CHAPTER 5

HABITATS AS SURROGATES FOR FAUNAL AND FLORAL ASSEMBLAGES ASSOCIATED WITH ROCKY REEFS ALONG THE VICTORIAN COAST

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5.1 Introduction

This chapter investigates if 'habitat' categories based on dominant vegetation types are effective surrogates for determining presence/absence of associated species. In this way the benefit of using dominant vegetation types as attributes for habitat mapping can be assessed as a useful method for representing marine biodiversity. The study targets smaller sessile and slow moving benthic fauna and flora (excluding fish) that use the canopies and holdfasts of larger dominant vegetation for primary shelter. The study also examines association patterns at various taxonomic scales in relation to different geographic locations and environmental variables.

5.1.1 Habitats as Biodiversity Surrogates

The terms 'habitats', 'communities' and 'assemblages' have been used for over a century in the marine environment as a way of understanding and describing spatial patterns of flora and fauna (Erwin 1983). The concept of describing communities began with the recognition that there appeared to be regularly occurring suites of marine animals that exist together (Petersen 1911). Jones (1950) suggested that environmental factors might determine which suite of animals was present. For this chapter the term 'assemblage' is used as a synonymous term for 'community' that describe suites of species existing together, while the term 'habitat' refers to dominant flora and physical variables that provide suitable refuge and niches for other species.

There has been a plethora of habitat and community classification schemes developed, many of which ascribe slightly different meanings to the terms (Erwin 1983). For Southern Australia, schemes have been proposed by Shepherd and Sprigg (1976), Shepherd and Womersley (1981), Edgar (1984) based on dominant flora. The habitat concept arose from an understanding that species tend to favour a particular set of environmental conditions. For example some species may favour sheltered reefs with low wave energy while other species may prefer heavy reefs with high wave energy. The term 'habitat' is often used to describe the structural and / or environmental conditions that affect whole suites of species at the same site. Underwood *et al* (1991) describe six habitats from subtidal reefs off New South Wales with the aim of providing a framework for experimental studies. These habitats are based on the dominant floral or faunal species.

In Australia, marine managers have come to use the term 'habitat' to describe components of ecosystems within a bioregional classification (eg Interim Marine and Coastal Regionalisation of Australia Technical Group 1998; Ward *et al* 1999). The use of habitat categories derived from biophysical units (termed 'ecounits') has also been employed in British Columbia in the establishment of marine reserves based on a representative ecosystems approach (Zacharias and Howes, 1998; Zacharias *et al*, 1998).

Mapping of marine habitats using physical attributes such as substratum types can be derived from modern remote sensing technology such as satellite images, aerial photographs or hydro-acoustic sonar techniques. Examples of physical habitat descriptors developed from

remote sensing mapping include high profile reefs, low profile reefs, seagrass beds and sand (Chapter 2; Edyvane 1999).

In Victoria, marine habitats are mapped and classified according to physical nature of the substratum combined with a description of dominant benthic biota, termed *Marine Habitat Classes*. These Classes function as surrogates to describing marine biodiversity at scales of 1:25,000 to 1:100,000 (Chapter 1). The use of similar attributes have also been used in the planning of marine reserves in South Australia (Edyvane 1999) and New South Wales (Ward *et al* 1999

5.2 Methods

5.2.1 Study Sites and Sampling

Marine flora and fauna were collected from 23 sites along the Victorian coast (Table 5.1, Figure 5.1) from 13 February 1996 to 17 May 1996. Sites were selected among accessible rocky reefs spaced across the Victorian coast. The aim was to sample across all of Victoria's open coast bioregions (refer Interim Marine and Coastal Regionalisation of Australia Technical Group 1998), and to include a range of attributes used for mapping marine habitats (ie dominant vegetation and substratum types) and environmental variables (depth range and wave exposure) as described in 5.2.2 below.

At each site, a variety of dominant vegetation habitats were sought within as many depth ranges as possible. Within each dominant vegetation type at a given depth range, four replicate 1.0 m^2 quadrats were sampled. Not all dominant vegetation types were present at each site nor at each depth range. Similarly, not all depth ranges were available to sample at all sites. At some sites rough conditions prevented the collection of all four replicate samples. In total, 104 replicate quadrat samples were collected.

All biological material within quadrats was collected by hand and placed in catch bags with 3 mm mesh. This collecting method targeted algae, seagrasses, sessile invertebrates and larger motile invertebrates. The material was preserved in 4% buffered formalin. The fauna was later transferred to 70% ethanol and the flora was pressed on herbarium sheets.

All specimens were identified to the lowest taxonomic level. The taxonomic groups identified included algae, seagrasses, molluscs, echinoderms, polychaetes (excluding serpulids), pycnogonids, corals, bryozoans and hydroids. Crustaceans appeared to be under-represented and were excluded from the analysis. Other taxa not included were sponges, ascidians, most cnidarians, and other minor phyla (eg sipunculids). Some larger algal species were identified in the field, all other floral and faunal specimens were identified in the laboratory.

