

Animal associations with the dominant species of shallow water macrophytes along the coastline of the Vestfold Hills, Antarctica

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Abstract

Benthic grab samples, taken through core holes in sea-ice 1983, returned eight species of marine macrophytes which had associated fauna on at least one sample. A total of 24 animal taxa were found on these eight macrophytes. *Phyllophora antarctica* had a significantly greater biomass of attached fauna per unit of macrophyte biomass than any of the other seven species. It also had the greatest variety of epiphytic fauna (21 taxa). *Phyllophora antarctica* was the only macrophyte collected from comparatively protected Ellis Fjord, apart from filamentous algae, including *Cladophora subsimplex* and *Geminocarpus austrogeorgiae*, which were found in the most landward basin. It therefore played an important role in the ecology of the fjord.

Palmaria decipiens was commonly collected at more exposed coastal sites and was dominant in Long Fjord, characterized here as intermediate in terms of water movement. Sixteen animal taxa were collected from this macrophyte with the greatest numbers being found in July and August. Only four animal taxa were collected from *Iridaea cordata*. The other five macrophyte species from which epiphytic animals were collected (*Porphyra endiviifolium*, *Plocamium cartilagineum*, *Desmarestia menziesii*, *Himantothallus grandifolius* and *Cladophora subsimplex*) had animals associated with them on less than half the occasions when they were found.

Introduction

The importance of marine macrophytes in coastal ecosystems as major primary producers, and therefore to certain species of grazing animals, has been long recognized. The coastal belt of marine macrophytes harbours diverse animal communities (Mukai, 1971; Sheppard *et al.*, 1980). However, the relationships between macrophytes and epiphytic dependent/adherent animal species are still not well understood (Gore *et al.*, 1981).

It has been reported that the distribution of epiphytic fauna is primarily influenced by algal shape, water depth, wave exposure and water movement (Sarma & Ganapati, 1972; Hicks, 1976; Dahl,

1948; Norton, 1971). However the abundance of the fauna is largely dependent upon seasonal factors (Mukai, 1971; Hagerman, 1966).

Tropical and temperate macrophytes have been investigated for epiphytic animal composition, abundance and species diversity (Sarma & Ganapati, 1972; Norton, 1971). The most numerous taxa found on these macrophytes were amphipods, molluscs, isopods and polychaetes. The species composition of these animals and their abundance are seasonal and depend largely on the availability of the food resource of the algal thallus (Hagerman, 1966; Jansson, 1967; Fauchald & Jumars, 1979).

Many areas of rocky antarctic coastline have extensive marine algal belts (Delepine *et al.*, 1966;

Zaneveld, 1966) inhabited by various invertebrate species; but there is even less known about the relationships between macrophytes and epiphytic animal species from these waters than elsewhere on the globe. In a general account of research into antarctic marine benthos, White (1984) noted that the fauna and flora of shallow marine sites were 'greatly under-sampled' and also that a requirement existed for 'basic (but now unfashionable) descriptive systematic and ecological studies'. The present study helps to address this need by describing the taxonomic composition, seasonal abundance and distribution of the fauna associated with eight macrophyte species collected from the nearshore area of a coastal oasis in East Antarctica.

Materials and methods

Collections were made through sea-ice (up to 1.9 m thick) by lowering a three pronged grab to the bottom through 11 cm holes cut by a SIPRE corer (Journal of Glaciology, 1958). A similar grab and its operation are described by Heath & Singleton (this volume). Collected macrophytes were immediately separated into different species with minimal disturbance to attached fauna and were transported to the laboratory in separate polythene bags.

In the laboratory, thalli were placed in a tray and carefully picked over to remove adhering animals. These animals were then preserved in 4% formaldehyde solution pending further examination, while the washed macrophyte thalli were blotted dry, weighed and measured. The preserved animals were separated into taxa, counted and then blotted dry and weighed.

Regular sampling was concentrated in Ellis Fjord and Burton Lake (Fig. 1) for the period May 1983–January 1984. Other sites were sampled, intensively, only in summer.

