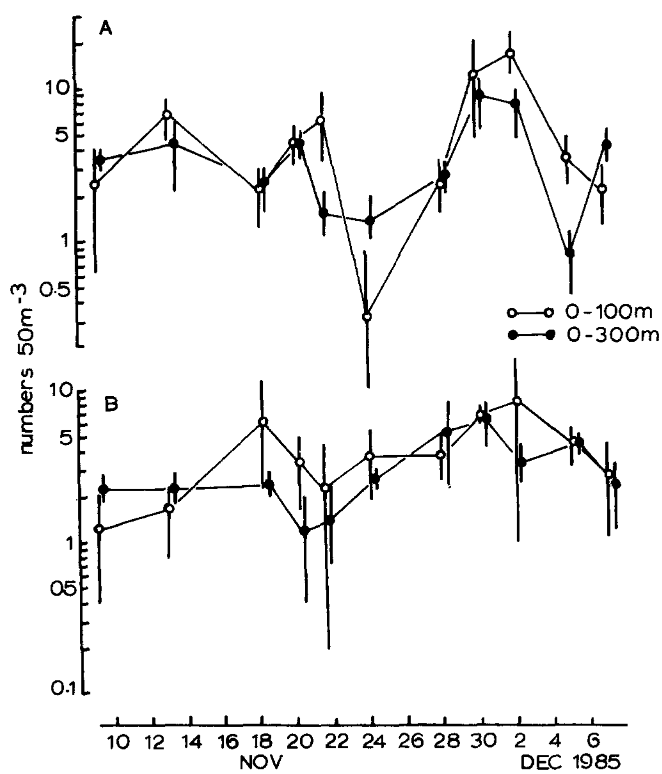

Fig. 5. Density of A *Limacina helicina* and B *Clione limacina* caught in shallow and deep hauls at Station A

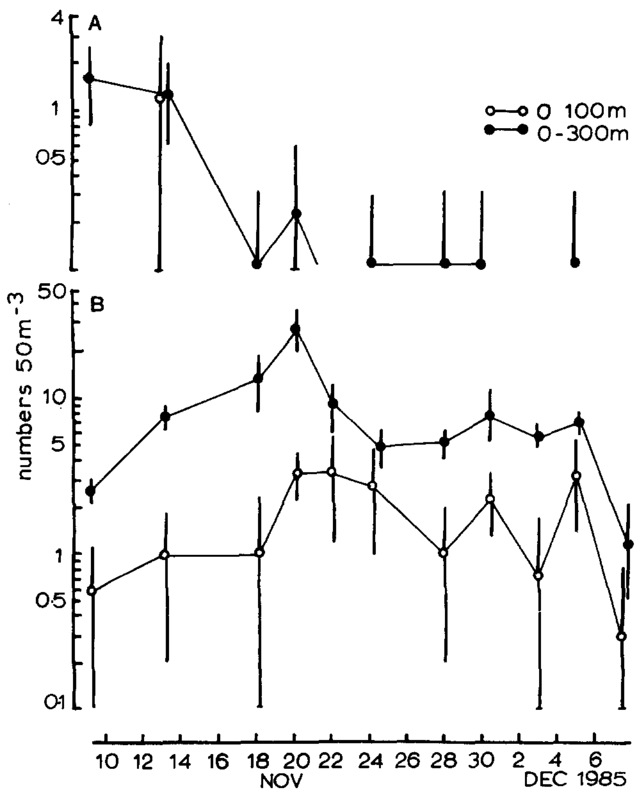

Fig. 7. Density of A *Euchaeta antarctica* and B *Conchoecia belgicae* caught in shallow and deep hauls at Station A

(subspecies *antarctica*) (Fig. 5) were apparently evenly distributed within the upper 300 m of the water column. The euphausiid *E. crystallorophias* (Fig. 6A) was consistently present in only deeper hauls, and on the one occasion it was taken in 100 m hauls fewer were caught. In contrast, even though chaetognaths (Fig. 6B) and the hyperiid amphipod *Hyperiella dilatata* (Fig. 6C) were more frequently taken in the deeper hauls, there is no indication they were present in greater densities at deeper layers in the water column. The extreme variation in these data is due to the low numbers caught in each sample, with frequent absences among the replicates.

With due caution about the high variability within most of this low density data, the following species were always caught at greater densities in deeper hauls: *Metridia gerlachei, Calanoides acutus, Euchaeta antarctica* (Fig. 7A), *Conchoecia belgicae* (Fig. 7B), *Orchomene rossi, Euphausia crystallorophias* and decapod shrimp larvae. *Hyperiella dilatata* was denser in deeper hauls on all but one occasion.