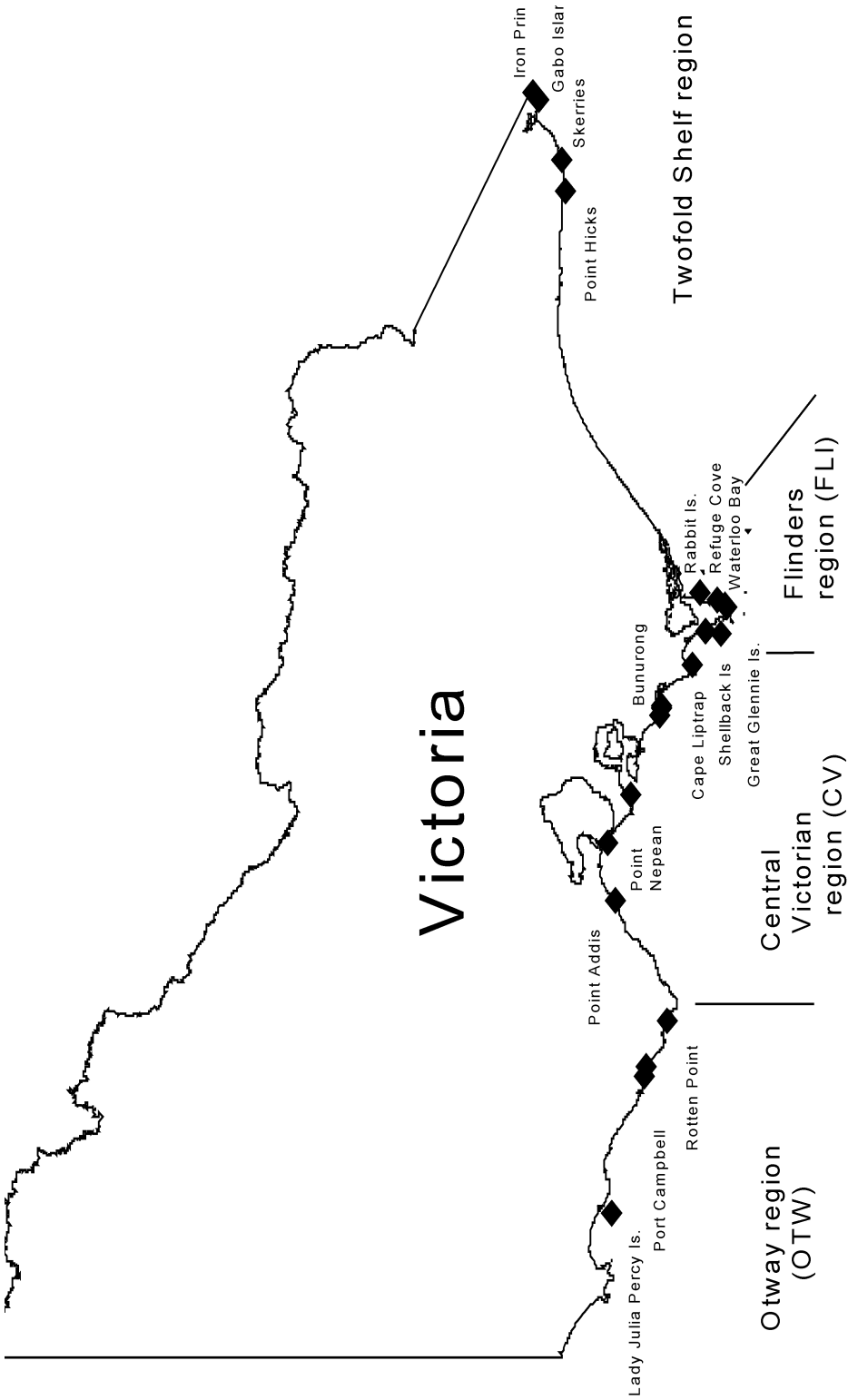

Figure 5.1. Map showing locations of sampling sites across Victoria's open coast (note 'region' refers to 'bioregion').

			Dominant Vegetation Type							
Bio-region	**Vicinity**	**Site**	***Amphibolis* Seagrass**	***Ecklonia*/ *Phyllospora***			***Cystophora*/ *Sargassum***			**Other**
			Depth (m)							
			4-8	**4-8**	**8-12**	**>12**	**4-8**	**8-12**	**>12**	
Otway	Lady Julia Percy	Dingy Cove	-	4	4	-	-	-	-	
	Port Campbell	Port Campbell Harbour, Mutton Bird Island	6	-	5	-	-	-	-	
	Glenaire	Rotten Point	-	-	-	2	-	-	-	
Central Victoria	Pt Addis	Pt Addis	4	-	-	-	-	-	-	
	Bunurong	Shack Bay, Eagles Nest	4	-	-	-	4	4	4	
	Cape Liptrap	Off Maitland Beach	4	-	-	-	-	-	-	
Flinders	Western Wilsons Promontory	Shellback Island, Black Reef, Great Glennie Island	6	4	4	-	-	-	-	*Hetero-zostera* (2)
	Eastern Wilsons Promontory	Lighthouse Cove, Waterloo Bay, Refuge Cove, Rabbit Island	2	6	4	-	2	-	-	*Hetero-zostera* (4)
Twofold Shelf	Cape Howe	Point Hicks, Gabo Island, Iron Prince	-	8	4	-	4	-	-	Urchin barren

Table 5.1. Number of quadrat samples collected within each available dominant vegetation type and depth range for all sites ('-' denotes dominant vegetation or depth range not observed / present). Refer to section 5.2.2 for further details.

5.2.2 Environmental Variables

For the study the following environmental variables were considered:

Bioregions

Sites were chosen across Victoria's open coast bioregions (also termed "IMCRA" regions) developed by the Interim Marine and Coastal Regionalisation for Australia Technical Group (1998) (Figure 5.1). The bioregions include:

- Otway bioregion - far western Victoria from the South Australian border to Cape Otway.
- Central Victoria bioregion - Cape Otway to Wilsons Promontory.
- Flinders bioregion - mid-eastern Victoria around Wilsons Promontory.
- Twofold Shelf bioregion - far-eastern Victoria from east of Wilsons Promontory to the NSW border.

(A fifth bioregion defined as Victorian Embayments bioregion, was not covered by this survey).

Dominant vegetation types

Five dominant vegetation types were encountered at sites investigated in this study:

- kelp dominated assemblages, predominantly dominated by *Phyllospora comosa* and/or *Ecklonia radiata*.
- A sublittoral mixed-algal assemblage, termed by Wilson *et al* (1983) as *Cystophora*/*Sargassum* dominated assemblage. Such assemblages result from the absence of a *Phyllospora*/ *Ecklonia* canopy (mainly restricted to the Bunurong area with small patches also occurring adjacent to *Phyllospora*/*Ecklonia* sites in other localities).
- *Amphibolis* seagrass dominated.
- *Heterozostera* seagrass dominated.
- Urchin 'barrens' formed by the large purple urchin *Centrostephanus rodgersii*, restricted to far-eastern Victoria, where vegetation is restricted to crustose coralline algae.

As there were relatively few sites encountered for *Heterozostera* and urchin-barren vegetation types, they were subsequently excluded from further analysis.

Substratum types

Substratum types were divided into granite, basalt, limestone, sandstone, calcarenite and following Handreck and O'Hara (1994). Substratum types vary along the Victorian coast, with basalt, calcarenite and limestone being restricted to the Otway and Central Victoria bioregions, and granite being largely restricted to the Flinders and Twofold Shelf bioregions.

Depth range

Depth was grouped into four zones:

- < 4 m;
- > 4 m to 8 m;
- > 8 m to 12 m; and
- > 12 m.

Exposure

Exposure classes were estimated based on the orientation of the surveyed sites to the prevailing oceanic swell. No quantitative information was available, although exposure is known to vary markedly along the Victorian coast (Victorian Institute of Marine Sciences *et al* 1994). The following exposure classes were assigned for each site, note that these classes should be treated cautiously as exposure is known to vary significantly over small distances (Bell and Denny 1994):

- high (fully exposed to the prevailing swell); and
- medium (partially sheltered).

No survey sites in this study could be classified as 'low exposure' (fully sheltered).

5.2.3 Analytical Methods

All species data were analysed using presence/absence within each replicate quadrat. The Bray-Curtis measure applied to presence/absence species data was used to generate the underlying similarity coefficients. Using the Bray-Curtis similarity coefficient on presence-absence data is equivalent to using the Sorensen binary coefficient (Clarke and Warwick 1994).

Dendrograms were generated using group-averaging and a hierarchical agglomerative clustering technique as implemented by the PRIMER software package (Clarke and Warwick 1994). Ordinations were produced using non-parametric multi-dimensional scaling (MDS) in the same software package. Analyses species data values of the various environmental variables were superimposed on the data-points of the ordination. Table 5.2 shows the number of replicate quadrats exhibiting each environmental variable. Stress levels were reasonably high (0.22) but not uninterpretable. High stress values are to be expected from datasets with large numbers of samples and species (Clarke and Warwick 1994).

Separate similarity matrices were generated at various taxonomic resolutions and on separate floral and faunal subsets of the species-sample data. These similarity matrices were correlated with the similarity matrix generated from the total data, using a Spearman-rank correlation coefficient (the PRIMER RELATE routine). The resulting R-values are used comparatively to assess the similarity of each matrix with the total. No significance can be attributed to these correlations, as the datasets are not independent.

To determine which environmental variables might explain biotic patterns and associations, one-way ANOSIM tests (Clarke and Warwick 1994) were computed on groups of samples defined by the five environmental variables described above. The R-values generated from these analyses were used only in a comparative manner. No significance can be attached to these tests as the survey was not orthogonal, precluding the separation of covarying variables (for example substratum type and bioregion). The environmental variables were also used in a BIOENV procedure to determine which combination of variables best matched the biotic pattern (Clarke and Warwick 1994). The Estabrook-Rogers similarity coefficient (Estabrook and Rogers 1968) was used to generate the environmental similarity matrix, as this coefficient is designed to accommodate continuous, ordinal and multi-state variables. The environmental variables were not weighted in any way. The species-sample and environmental similarity matrices were correlated using the Harmonic Rank correlation coefficient (Clarke and Ainsworth 1993).