Results

Eight species of marine macrophyte, collected from the nearshore waters and marine fjords of the Vestfold Hills, Antarctica, had associated fauna on at

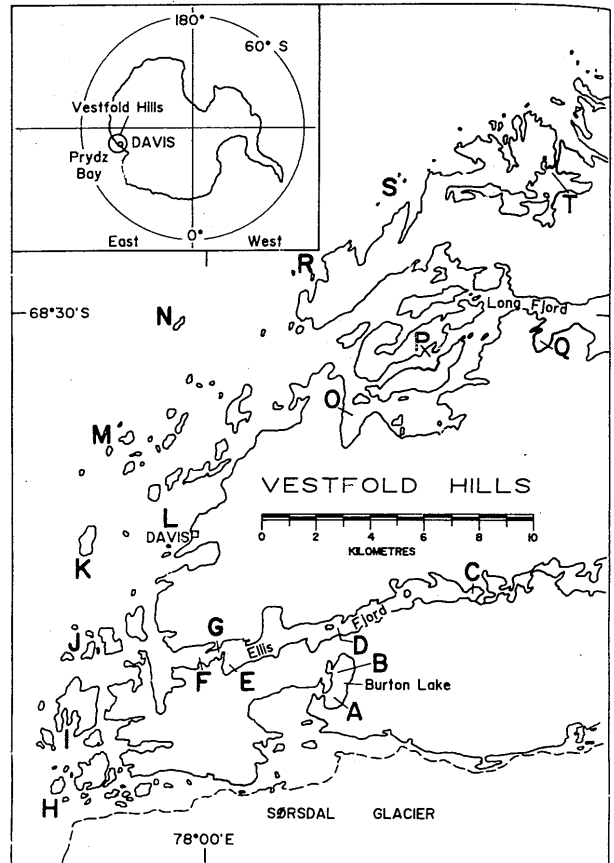


Fig. 1. Locations of the twenty sampling sites along the coastline of the Vestfold Hills, Antarctica.

least one sample (Table 1). These were *Palmaria decipiens* (Reinsch) Ricker comb. nov., *Phyllophora antarctica* A & E.S. Gepp, *Iridaea cordata* (Turner) Bary, *Porphyra endiviifolium* (A & E.S. Gepp) Chamberlain, *Plecomium cartilagineum* (Linnaeus) Dixon, *Desmarestia menziesii* J. Agardh, *Himantothallus grandifolius* (A & E.S. Gepp) Zinova and *Cladophora subsimplex* Kutzing.

The twenty sites sampled during this study fell approximately into three categories on the basis of exposure to water movement, subjectively assessed from our experience of the region. Sites G, H, I, J, K, L, M, N, R, S & T were directly exposed to the turbulence associated with wave action or strong tidal flow in summer. Sites A, B, C, D & E, on the other hand, were comparatively protected from these sources of mechanical disturbance; sites A, B & C were almost lake-like in their isolation from the sea, being tidal only in the summer months (Burke &

Table 1. Animal biomass (mg) (left figure) and numbers (right figure) g^{-1} of plant on eight macrophyte species. An empty space indicates that the macrophyte was not collected on that sampling date. A dash indicates no animals were present in that macrophyte sample.

Collection Date	Rhodophyta					Chlorophyta	Phaeophyta	
	<i>Palmaria decipiens</i>	<i>Phyllophora antarctica</i>	<i>Iridaea cordata</i>	<i>Porphyra endiviifolium</i>	<i>Plocamium cartilagineum</i>	<i>Cladophora subsimplex</i>	<i>Desmarestia menziesii</i>	<i>Himantothallus grandifolius</i>
6/ 5/83	-	1176.27/1.21		-				
8/ 5/83	88.78/2.14				-		1.04/0.075	-
15/ 5/83	59.84/0.47							
27/ 5/83	11.44/0.50			-	-	-		
23/ 6/83	0.51/0.29			0.79/0.26			-	-
29/ 6/83	6.02/0.31		12.61/2.10		6.36/14.55		-	-
23/ 7/83	15.90/4.20				-	29.33/18.67		-
10/ 8/83		31.76/2.66						
22/ 8/83	12.69/3.54					-		
12/ 9/83		1109.92/1.98						
16/ 9/83		31.74/2.93				-		
3/10/83	-	235.75/1.30						
25/10/83	49.50/6.50	-	-					
29/10/83	1.73/0.66							
30/10/83	1.98/0.37		2.41/0.46					
1/11/83		887.95/2.24						
14/11/83	3.19/0.53		7.81/1.02		-			
18/11/83	1.43/0.30	13.21/1.32	2.59/0.77		-			0.19/0.045
26/11/83	9.25/1.28		0.83/0.38		-			
6/12/83		1.58/0.18						
8/12/83	3.42/0.49	112.17/8.83			-		10.65/1.70	5.54/0.031
19/12/83	2.20/0.46		2.85/0.82					
29/12/83	11.23/0.98							
30/12/83	0.30/0.32		-	-				
31/12/83	0.54/0.055		-	-				
8/ 1/84	0.65/0.20		0.64/0.12					
10/ 1/84	1.20/0.40						16.21/0.75	
12/ 1/84	0.04/0.010		0.04/0.012	0.04/0.006	3.82/1.99	-	0.57/0.029	0.56/0.19
Mean	11.74/1.00	327.30/2.06	2.71/0.52	0.14/0.04	1.02/1.65	3.67/2.33	3.56/0.32	0.63/0.03