The density of some of these larger (>3 mm length) taxa showed a bimodality of occurrence with peaks on or about 20 November and 5 December. This is apparent in the plots for *M. gerlachei* (Fig. 5A), *C. acutus* (Fig. 5B) and *E. crystallorophias* (Fig. 6A), which were probably the main contributors to the two biomass increments in deeper samples in Fig. 3.

Spatial Variation

The stations near Cape Royds were sampled on fewer occasions than Station A, and only to 100 m, but there are some clear differences in the order of frequency of capture of the taxa (Table 1). Mean densities of plankters from equivalent numbers of samples taken at about the same time are compared in Table 3. Taking particular note of differences of at least an order to magnitude the main differences are:

(i) Station B has higher densities of *Limacina helicina.*
(ii) Station C lacks *Metridia gerlachei, Stephus longipes* and *Oncaea curvata*, and generally has low numbers of microcopepods.
(iii) Stations B and C have higher densities of *Paralabidocera antarctica* and *Globigerina pachyderma* than at Station A, when they occurred later in the sampling period.

Discussion

Analysis of the samples collected during this programme has enabled a better appreciation of the composition of the zooplankton under the sea ice of McMurdo Sound. The low biomass values are in agreement with the values obtained by Hicks (1974) who estimated wet weights of

Table 3. Comparison of zooplankton caught on or about the same dates in the upper 100 m at the 3 stations, expressed as mean number 50 m^{-3} for the three hauls (1 = ≤1; 0 = not caught). Each haul filtered 50 m^3 of sea water

	Station A				Station B				Station C			
Date	7	18	28	2	6	16	27	3	6	16	27	3
Copepods:												
Oithona	1613	2763	2498	6870	2029	3719	4809	9295	683	691	1523	2524
Ctenocalanus	318	893	1120	2223	3236	5930	1713	11950	582	296	80	133
Oncaea	85	523	646	909	165	302	659	885	0	0	0	0
Stephus	64	43	430	101	55	100	66	0	0	0	0	0
Metridia	20	17	26	18	0	20	1	4	0	0	0	0
Calanoides	1	3	5	2	2	1	0	2	1	0	0	0
Calanus	1	1	2	1	1	1	1	1	1	1	0	0
Euchaeta	0	0	7	7	0	1	0	0	0	0	0	0
Paralabidocera	0	0	0	0	0	0	3	414	0	0	2	10
Other crustacea:												
Conchoecia	0	1	1	1	0	1	0	0	0	0	0	1
Hyperiella	0	1	1	0	0	0	1	1	0	1	1	0
Euphausia	0	0	0	0	0	0	0	0	0	1	0	1
Orchomene	0	0	0	0	0	1	1	0	0	0	1	4
Pteropod mollusca:												
Clione	1	6	4	5	1	2	4	6	1	2	1	1
Limacina	3	2	2	17	39	117	161	132	11	99	17	7
Gelatinous forms:												
Sagitta	0	0	1	1	0	1	0	1	0	0	0	0
Oikopleura	0	1	8	1	0	0	0	0	0	0	0	0
Globigerina	0	0	3	2	0	3	16	46	0	14	39	20
hydromedusae	0	0	1	1	0	0	1	1	0	0	0	0
Larval forms:												
polychaete	1	3	5	1	0	0	0	2	1	1	0	0
nemertean	0	0	7	10	0	4	3	7	0	5	12	5
asteroid	0	0	1	0	0	1	0	0	0	0	0	0
decapod crustacean	0	0	0	0	0	1	1	1	1	0	0	1
cirripede	0	0	1	0	0	0	0	0	0	0	0	0

$0.073-3.309\ mg\ m^{-3}$ for samples taken during January to early February 1971 in the same general region of McMurdo Sound. Hicks sectioned the water column with a closing net, and worked at 5 stations around Cape Armitage. He claimed that (i) low biomass at deeper layers off Pram Point result from a depleted current emerging from beneath the McMurdo Ice Shelf, and (ii) higher biomass elsewhere, and at high tide, resulted from transport of enriched open-sea water into the Sound from the north. No account was taken of tide in this study, but the general south-westward set of the net at Station A supports a notion of flow from under the ice shelf. However, in contrast to the findings of Hicks (1974), higher quantities of zooplankton were found at depth at this site, apparently mainly due to greater densities of the larger copepods *M. gerlachei* and *C. calanoides*. The higher biomass peaks on 20 November and 5 December are suggestive of a lunar cycle effect, perhaps a tidal effect on plankton transport.