Finally, the difference in species composition between groups of samples defined by dominant vegetation was further explored by comparing the frequency of occurrence for each species in each group. The best discriminating species are those that show the greatest difference in frequency of occurrence (> 25%) between the various dominant vegetation groups.

Environmental variable	No of replicate quadrat samples
Bioregion	
Otway	20
Central Victoria	24
Flinders	42
Twofold Shelf	18
Dominant vegetation type	
Amphibolis	27
*Heterozostera**	6
Ecklonia/Phyllospora	56
Cystophora/Sargassum	14
Urchin barren*	1
	8
Substratum type	
Granite	51
Basalt	8
Sandstone	26
Limestone	15
Calcarenite	4
Depth range	
< 4 m	10
> 4 – 8 m	58
> 8 - 12 m	30
> 12 m	6
Exposure	
High	59
Medium	45

Table 5.2. Numbers of replicate quadrat samples exhibiting each environmental variable. * Note due to the low number of replicates with *Heterozostera* and urchin barren dominant vegetation categories, these replicates were subsequently excluded from further analyses.

5.3 Results

5.3.1 Taxa Composition

Five hundred and seventy-six taxa were identified from the quadrat samples across a range of taxonomic groups (Table 5.3). The taxa covered a range of trophic ecological groups, including primary producers, filter-feeding invertebrates, herbivores and predators. The majority of taxa (303) were recorded from only one or two quadrat samples (Figure 5.2). The most frequently recorded species were *Ecklonia radiata* (brown alga - in 39 samples), *Haliptilon roseum* (red alga - 39), *Plocamium angustum* (red alga - 35), *Musculus nanus* (bivalve - 33), *Branchiomma* sp (sabellid worm - 29), *Amphibolis antarctica* seagrass (27), *Rhodymenia australis* (red algae - 27), an undescribed syllid worm (26), *Phyllospora comosa* (brown alga - 25), and *Platynereis dumerilii antipoda* (nereid worm - 25).

Phylum name	Families	Genera	Species
Flora			
Magnoliophyta	3	3	3
Chlorophyta	5	6	16
Phaeophyta	13	24	42
Rhodophyta	24	59	111
Fauna			
Cnidaria (Hydroids)	6	14	27
Mollusca	39	71	99
Annelida	16	35	68
Pycnogonida	4	10	14
Bryozoa	44	81	154
Echinodermata	20	32	42
Total	176	335	576

Table 5.3 Summary of taxa identified from the quadrat samples.

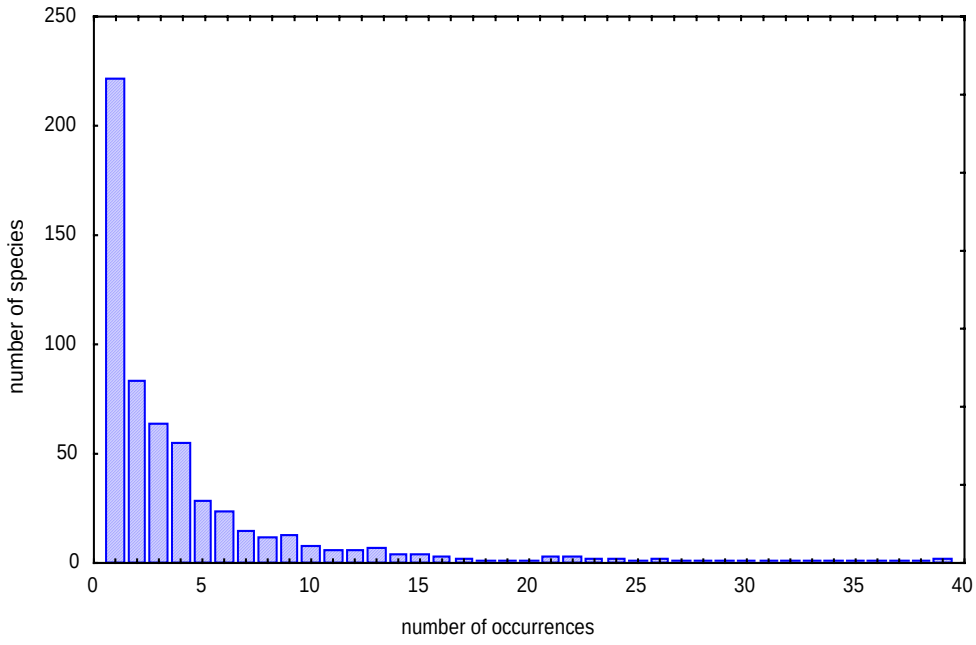

Fig 5.2. Frequency of species occurrences for all quadrat samples.

5.3.2 Cluster Dendrograms

The dendrogram (Figure 5.3) shows samples divided evenly into two primary clusters:

- The *upper primary cluster* represents samples taken from algal beds. This cluster divides into several secondary clusters characterised by a combination of dominant vegetation and site area. The first cluster represents the *Cystophora*/*Sargassum* samples from the Bunurong area. The other secondary clusters are broadly characterised by separate site areas: Wilsons Promontory; Port Campbell; and a mixed cluster from far-eastern and western Victoria.

- The *lower primary cluster* is dominated by samples from *Amphibolis* seagrass beds. Secondary clusters are broadly site-based. The Bunurong/Cape Liptrap secondary cluster includes some *Cystophora*/*Sargassum* samples that were collected adjacent to the seagrass beds.

Two main points about the variability between samples are worth noting:

- Firstly, the variability between samples is very high (Bray-Curtis similarity = 35 - 75%). This is true even where the neighbouring samples were collected within a few metres of each other (eg samples 30k-3 and 30k-4 from a kelp bed at Refuge Cove are only 37% similar; 68k-1 and 68k-2 from a kelp bed at the Iron Prince are only 35% similar). Nevertheless, replicate samples from each site generally cluster closely together.

- Secondly, the difference in the level of similarity defining primary and secondary clusters is very small (8 - 15%). A change to the taxa included in the analysis can alter the overall arrangement of clusters. For example, a dendrogram based only on faunal species (not illustrated) has numerous higher level clusters that correspond with sample area with secondary clusters corresponding to dominant vegetation within each area. Interestingly, kelp samples from far-eastern (eg Iron Prince, Gabo Island, Point Hicks) and far-western (Lady Julia Percy Island) samples cluster together in all dendrograms.

In summary, cluster analysis of the replicate quadrat samples indicates that variability between samples is high, although in most cases variability of replicate samples within a given site is lower than between sites. Higher-level clusters correspond to samples with similar dominant vegetation in the same geographic areas.