Burton, this volume; J. B. Gallagher, pers. commun.). Sites F, O, P & Q were regarded as intermediate.

The distribution and abundance of some macrophytes was related to this gradient. The thalloid Phaeophyta *Himantothallus grandifolius* and *Desmarestia menziesii* were found almost exclusively at the most exposed sites; they also occurred at one intermediate site (site F). These algae dominated the macrophyte biomass at more exposed sites in summer and probably also in winter although they could not be collected through the small diameter SIPRE ice-corer holes. The rhodophyte *Iridaea cordata* was

also confined to exposed sites.

In contrast, *Phyllophora antarctica* (Rhodophyta) was only abundant in the comparatively protected waters of Ellis Fjord, although it occurred at more exposed sites. In a subsequent study, using SCUBA in 1985, this alga was the only apparent macrophyte in the main body of Ellis Fjord (Kirkwood & Burton, in press). Another rhodophyte, *Palmaria decipiens*, was the dominant contributor to macrophyte biomass in Long Fjord, an area of intermediate exposure in the above classification, and was commonly collected at all exposed and intermediate sites. Filamentous algae, including *Cladophora subsim-*

plex (Chlorophyta) and *Geminocarpus austrogeorgiae* (Phaeophyta), were the only macrophytes collected from the most protected sites (sites A, B & C).

Sea-ice was also an important factor affecting the distribution of macrophytes. Its effect was to preclude macrophytic growth in the intertidal zone and down to about 2 m below low tide level for 10–12 months of the year. In summer, the sea-ice usually breaks out along the coast and may break out of the fjords, though usually only partially. Bare rock, newly exposed when the sea-ice disappeared, was colonized by the rhodophyte *Porphyra endiviifolium* with chlorophyte and phaeophyte filamentous algae growing in rock crevices: *Enteromorpha* spp., *Urospora penicilliformis* (Roth) Areschoug, *Ulothrix* sp., *Cladophora* spp. and *Geminocarpus austrogeorgiae*.

In all, 24 animal taxa were collected from the marine macrophytes of the inshore waters of the Vestfold Hills (Table 2). To enable comparison of epiphytic fauna on macrophyte samples of very different weights (ranging from 0.55 to 2186 g wet weight), faunal composition is expressed in terms of number and wet weight of each species g^{-1} (wet weight) of macrophyte.

The number of individual animals from each taxon per unit biomass of *Palmaria decipiens*, *Phyllophora antarctica* and *Iridaea cordata* are contained in Tables 3, 4 & 5. These three Rhodophyta, considered in detail here, were the only species to have animals associated with them on more than 50% of the occasions on which they were collected (Table 1) and virtually all taxa of associated animals collected from macrophytes in this study were represented on these algae.

Animal diversity

Overall, the greatest number of animal taxa were found on *Phyllophora antarctica* (21), followed by *Palmaria decipiens* (16). Only four taxa were found associated with *Iridaea cordata*. In any one month, the greatest diversity of animals was found on *Phyllophora antarctica* in November (14 taxa; Shannon diversity = 0.933), but 13 animal taxa were found on

Table 2. List of animal taxa collected from marine macrophytes in this study.