It is generally agreed that the influence of the Ross Sea gyre in the northern part of the Sound extends only as far as Cape Royds before turning westwards and then north along the Victoria Land coast. Coastal currents south to Cape Armitage are apparently quite complex because of tidal and counter-currents associated with headlands (Heath 1971, 1977; Neal et al. 1976; Carter et al. 1981). Consequently, some heterogeneity among spatially arrayed plankton samples can be expected along this coast. Indeed, it is clear that there are quantitative differences in the zooplankton at and north of Cape Royds compared with the zooplankton off Pram Point. Whether these differences are ice-edge effects, or otherwise hydrologically determined, is not clear. On the last two sampling occasions at Cape Royds and in Wohlschlag Bay increased numbers of microalgae were noteworthy, colouring the net in such a way never seen at Station A, and considerably increasing the settled volume of the samples, with both the microalgae (mainly *Nitzschia stellata*) and crustacean fecal pellets from unidentified grazers of euphausiid size.

Faunistically the zooplankton yielded no surprises. Bradford (1971) has reviewed the copepods of the Ross Sea and considered that *Calanoides acutus*, *Ctenocalanus citer* (as *C. vanus*), *Metridia gerlachei*, *Oithona similis* and *Calanus propinquus* make up the bulk of surface dwelling summer species. The lack of *Rhincalanus gigas* from the McMurdo Sound samples (this study, and those stations sampled in 1958–1959 documented by Bradford 1971) indicates that the Sound is relatively unaffected by Circumpolar Deep Water, being largely neritic in nature. It is, nevertheless, a rather restricted copepod assemblage, even for a neritic one.

Chojnacki and Weglenska (1984) documented the summer (December through March) zooplankton at an inshore station at King George Island in the South Shetlands, some 15° of latitude further north, and found a richer copepod fauna, including some sub-Antarctic species, and abundant *Drepanopus pectinatus* and *Scolecithricella glacialis* not encountered in the McMurdo Sound samples. Zooplankton biomass at King George Island reached maxima of $5\ mg\ m^{-3}$ during the day, with some occasional much greater amounts (up to $165\ mg\ m^{-3}$) at night when most of the extra input was from larger species such as *Metridia* spp., *Calanoides acutus* and periodically *Calanus propinquus*. The diel effect on vertical migrating plankters is probably more pronounced at lower latitudes, but may be less important in McMurdo Sound when there was continuous daylight during the sampling period of this study.

Hopkins (1985) sampled the zooplankton at Croker Passage on the Antarctic Peninsula, to depths of 1000 m, and in late summer (March and April 1983). There, *Euphausia superba* dominates the pelagic biomass, and subdominants are *Metridia gerlachei*, *Calanoides acutus* and *Euchaeta antarctica*. Species of *Oncaea* numerically dominated the community. The more diverse fauna at Croker Passage, compared with McMurdo Sound, is partly because of inclusion of deep water species, but probably also because geographical and hydrological considerations that isolate the south-west extremity of the Ross Sea.

Most plankton sampling programmes in the southern oceans are limited to short intervals in the summer. Chojnacki and Weglenska (1984) detected some seasonal succession in the occurrence of the larger species of copepods, with *Calanoides acutus* most abundant at the beginning of summer, *Calanus propinquus* in mid summer, and *Rhincalanus gigas* at the end of summer. There are few suggestions of seasonal trends in the six weeks of the present data, the most notable being the later appearance of *Paralabidocera antarcticus* along with notable surface phytoplankton at the more northern stations in early December.

The most persistent previous plankton sampling in McMurdo Sound has been that of the British Antarctic ("Terra Nova") Expedition 1910–12. The copepods of that expedition were reported on by Farran (1929) who gave numbers of copepods caught at each station, but with little information to enable standardisation of these numbers. Some of the plankton sampling was done from a hole in the ice between Cap Evans and Inaccessible Island, but mostly only to a depth of 10 m (Harmer and Lillie 1919). This site was sampled on more or less consecutive days on four occasions in January, August and October 1911, and May 1912. The mean numbers of copepods in these samples are shown in Table 4. The standard deviations around the means equal or exceed the means because of frequent zeros in the data. *Oncaea curvata* is merely reported as numerous. Assuming that there is some comparability within these data, then it would seem the copepod species are present in McMurdo Sound the year round, but with greater catches being made in these quite shallow hauls in the dark winter months (fourth column in Table 4). The absence of *E. antarctica* in October is in accord with the present data set, for shallow sampling.