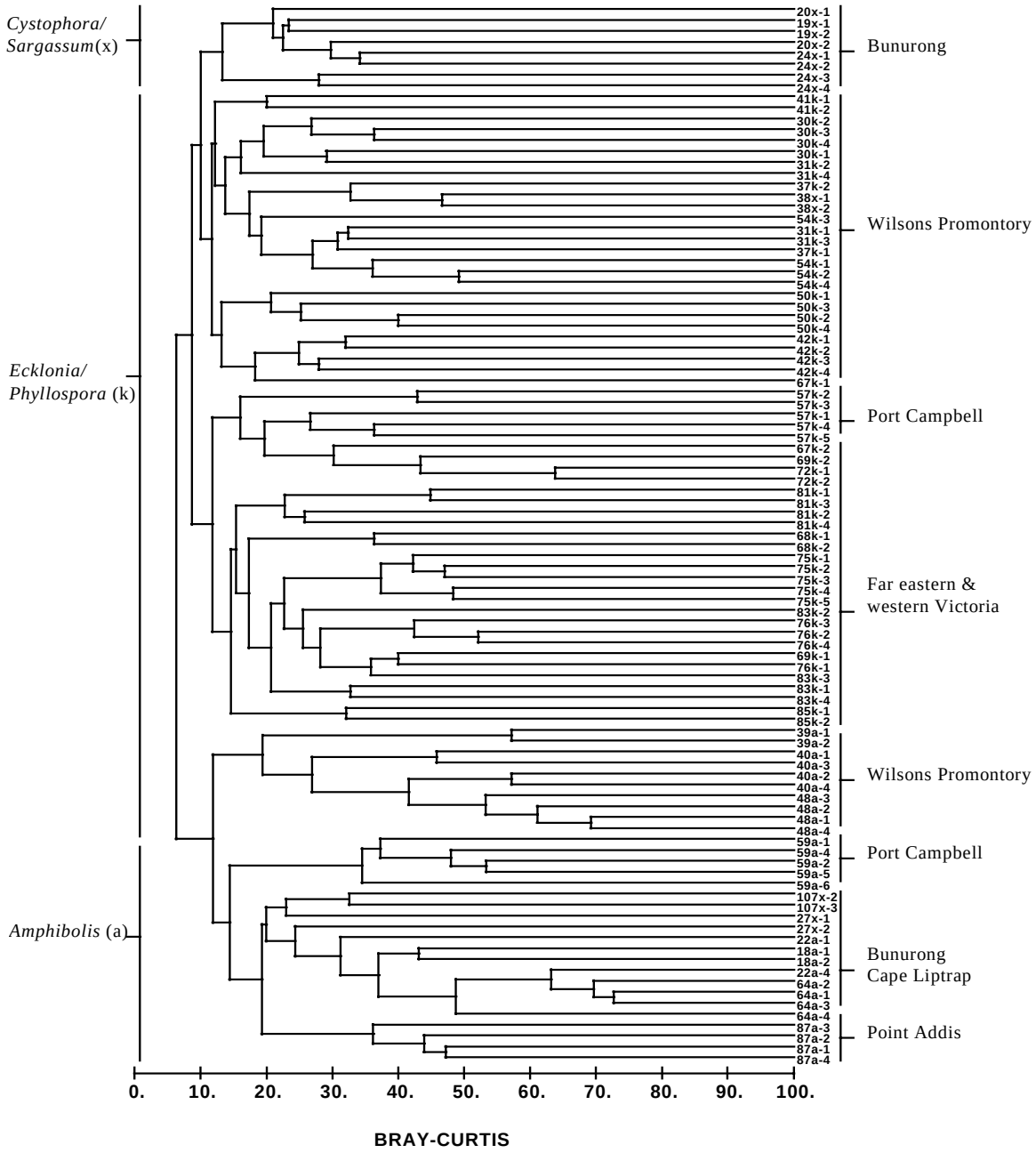

Figure 5.3. Dendrogram of quadrat samples showing distinct clustering of samples principally by dominant vegetation then by geographic locality.

5.3.3 Ordination

Ordination patterns in two dimensions were produced for the 97 quadrat samples. Five multi-state environmental variables (refer section 5.2.2 above) were superimposed on the ordination (Figures 5.4 to 5.8).

Superimposing dominant vegetation groups (Figure 5.4) onto the ordination points produces a gradient of sites from *Amphibolis* on the lower left through the *Cystophora*/*Sargassum* sites in the middle to the *Ecklonia*/*Phyllospora* sites on the upper right.

On the ordination superimposed with regional groups (Figure 5.5), the Twofold Shelf bioregion samples are clustered on the lower left of the ordination. Samples from the Flinders bioregion are predominantly near the top and to the lower left, reflecting the separation of samples based on dominant vegetation (Figure 5.4). Interestingly many of the Otway (far-western) bioregion samples are situated nearest to the Twofold Shelf bioregion (far-eastern) samples. Ordinations based on depth range, substratum type and exposure do not form distinct patterns (Figures 5.6 to 5.8)..

Similarity matrices were also generated at higher taxonomic scales and for floral and faunal subsets of the data. These similarity matrices were then Spearman rank correlated with the entire data set. The resulting correlation coefficients are shown in Table 5.4. The correlation coefficients for genus and family are generally high, indicating a relatively good correspondence between the species-level data and data at these taxonomic scales. In contrast the correlation coefficient for phyla is comparatively low. The floral and faunal data subsets generate similar, moderately high, R-values when correlated to the entire data set. Clearly both the flora and fauna contribute to the overall pattern.

Species-sample matrix	**R-value**
Taxonomic resolution	
Genus	0.867
Family	0.723
Phylum	0.346
Data subset	
Fauna	0.667
Flora	0.661

Table 5.4. Spearman correlation (R) between the total species-sample similarity matrix and derived similarity matrices based on taxonomic resolution or separate floral and fauna data.

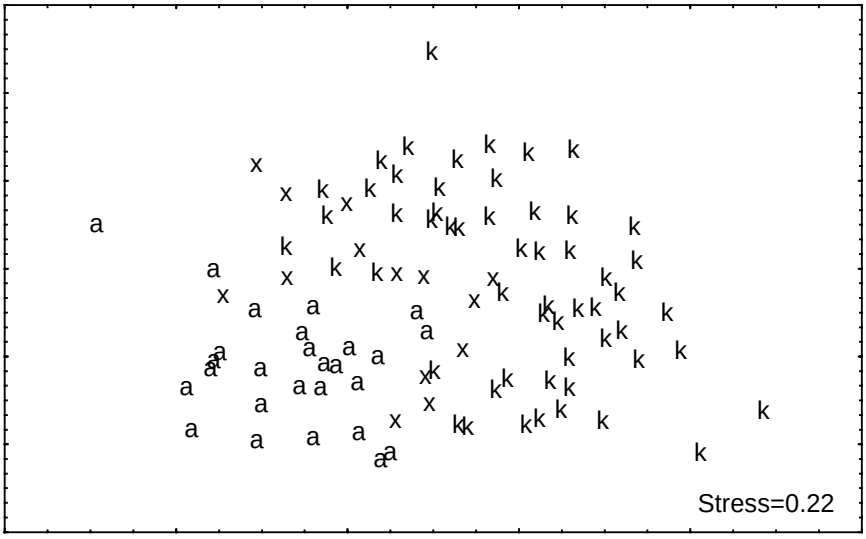

Figure 5.4 MDS plot of presence/absence species-sample data, labelled by dominant vegetation (a = *Amphibolis* seagrass, k = *Ecklonia/Phyllospora* kelps, x = *Cystophora/Sargassum*).