Taxon number	
1.	<i>Actiniaria</i> sp. (Anthozoa)
2.	Nematoda spp
3.	<i>Lagisca flocculosa</i> (Polychaeta, Polynoidae)
4.	<i>Serpula narconensis</i> Baird (Polychaeta, Serpulidae)
5.	Polychaeta spp
6.	<i>Lepeta coppingeri</i> E. A. Smith (Gastropoda, Lepetidae)
7.	<i>Laevilacunaria</i> sp. (Gastropoda, Littorinidae)
8.	<i>Submargarita crebrilirulata</i> (E. A. Smith) (Gastropoda, Trochidae)
9.	<i>Laternula elliptica</i> (King & Broderip) (Pelecypoda, Laternulidae)
10.	<i>Philobrya sublaevis</i> (Pelseneer) (Pelecypoda, Philobryidae)
11.	Pelecypoda sp.
12.	Pycnogonida spp
13.	<i>Paramoera walkeri</i> Stebbing (Amphipoda, Lysianassidae)
14.	Gammaridea spp (Amphipoda)
15.	<i>Glyptonotus acutus</i> Eights (Isopoda, Iodoteidae)
16.	<i>Cymodoce tubicauda</i> Pfeffer (Isopoda, Sphaeromatidae)
17.	<i>Antarcturus</i> sp. (Isopoda, Arcturidae)
18.	Isopoda sp.
19.	<i>Chorismus antarcticus</i> (Pfeffer) (Decapoda, Hippolytidae)
20.	<i>Sterechinus neumayeri</i> (Meissner) (Echinoidea, Echinidae)
21.	Asteroidea sp.
22.	Ophiuroidea spp
23.	Holothuroidea sp.
24.	Ascidiacea sp.

Palmaria decipiens in May (Table 3). Only a few of the recorded taxa were found consistently on each of these algae. The number of taxa found in more than 50% of months for which animals were recorded, was five on *Palmaria decipiens*, four on *Phyllophora antarctica* and three on *Iridaea cordata* (Tables 3, 4 & 5).

Numbers of animals

An analysis of variance found a significant difference in the number of animals g^{-1} of macrophyte

Table 3. Population density of animal taxa collected from *Palmaria decipiens* (number of individuals g⁻¹). A dash indicates an absence of that taxon in samples from that month.

Taxon	Month							
	May	June	July	Aug	Oct	Nov	Dec	Jan
2 Nematoda spp	0.003	0.073	0.280	0.187	-	0.001	0.001	0.005
3 <i>L. flocculosa</i>	0.011	0.004	-	-	-	-	0.001	-
4 <i>S. narconensis</i>	0.003	-	-	-	0.001	-	-	-
5 Polychaeta spp	0.088	0.048	-	-	0.020	0.037	0.013	0.023
7 <i>Laevilacunaria</i> sp.	0.071	0.026	3.642	3.172	0.401	0.433	0.164	0.028
8 <i>S. crebrilirulata</i>	0.011	0.010	-	-	-	-	-	-
10 <i>P. sublaevis</i>	0.003	-	-	-	-	0.001	0.001	-
11 Pelecypoda sp.	-	-	-	-	-	0.001	-	-
12 Pycnogonida spp	-	-	-	-	0.001	-	-	0.002
13 <i>P. walkeri</i>	0.201	0.046	0.140	0.187	0.005	0.014	0.118	0.002
14 Gammaridea sp.	0.017	0.046	-	-	0.003	-	-	-
15 <i>G. acutus</i>	0.003	-	-	-	-	-	-	-
16 <i>C. tubicauda</i>	0.093	-	-	-	0.001	0.025	0.017	0.012
17 <i>Antarcturus</i> sp.	-	-	-	-	-	-	0.006	-
18 Isopoda sp.	0.006	-	-	-	-	-	-	-
22 Ophiuroidea spp	0.003	-	-	-	-	-	-	-
Weight of <i>P. decipiens</i> (g)	354.15	504.92	7.14	5.36	1976.2	1401.7	139.1	427.66

Table 4. Population density of animal taxa collected from *Phyllophora antarctica* (number of individuals g⁻¹) in those months when animals were present. A dash indicates an absence of that taxon in samples from that month.