Table 4. Mean numbers of the commoner copepods taken at ice holes off Cape Evans during the British Antarctic Expedition 1910–11, from numbers per sample given by Farran (1929) and station data in Harmer and Lillie (1919)

Station	317/4–10	317/15–25	317/37–38; 323/41–48	351/57–65
Dates	Jan 1911	Aug 1911	Oct 1911	May 1912
No. of samples	6	9	8	9
Oithona similis	407	476	293	1091
Ctenocalanus "vanus"	2099	454	465	2707
Stephus longipes	1	6	5	11
Metridia gerlachei	1830	1307	316	3566
Calanoides acutus	84	319	18	1022
Calanus propinquus	8	4	2	52
Euchaeta antarctica	2	7	0	10

Fukuchi et al. (1985) sampled from 0–660 m under the sea ice in Lutzow-Holm Bay, Enderby Land, over the winter and spring (May to December 1982). The copepods are not separately identified, but collectively they dominated the samples in all months. Biomass of the integrated samples ranged from 1.5 mg m^{-3} in May to 25.5 mg m^{-3} in August, averaging at 13.5 mg m^{-3} in the spring. These spring values are higher than for McMurdo Sound, but then a greater depth of the water column was sampled. The high midwinter biomass may also represent seasonality in the vertical distribution of species comparable to diurnal migrations known in seas of lower latitudes.

Although copepods are numerically dominant they are not the only forms. The pteropods *Limacina helicina* and *Clione limacina* are notable components of the McMurdo zooplankton, and they were also collected in quantity (24000 and 3000, respectively) during the British Antarctic Expedition in 1911 (Massy 1920). This ratio of abundance approximates that obtained in the present programme near Cape Royds, but it is noted that more equal densities were obtained off Pram Point where *L. helicina* was less abundant. *Clione* feeds on *Limacina* (= *Spiratella*) (Conover and Lalli 1972) and *Limacina* is a phytoplankton filterer, and the higher concentrations of the latter near Cape Royds where phytoplankton crop became obvious in early December suggests an enhanced energetic input by herbivory into the zooplankton. The abundance of *Paralabidocera antarcticus* at the northern stations was also associated with phytoplankton abundance under the ice and discolouring of the net, but the feeding habits of this copepod are not known.

Larger plankters such as *Euphausia crystallorophias*, amphipods, and various carnivorous medusae, ctenophores, siphonophores and chaetognaths were obvious in the samples though in low numbers. Particularly numerous in near-surface samples at Station A was a radiolarian which was not fully enumerated because of its dissolution in the fixatives of some of the samples before they were examined. In fresh samples a maximum of 30/50 m^3 haul was counted, and in these samples the radiolarians had captured microcopepods onto their outer surfaces among the projecting spicules. Whether this is a real carnivore trophic link within the zooplankton has yet to be confirmed.

The quite numerous polychaete and nemertean larvae have not been specifically determined, but are probably derived from the well-developed benthic fauna of McMurdo Sound (Dayton et al. 1970), or from benthic assemblages further afield in the Ross Sea (Bullivant and Dearbon 1967). Other larval forms included nauplius and cyprid larvae of barnacles, tadpole larvae of ascidians, bipinnaria and brachiolaria of starfish, a decapod crustacean larva, and an echinospira larva of a lamellarian gastropod. Invertebrate larvae in the McMurdo zooplankton typifies its neritic or coastal nature. Only one fish larva was collected, in a 100 m haul at Station A on 2 December.

This study has not been faunistically exhaustive. Many species recorded in the literature from the Ross Sea were not encountered. However, the samples provide insights into the variation that can be expected in the composition of the commoner zooplankton, both spatially and temporally. It is clear that the usual variability associated with plankton communities in coastal situations subject to considerable hydrological complexity also occurs in this corner of the Antarctic Ocean. But the spring concentrations of this neritic zooplankton are not high, in contrast to the average Antarctic oceanic biomass of 55 mg m^{-3} (Foxton 1956; Holdgate 1967; Knox 1970). It is even less than the few more northern Antarctic coastal biomass values that are available (Chojnacki and Weglenska 1984; Fukuchi et al. 1985), but the data base for making useful comparisons is still very limited. For one thing, the data described in this paper are only for part of the water column of McMurdo Sound (maximum depths 900 m) and therefore describe only part of the zooplankton.

It is known that in the Ross Sea pelagic crustaceans and molluscs are fed on by fish (Takahashi and Nemoto 1984; Foster et al. 1987, in press), and that these fish help support penguin and seal populations of the region (Dearborn 1965; Emison 1968). It is probable that the fish do not have to contend with a relatively dilute zooplankton as determined in this study, but make use of greater concentrations that may occur away from the land-fast sea-ice, or are locally concentrated in association with microbial accumulations associated with the sea ice or sea floor.

Acknowledgements. The author wishes to thank Mr. John Cargill and Miss Treffery Barnett for field assistance, and Dr. John MacDonald for valuable advice and support at all times. The staff of New Zealand's Scott Base are all acknowledged for the various support roles that are vital for success of field programmes. Antarctic Division of the New Zealand Department of Scientific and Industrial Research provided organisational and logistic support. Satellite images on the position of the ice edge were obtained from DMSP at McMurdo, and LCDR Lee Devendorf is thanked for arranging these. Financial assistance was received from the New Zealand University Grants Committee.

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