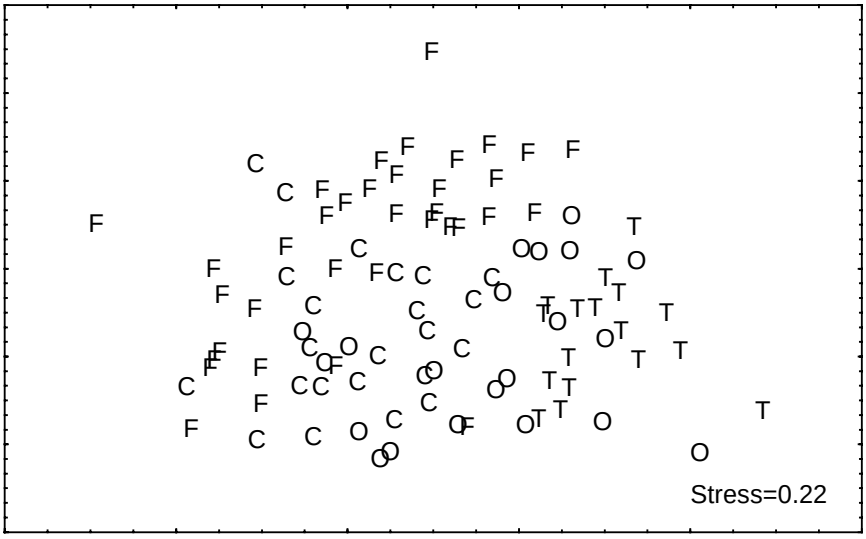

Figure 5.5 MDS plot of presence/absence species-site data, labelled by bioregion (T = Twofold Shelf, F = Flinders, C = Central Victoria, O = Otway)

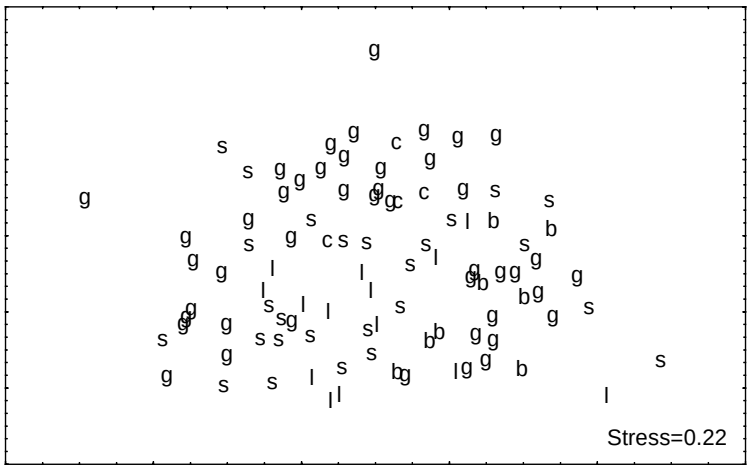

Figure 5.6. MDS plot of presence/absence species-site data, labelled by substratum type (b-basalt, g-granite, l-limestone, s-sandsone, c-calcarenite).

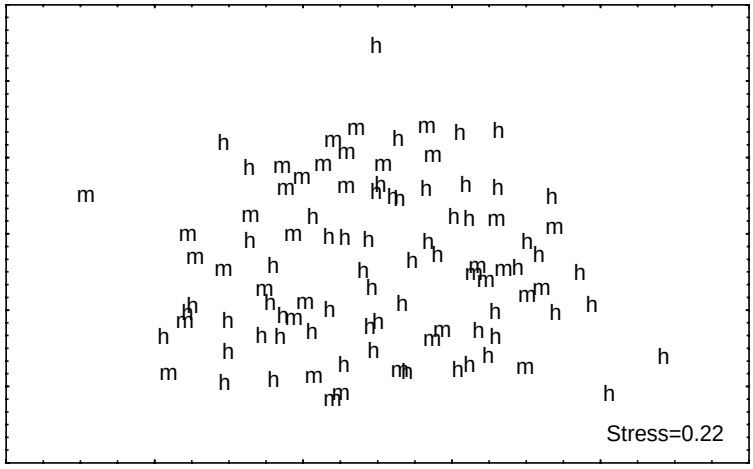

Figure 5.7. MDS plot of presence/absence species-site data, labelled by estimated exposure (m = medium, h = high).

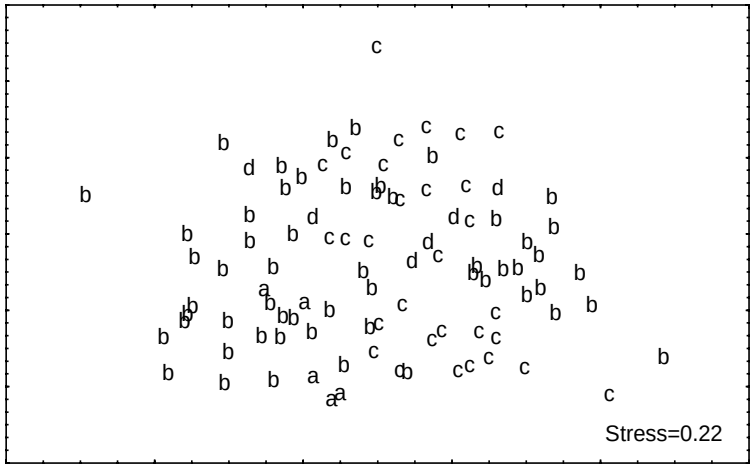

Figure 5.8. MDS plot of presence/absence species-site data, labelled by depth (a = < 4m, b = 4 to 8 m, c = > 8 to 12 m, d = > 12 m).

5.3.4 Association with Environmental Variables

ANOSIM tests statistics for various environmental variables are given in Table 5.5. The environmental variables were analysed by global tests across all groups and then individual tests on each pair of groups for all samples. The resulting R-values are used here in a comparative sense. No significance is attached to the R-values as the survey was opportunistic and not orthogonal for all environmental variables.

Groups based on dominant vegetation generate the highest global R-value, followed by region, substratum type, depth and exposure. The pairwise tests indicate that it is the difference between the seagrass samples and the samples from each of the two algal assemblages that contribute most to the global R-value for dominant vegetation. The highest pairwise values for region include comparisons between Twofold Shelf (far-eastern) samples and those collected from the Flinders region (around Wilsons Promontory) and central Victoria. The Twofold Shelf and Otway (far-western) comparison generates the lowest R-value, perhaps reflecting the dominance of *Ecklonia/Phyllospora* samples in both those regions. The highest pairwise R-values for comparisons between various substratum types are for basalt and sedimentary rocks (limestone/sandstone). The highest pairwise R-values for comparisons between depth levels are, not surprisingly, between the shallowest and deepest samples.

The results from a BIOENV analysis are given in Table 5.6. Dominant vegetation and region in combination are the environmental variables that best match the biotic pattern. Dominant vegetation appears to be the fundamental variable as it occurs in all the best matches. Variable combinations with exposure, substratum type or depth generate lower correlation coefficients

5.3.5 Species Analysis

A comparison of the frequency of occurrence of species from groups of quadrat samples defined by dominant vegetation type is shown in Tables 5.7 to 5.9. Species occurring more frequently in *Amphibolis* samples are generally epiphytic, including the red (*Haliptilon, Metagoniolithon*) and brown algae (*Dictyopteris*, *Lobospira*), the common nereid worm (*Platynereis antipoda*), an epiphytic bivalve (*Micromytilus*), limpet (*Asteracmea*), chiton (*Stenochiton*) and the grazing gastropod (*Cantharidus*). The species found more frequently in *Ecklonia/Phyllospora* are characteristic of holdfast assemblages, including two ophiuroids (*Ophiactis*, *Ophiothrix*), a syllid worm and common bryozoans (*Emma*) and benthic red algae (*Rhodymenia*). The *Cystophora/Sargassum* assemblage contains a diverse range of benthic brown (*Sargassum* spp. *Acrocarpia* spp. *Seirococcus* spp.) and red algae (*Phacelocarpus*, *Callophyllis*, *Plocamium*, *Sonderopelta*), bryozoans and small epiphytic bivalves (*Musculus nanus*, *Notomytilus*).