Taxon	Month					
	May	Aug	Sept	Oct	Nov	Dec
1 Actiniaria sp.	-	-	-	-	0.134	-
2 Nematoda spp	-	-	-	-	0.067	-
3 <i>L. flocculosa</i>	-	0.121	-	-	-	-
4 <i>S. narconensis</i>	0.115	-	-	-	0.067	0.037
5 Polychaeta spp	0.115	0.242	0.345	-	0.670	0.074
6 <i>Lepeta coppingeri</i>	0.634	1.932	1.476	1.296	0.402	0.889
7 <i>Laevilacunaria</i> sp.	-	-	-	-	0.067	-
8 <i>S. crebrilirulata</i>	-	0.121	0.049	-	-	0.111
9 <i>L. elliptica</i>	-	-	-	-	0.034	-
10 <i>P. sublaevis</i>	-	-	-	-	0.067	-
12 Pycnogonida spp	-	-	0.098	-	-	-
13 <i>P. walkeri</i>	0.230	0.121	-	-	0.034	0.074
14 Gammaridea spp	-	0.121	0.098	-	-	0.037
16 <i>C. tubicauda</i>	-	-	-	-	0.034	-
17 <i>Antarcturus</i> sp.	-	-	0.049	-	-	-
18 Isopoda sp.	-	-	-	-	0.134	-
19 <i>C. antarcticus</i>	-	-	-	-	0.034	-
20 <i>S. neumayeri</i>	0.115	-	0.148	-	0.201	0.259
21 Asteroidea sp.	-	-	-	-	-	0.037
22 Ophiuroidea spp	-	-	0.197	-	-	-
24 Ascidiacea sp.	-	-	-	-	0.134	-
Weight of <i>P. antarctica</i> (g)	17.36	8.28	20.32	3.86	29.86	26.99

Table 5. Population density of animal taxa collected from *Iridaea cordata* (number of individuals g^{-1}) in those months when animals were present.

Taxon	Month				
	June	Oct	Nov	Dec	Jan
2 Nematoda spp	0.840	-	-	-	-
5 Polychaeta spp	-	-	0.115	0.407	0.010
7 <i>Laevilacunaria</i> sp.	0.840	0.434	0.659	0.713	0.020
13 <i>P. walkeri</i>	0.420	0.024	0.029	-	-
Weight of <i>I. cordata</i> (g)	2.38	41.45	34.93	9.82	202.94

for the eight species of algae ($F = 2.15$, $P < 0.05$).

The total number of animals on *Palmaria decipiens* varied seasonally from 0.1 to 4.2 individuals g^{-1} (Fig. 2) and showed a definite peak in winter (July/August), followed by a decline to < 1 individual g^{-1} over spring and summer; this macrophyte was collected in every month of the study period except September. A similar pattern may have applied to *Phyllophora antarctica* but this macrophyte was not collected in June or July. In those months when *Phyllophora antarctica* was collected, it had from 1.2 to 2.7 individuals g^{-1} , a greater number than was found on *Palmaria decipiens* during spring and early summer (Fig. 2). In the five months for which speci-

mens of *Iridaea cordata* were collected, from 0.03 to 2.1 individual animals g^{-1} were found associated with it (Fig. 2).

Animal biomass

The weight of animals g^{-1} of macrophyte varied significantly between the eight species of macrophyte on which animals were found ($F = 4.24$, $P < 0.001$). Further analysis, using the Tukey multiple comparison test (Zar, 1984), showed that *Phyllophora antarctica* supported a significantly ($P < 0.001$) greater animal biomass g^{-1} than the other seven macrophyte species (Table 6). In fact, the biomass of associated animals occasionally approached or exceeded that of *Phyllophora antarctica* (Table 1) when the sea-urchin *Sterechinus neumayeri* was found.