Different sets of species distinguish the *Amphibolis* and *Cystophora/Sargassum* assemblages (Table 5.8). The species characterising *Amphibolis* are similar to the *Amphibolis-Ecklonia/Phyllospora* comparison. The presence of a holdfast fauna and flora in the *Ecklonia/Phyllospora* samples and the mixed algal/epiphytic mollusc assemblage in the *Cystophora/Sargassum* samples are again reflected in a comparison of those groups (Table 5.9). Few common species are found exclusively in one group or the other. Even species known to be closely associated with Amphibolis seagrass in the literature are occasionally found on nearby algae, including the chiton *Stenochiton cymodocealis* and the limpet *Asteracmea stowae*. Obligate associates of *Amphibolis* found in this survey include molluscs (*Stenochiton pilsbryanus*), bryozoans (*Electra flagellum*), and algae (*Cystophora cymdoceae*, *Kraftia dichotoma*, *Mychodea hamata*, *Dicranema revolutum*).

Variable	Global R	Pairwise combinations					
		Group 1	Group 2	R	Group 1	Group 2	R
Dominant vegetation	0.429	*Amphibolis*	*Cystophora/ Sargassum*	0.531	*Cystophora/ Sargassum*	*Ecklonia/ Phyllospora*	0.259
		Amphibolis	*Ecklonia/ Phyllospora*	0.518			
Region	0.399	Otway	Twofold	0.204	Twofold	Flinders	0.498
		Otway	Flinders	0.266	Twofold	Central	0.769
		Otway	Central	0.358	Flinders	Central	0.357
Substratum type	0.142	Basalt	Granite	-0.034	Granite	Limestone	0.218
		Basalt	Calcarenite	0.670	Granite	Sandstone	0.199
		Basalt	Limestone	0.451	Calcarenite	Limestone	0.238
		Basalt	Sandstone	0.213	Calcarenite	Sandstone	0.042
		Granite	Calcarenite	-0.040	Limestone	Sandstone	0.039
Depth	0.069	2.5-4 m	4-8 m	-0.067	4-8 m	8-12 m	0.082
		2.5-4 m	8-12 m	0.384	4-8 m	12-17 m	0.041
		2.5-4 m	12-17 m	0.732	8-12 m	12-17 m	-0.082
Exposure	0.053	High	Medium	0.053			

Table 5.5. ANOSIM test statistics for samples based on five environmental variables.

Variables	R-value
Dominant vegetation, region	0.399
Dominant vegetation, exposure, region	0.340
Dominant vegetation	0.338
Dominant vegetation, substratum type, region	0.332
Dominant vegetation, depth, region	0.324
Dominant vegetation, substratum type	0.298
Dominant vegetation, exposure, depth, region	0.293
Dominant vegetation, substratum type, exposure, region	0.292
Dominant vegetation, substratum type, depth, region	0.282
Dominant vegetation, exposure	0.274
Dominant vegetation, substratum type, exposure, depth, region	0.265
Dominant vegetation, depth	0.260
Dominant vegetation, substratum type, exposure	0.257
Dominant vegetation, substratum type, depth	0.247
Dominant vegetation, substratum type, exposure, depth	0.234
Dominant vegetation, exposure, depth	0.232
Region	0.212
Exposure, region	0.180
Depth, region	0.169
substratum type, exposure, region	0.167
substratum type, region	0.159
substratum type, depth, region	0.155
Exposure, depth, region	0.154
substratum type, exposure, depth, region	0.152
substratum type, exposure, depth	0.087
substratum type, exposure	0.080
substratum type, depth	0.076
substratum type	0.053
Exposure, depth	0.045
Exposure	0.032
Depth	0.026

Table 5.6. Spearman rank correlations (R) between the species-sample similarity matrix and matrices generated by various combinations of environmental variables (BIOENV procedure).

Species	Phylum	Frequency of occurrence %		Difference in frequency %
		Amphibolis	***Ecklonia/ Phyllospora***	
Amphibolis antarctica	Magnoliophyta	96	2	94
Ecklonia radiata	Phaeophyta	0	64	64
Platynereis dumerilii antipoda	Annelida	52	5	47
Phyllospora comosa	Phaeophyta	0	45	45
Haliptilon roseum	Rhodophyta	67	23	44
Metagoniolithon steliferum	Rhodophyta	44	2	42
Stenochiton cymodocealis	Mollusca	41	0	41
Asteracmea stowae	Mollusca	41	2	39
Cantharidus pulcherrimus	Mollusca	37	2	35
Dictyopteris muelleri	Phaeophyta	37	4	33
Lobospira bicuspidata	Phaeophyta	37	5	32
Ophiactis resiliens	Echinodermata	4	36	32
Rhodymenia australis	Rhodophyta	7	38	31
Syllid sp	Annelida	7	36	29
Ophiothrix caespitosa	Echinodermata	4	32	28
Emma rotunda	Bryozoa	4	30	26
Micromytilus crenatuliferus	Mollusca	30	4	26

Table 5.7. Species that differ most in frequency of occurrence (> 25%) between *Amphibolis* and *Ecklonia/Phyllospora* samples.

Species	Phylum	Frequency of occurrence %		Difference in frequency %
		Amphibolis	***Cystophora/ Sargassum***	
Amphibolis antarctica	Magnoliophyta	96	0	96
Sonderopelta coriacea	Rhodophyta	0	57	57
Acrocarpia paniculata	Phaeophyta	4	50	46
Metagoniolithon steliferum	Rhodophyta	44	0	44
Corallina officinalis	Rhodophyta	7	50	43
Sargassum sp	Phaeophyta	15	57	42
Haliptilon roseum	Rhodophyta	67	29	38
Musculus nanus	Mollusca	26	64	38
Seirococcus axillaris	Phaeophyta	0	36	36
Stenochiton cymodocealis	Mollusca	41	7	34
Nereis bifida	Annelida	33	0	33
Amphipholis squamata	Echinodermata	33	0	33
Plocamium dilatatum	Rhodophyta	4	36	32
Notomytilus rubra	Mollusca	26	57	31
Dictyopteris muelleri	Phaeophyta	37	7	30
Callophyllis rangiferina	Rhodophyta	0	29	29
Phacelocarpus peperocarpos	Rhodophyta	0	29	29
Triphyllozoon munitum	Bryozoa	0	29	29
Cribricellina rufa	Bryozoa	0	29	29
Stereotheca elongata	Cnidaria	26	0	26

Table 5.8. Species that differ most in frequency of occurrence (> 25%) between *Amphibolis* and *Cystophora/Sargassum* samples.

Species	Phylum	Frequency of occurrence %		Difference in frequency %
		Ecklonia/ Phyllospora	***Cystophora/ Sargassum***	
Notomytilus rubra	Mollusca	5	57	52
Phyllospora comosa	Phaeophyta	45	0	45
Platynereis dumerilii antipoda	Annelida	5	50	45
Sonderopelta coriacea	Rhodophyta	13	57	44
Ecklonia radiata	Phaeophyta	64	21	43
Sargassum spp	Phaeophyta	18	57	39
Acrocarpia paniculata	Phaeophyta	13	50	37
Ophiactis resiliens	Echinodermata	36	0	36
Musculus nanus	Mollusca	29	64	35
Seirococcus axillaris	Phaeophyta	2	36	34
Trypanosyllis sp	Annelida	32	0	32
Cribricellina rufa	Bryozoa	0	29	29
Plocamium dilatatum	Rhodophyta	9	36	27
Corallina officinalis	Rhodophyta	23	50	27
Caulerpa flexilis	Chlorophyta	2	29	27
Asteracmea stowae	Mollusca	2	29	27

Table 5.9. Species that differ most in frequency of occurrence (> 25%) between *Ecklonia/Phyllospora* and *Cystophora/Sargassum* samples.

5.3.6 Species Accumulation Curves

Species accumulation patterns across geographic ranges or habitats can be used to distinguish change in biological assemblages. Distinct increases would be expected in a species curve when species data coincide with changes in environmental variables that effect the distribution of species.