Distribution of animal taxa

Five taxa were found on *Palmaria decipiens* in more than 50% of months for which animals were recorded: *Laevilacunaria* sp., *Paramoera walkeri*, Nematoda spp., Polychaeta spp., and *Cymodocella tubicau-*

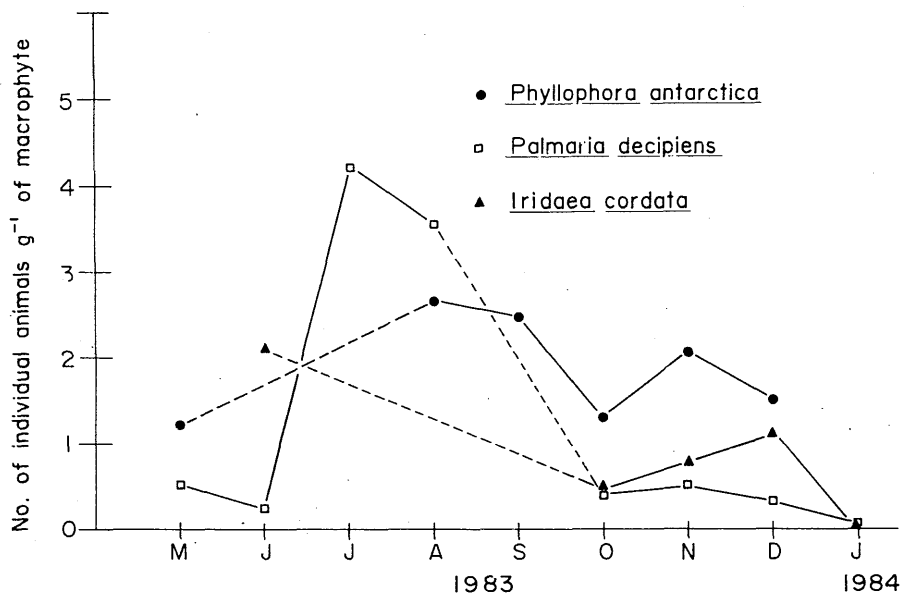


Fig. 2. Seasonal variations in the total number of epiphytic animals g^{-1} of macrophyte for the three macrophyte species supporting the greatest epiphytic animal populations.

Table 6. Comparison of mean animal biomass g^{-1} of plant tissue on eight macrophyte species.

a: Macrophytes ranked by mean animal biomass ($mg\ g^{-1}$ wet weight).

Rank	Macrophyte Species	Animal Biomass ($mg\ g^{-1}$)	n
1	<i>P. antarctica</i>	327.30	11
2	<i>P. decipiens</i>	11.74	24
3	<i>C. subsimplex</i>	3.67	8
4	<i>D. menziesii</i>	3.50	8
5	<i>I. cordata</i>	2.71	11
6	<i>P. cartilagineum</i>	1.02	10
7	<i>H. grandifolius</i>	0.63	10
8	<i>P. endiviifolium</i>	0.14	6

b: Tukey multiple comparison test.

Comparison (A vs B)	n_A	n_B	Difference ($X_A - X_B$)	SE	q
1 vs 2	11	24	315.56	43.74	7.21
2 vs 3	24	8	8.07	49.04	0.165
3 vs 4	8	8	0.15	60.06	0.002
4 vs 5	8	11	0.79	55.82	0.014
5 vs 6	11	10	1.69	52.48	0.032
6 vs 7	10	10	0.59	53.72	0.011
7 vs 8	10	6	0.39	62.03	0.006

$q_{(0.001) 60,8} = 6.268$ (Zar, 1984).

da (Tables 2 & 3). *Paramoera walkeri* and Nematoda spp. were numerically dominant in May and June respectively, and the gastropod *Laevilacunaria* sp. was numerically dominant from July onwards.

Four taxa were found on *Phyllophora antarctica* in more than 50% of months for which animals were recorded: *Lepeta coppingeri*, Polychaeta spp., *Paramoera walkeri* and the sea-urchin *Sterechinus neumayeri*. The limpet *Lepeta coppingeri* was numerically dominant in all months except November, when Polychaeta spp. dominated (Table 4).

Three of the four taxa found on *Iridaea cordata* were present in more than 50% of months for which collections were made: *Laevilacunaria* sp., Polychaeta spp. and *Paramoera walkeri*. *Laevilacunaria* sp. was numerically dominant in all months, although

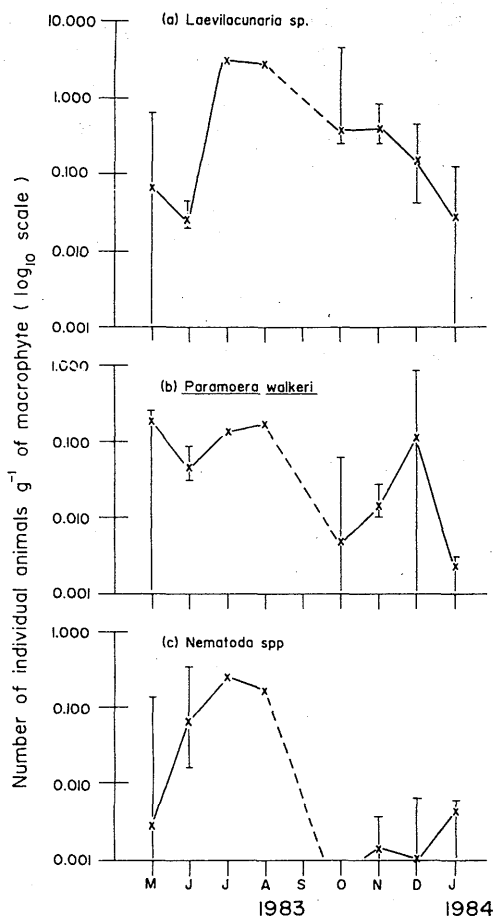


Fig. 3. Seasonal variations in the populations of the three epiphytic animal taxa occurring most consistently on *Palmaria decipiens*: a. *Laevilacunaria* sp.; b. *Paramoera walkeri*; c. Nematoda spp.

Nematoda spp. were equally frequent in June (Table 5).

It is evident that while *Paramoera walkeri* and Polychaeta spp. were frequently associated with all three of the macrophyte red algae considered here, the distribution of other taxa was macrophyte specific and/or determined by water movement. *Cymodocella tubicauda* and Nematoda spp. were a frequent component of the fauna on *Palmaria decipiens* but were rarely associated with either *Phyllophora antarctica* or *Iridaea cordata*. The gastropod *Laevilacunaria* sp. was usually numerically dominant on *Palmaria decipiens* and also on *Iridaea cordata*, macrophytes that were found at exposed or intermediate sites. *Laevilacunaria* sp. was not found

in the more protected Ellis Fjord, where *Phyllophora antarctica* was abundant, instead, the limpet *Lepeta coppingeri* was dominant on this macrophyte and was not found on either *Palmaria decipiens* or *Iridaea cordata*. *Phyllophora antarctica* was the only macrophyte with which the sea-urchin *Sterechinus neumayeri* was found to be associated.

Seasonal change of animal numbers on *Palmaria decipiens*

The seasonal change in numbers (g^{-1} of macrophyte) of *Laevilacunaria* sp., *Paramoera walkeri* and Nematoda spp. on *Palmaria decipiens* are shown in Fig. 3; error bars indicate that the variability of animal numbers was quite large in some months. No data are available for September. Both *Laevilacunaria* sp. and Nematoda spp. showed winter maxima. *Laevilacunaria* sp. subsequently declined gradually over spring and summer, while Nematoda spp. showed a sudden decline in spring and remained in low numbers until January when a slight increase was evident (Fig. 3). *Paramoera walkeri* maintained its numbers over the period May to August, declined suddenly in spring and then increased again, peaking briefly in early summer.

Discussion

The list of 24 animal taxa which were collected from the marine macrophytes of the inshore waters of the Vestfold Hills (Table 2) is certainly incomplete, but does indicate the more common epiphytic species. Active, quickly moving animals (e.g. Amphipoda) are likely to be discriminated against by grab sampling.