An accumulation curve for all the species collected has been plotted for replicate quadrat samples ordered geographically (Figure 5.9). The resulting curve has few notable variations along its path. A similar result was obtained when the samples were ordered by dominant vegetation, depth, and substratum type (not shown). This pattern would seem to indicate that these environmental variables, as measured by this survey, are not characterised by substantial increases in the presence of new species.

The species-accumulation curve in Figure 5.9 also shows no sign of levelling off indicating that the number of quadrat samples collected by this survey was not sufficient describe all species within the range of habitats and taxonomic groups used for this study. Indeed the total number of species identified in this study is likely to represent less than 5 % of the known Victorian marine macrobenthic species, although the figure varies between taxonomic groups (O'Hara unpublished data). For example, approximately 25% of known Victorian echinoderm species, 7% of mollusc species and < 20% of red-algal species were collected (O'Hara unpublished data).

Species accumulation curves can also be used to compare species richness. Separate curves have been plotted for regions (Figure 5.10) and dominant vegetation types (Figure 5.11). Species accumulation curves for the four separate regions accumulate at approximately the same rate, indicating little difference in relative species richness across Victoria within the habitats and taxonomic groups that were sampled and identified.

The *Amphibolis* seagrass habitat appears to have a lower relative species richness per sample than algal-dominated habitats. However this result must be viewed cautiously as crustaceans, known to be abundant *Amphibolis* epibiota, were not included in this survey. The *Cystophora / Sargassum* and *Phyllospora / Ecklonia* habitats accumulate species at approximately the same rate.

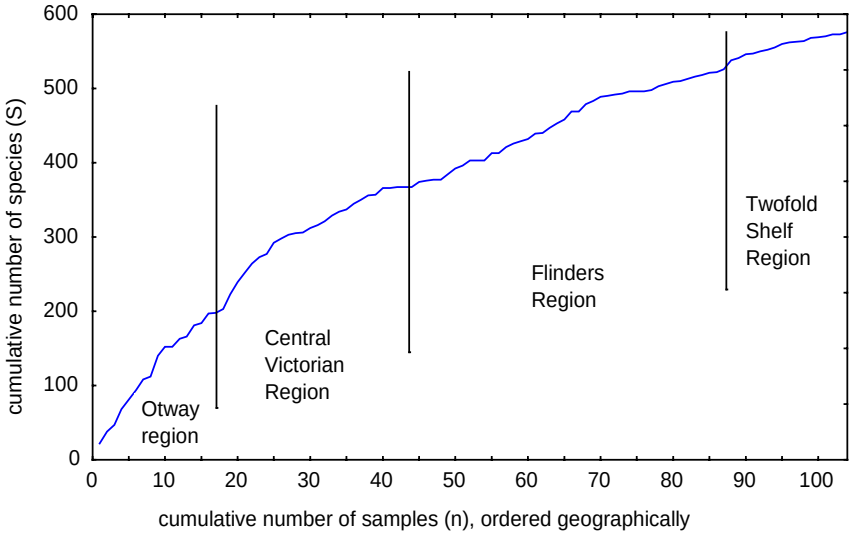

Figure 5.9 Species accumulation curve with samples ordered by bioregion (note 'region' refers to 'bioregion') .

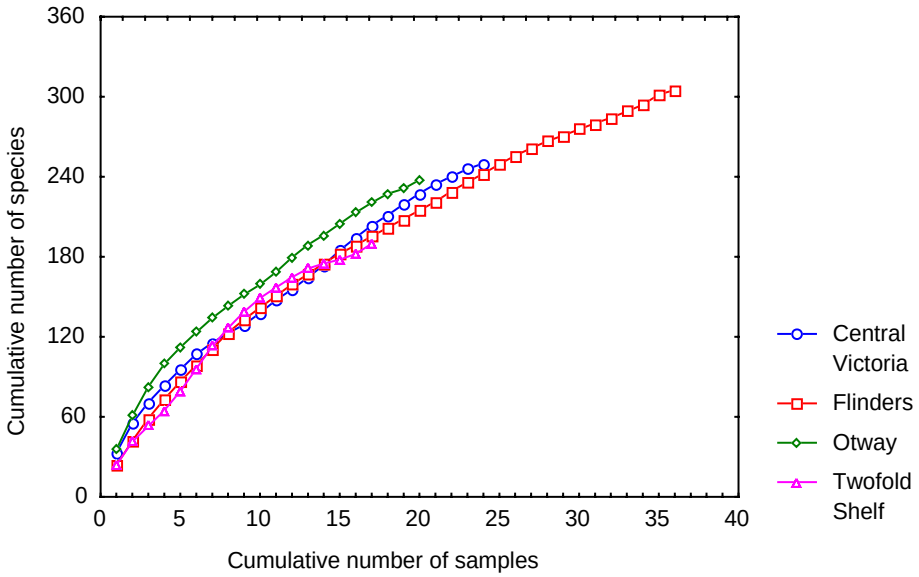

Figure 5.10 Species accumulation curves for Victoria's open coast bioregions.

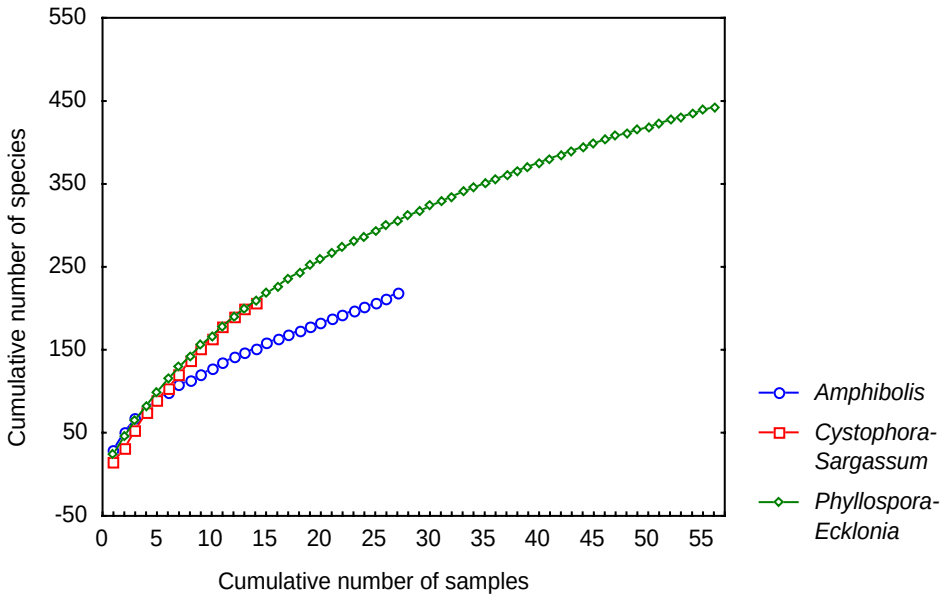

Figure 5.11. Species accumulation curves for dominant vegetation types.

5.3.7 Species Distributions

Of the 193 species found by this study in far-eastern Victoria (east of and including Point Hicks) only four are known from museum records and the literature to be restricted to that region within Victoria (O'Hara unpublished data). These are the molluscs: *Ischnochiton elongatus crispus*, *Chiton jugosus* and *Eurytrochus strangei*, and the echinoid *Centrostephanus rodgersii*. Several notable western Victorian plants have eastern distribution limits between Wilsons Promontory and Point Hicks, including *Amphibolis antarctica* (eastern Wilsons Promontory) and *Macrocystis angustifolia* (Cape Conran). None of the molluscs or echinoderms found only in the west of the state in this survey are known to have distributional boundaries within that region (O'Hara unpublished data).