Little is known of the general growth patterns of perennial antarctic macroalgae (Heywood & Whitaker, 1984). During the present study, macrophytes were found in crumpled condition during winter, indicating an absence of growth. Heywood & Whitaker (1984), reviewing earlier studies, reported that growth of the endemic brown alga *Phyllogigas grandifolius* (now *Himantothallus grandifolius*; see Skottsberg & Neushal, 1960), at Signy Island

(60° 43' S), was not measurable from June to August. The Vestfold Hills receive little solar input in winter as they are situated at 68° 30' S and thus photosynthesis is likely to be inhibited in this period. The ragged condition of the macrophyte thalli, in winter, may also indicate active consumption by animals. The greater population density of animals, particularly the gastropod *Laevilacunaria* sp., on *Palmaria decipiens* in July and August (Fig. 2) may possibly be consistent with active grazing in these months. Seasonal changes in biomass of the macrophytes collected in this study can be inferred from the wet weight of material collected in each month and such changes are obviously important to the animals that associate with them. *Palmaria decipiens* was collected in small quantities in July and August and was not found in September; similarly, *Phyllophora antarctica* and *Iridaea cordata* were not found or were collected in relatively small quantities in winter (Tables 3, 4&5). Grab sampling is not sufficiently intensive a technique for us to assert that the absence of a particular macrophyte in a monthly sample denotes its absence from the environment. However, our observations seem to indicate that these macrophytes were far less abundant in winter than in summer, and that this seasonality may have reflected a balance between macrophyte growth, on one hand, and their consumption by animals, on the other. SCUBA divers observed a winter decline of macrophytes at a near-shore marine site off Davis in 1982. They estimated a decline of macrophyte cover from nearly 100% to about 20% on a rocky substrate at a depth of 15 m (Tucker & Burton, this volume).

The lower total animal numbers on *Palmaria decipiens* in spring (Fig. 2) were primarily the result of the fall in numbers of *Laevilacunaria* sp. from its winter peak, but both *Paramoera walkeri* and Nematoda spp. were also present in lower numbers than in the preceding winter (Fig. 3). The steady decline in numbers of *Laevilacunaria* sp. from October to January may represent a 'dilution effect' (Norton, 1971) with the rapid growth of the macrophyte thallus causing the epiphytic animal populations to become less dense. *Paramoera walkeri* had decreased in numbers, by October, and this may be explained by the reported tendency of this amphipod to depart benthic macrophytes in the spring to feed on dense

under-ice algal growths (Rakusa-Suszczewski, 1972; Tucker & Burton, this volume). The reasons for the great increase in abundance of Nematoda on *Palmaria decipiens* in the winter and the sharp decline in spring are not known, but it may be that these Nematoda exploit different food sources at different times of the year.

Seasonal variations aside, the number of *Laevilacunaria* sp. on *Palmaria decipiens* was relatively high throughout the study period. This macrophyte usually supported a thin covering of diatoms which may possibly have provided a food source for *Laevilacunaria* sp. A large number of individuals of this gastropod were juveniles. Fretter & Manly (1977) have also reported large numbers of juveniles of the gastropods *Lacuna vineta* and *Cerithiopsis tubercularis* on *Sargassum muticum*.

Polychaetes and nematodes were usually found on the lower part of the macrophyte, while gastropods, limpets and amphipods did not appear to show a preference for any particular part of the thallus. Withers *et al.* (1975) discussed the distribution of animal species over the thallus of *Sargassum muticum*, and concluded that distributions similar to those found in the present study were related to the animals' feeding habits. Other factors which may influence the distribution of a particular animal species over the macrophyte thallus are the amount of sediment accumulated on the plant surface and the turbidity of the water column (Dahl, 1948; Hagerman, 1966; Moore, 1972; Boaden *et al.*, 1975; Hicks, 1980).

The significantly higher weight of associated animals g^{-1} of *Phyllophora antarctica* may be due to the characteristic bushy growth of this species, which would be expected to afford better shelter for the animals than would other macrophyte species. This macrophyte also had a larger number of associated animal taxa (21) and higher species diversity of associated animals than other macrophytes collected in this study. The fact that in subsequent investigations *Phyllophora antarctica* was the only macrophyte recorded along all of Ellis Fjord apart from the meromictic landward basin (Kirkwood & Burton, in press) and that it harboured such a rich and diverse fauna indicate its importance in the ecology of this fjord. The present study also indicates the

probable significance of *Palmaria decipiens* in nearby Long Fjord (3 sites sampled; Fig. 1), as this macrophyte was a major contributor to the benthic algal biomass there and supported a comparatively large number of individual animals g^{-1} , in winter.

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