Over 175 marine species are considered to be potentially introduced into Victorian marine waters (Hewitt *et al* 1999). Only one was collected during this survey, the bryozoan *Bugula neritina*, which was recorded from south-eastern Wilsons Promontory. This species is a common fouling organism on ships and has achieved a worldwide distribution.

5.4 Discussion

5.4.1 Environmental Variables

Multivariate analyses of floral and faunal assemblages indicate variability dependent on the type of dominant vegetation and geographic location. When examining replicate quadrat samples at the smallest scales of a few metres, some replicate samples exhibit Bray-Curtis similarity coefficients as low as 35%. However, when all replicate quadrat samples are compared across Victoria, the majority of replicate quadrat samples from a given site tend to group together in a cluster or ordination analysis. This indicates regional (geographic) associations are evident within each dominant vegetation type. The relative significance of these variables is confirmed by comparative R-values derived from ANOSIM and BIOENV procedures.

The pattern of sites with similar estimated exposure or depth do not reflect the dominant vegetation groupings as would be expected from other studies (eg Shepherd and Womersley 1981; Edgar 1984). Similarly, the analyses did not suggest that the environmental variables that were measured or estimated during this survey strongly influenced the composition of associated flora and fauna within dominant vegetation types across the entire geographic range. Explanations for this include:

- The depth range for the study was within a relatively narrow range (2.5 to 17 m) which corresponds with observations in Chapter 1 that marine communities between 2.5 to 20 m are generally more similar compared to communities living between 0 to 2.5 m depth range, and compared to communities that live > 20 m. Before this study commenced, however, it was not certain if these depth ranges also applied to lesser known and cryptic species.

- It has been demonstrated in the Chapter 4 study that substratum type does not have a major influence on the structure of subtidal biological communities (macroalgae and macro-invertebrates). The Chapter 4 study found that substratum structure (topography and complexity) plays a key role rather than the substratum lithology of the reef itself.

- Exposure estimates for this study were too crude to adequately reflect influence, or exposure does not directly influence associations of smaller flora and fauna that use vegetated habitats as shelter. However, exposure has been found to have a major influence on dominant vegetation structure itself. (Chapter 4).

Dominant vegetation types were *a priori* defined for this study based on previous field experience: *Ecklonia*/*Phyllospora*, *Cystophora*/*Sargassum*, *Amphibolis*, *Heterozostera*, and urchin "barrens" formed by the large purple urchin *Centrostephanus rodgersii* in far-eastern Victoria. *Heterozostera* and the "barrens" habitat were not encountered frequently enough to be formally included in the multivariate analysis, however preliminary analyses that included these data did show clustering on the few sites that were encountered.

The primary clusters on the cluster dendrogram (Figure 5.3) are strongly linked to dominant vegetation types. The three dominant vegetation types are spread in a gradient across the ordination diagram (Figure 5.4), with *Amphibolis* samples on the lower left, *Cystophora*/*Sargassum* samples in the centre, and *Ecklonia*/*Phyllospora* samples on the upper right. Evidence from other studies (eg Edgar 1984; Shepherd and Womersley 1981) would suggest that this pattern might reflect an exposure gradient from relatively sheltered (*Amphibolis*) sites through moderately exposed (*Cystophora*/*Sargassum*) to highly exposed

(*Ecklonia*/*Phyllospora*). However, this was not confirmed by the exposure levels estimated during the current study.

The pattern was observed from both faunal and floral data sets. Separate faunal and floral datasets, produce similar, moderately high, R-values when correlated against the entire data set. There are moderate correspondences between the similarity matrix generated from species-level data and matrices generated from genus or family-level data. However, there is a relatively low correspondence at the phylum level.

Geographic location appears to play a role in the composition of faunal and floral associations. From the cluster dendrogram (Figure 5.3), the following general observations can be made:

- Samples > 100 km apart (at the bioregional scale) are not clearly distinguished between the Central Victoria and Otway bioregions on the ordination diagram (Figure 5.4), and areas within these bioregions do not necessarily cluster together on the dendrogram (Figure 5.3). However, samples from Eastern Victoria (Twofold Shelf bioregion) do group together, however, most of these samples are from only one dominant vegetation type (*Ecklonia*/ *Phyllospora*).

- Samples 10 km to 50 km apart form secondary clusters within the primary clusters formed by dominant vegetation type. A good example is the *Ecklonia*/*Phyllospora* samples from Wilsons Promontory (Flinders bioregion) (Figure 5.3).

- Samples 1 km to10 km apart cluster together, in some instances these clusters override the primary pattern based on dominant vegetation types (Figure 5.3).

- Samples 1 m to 10 m apart for comparing replicates taken at the same sites generally cluster together at the lowest level on the dendrogram (Figure 5.3)

In summary, the primary division of samples is by dominant vegetation type, however the division is not absolute and the assemblages associated with these dominant vegetation types do grade into one another. There appear to be relatively few individual species that are exclusive to a single dominant vegetation type.

Within the clustering divisions for each dominant vegetation type, different geographical areas can be distinguished, but there is no indication from these analyses of an obvious biogeographic gradient influencing the presence / absence of species associated with dominant vegetation types. The geographical patterns are more indicative of spatial heterogeneity of physical processes at the scale of 10 to 100 km. Each section of coastline within Victoria at this scale experiences a unique set of environmental conditions (Land Conservation Council 1993). Physical processes such as exposure, tidal streams, residual currents, and water temperature differ across the State and are not necessarily correlated with longitude (Victorian Institute of Marine Science *et al* 1994).

5.4.2 Habitats as Surrogates for Faunal and Floral Assemblage Associations

This study has demonstrated that 'habitats' based on dominant vegetation types act as useful surrogates for describing the distribution of marine biodiversity within a geographical context at scales of 10 to 100 km. This relationship is consistent with the findings of Ward *et al* (1999) which found that habitat categories assigned within Jervis Bay (New South Wales) acted as surrogates for approximately 93% of all identified associated species. In Victoria, dominant vegetation types are an attribute used for the mapping of *Marine Habitat Classes* (Chapter 1). Dominant vegetation types can be readily identified and mapped through remote sensing and field verification techniques. For this reason they offer a cost-effective alternative to sampling and identifying a large range of taxa for the purpose of representing marine biodiversity. For dominant vegetation types investigated in this study, the following general observations were made:

- *Amphibolis antarctica*

Characterised by numerous epiphytes and a suite of species that are obligate or facultative associates (Ducker *et al* 1977). *Amphibolis* beds were found mainly in the Central Victorian bioregion, although scattered patches exist in the west of the State near Port Campbell and around Wilsons Promontory.

- *Ecklonia/Phyllospora*

These large brown algae form dominant canopies in many exposed open-coast localities across Victoria. *Phyllospora comosa* forms a dense canopy on high relief, shallow (3 to 8 m), exposed or semi-exposed reefs. It is often absent from low-relief reef, such as at the Bunurong. *Ecklonia radiata* is the most ubiquitous of the large brown algae. It often occurs in combination with *Phyllospora* or in combination with *Macrocystis*, *Cystophora* and other brown algae in shallow water when *Phyllospora* is absent (refer also Chapter 6 of this report). It forms canopies at lower depths (10 to 25 m). The stipe grows long or short depending on the environmental conditions, the long-stiped form is common in far-eastern Victoria. There is some regional clustering of assemblages dominated by *Phyllospora*/*Ecklonia*, but no distinct biogeographic gradient, with the samples from Lady Julia Percy Island clustering with those from far-eastern Victoria.

- *Cystophora/Sargassum*

A diverse mixed-algal assemblage occurs in some subtidal rocky areas where the usual *Phyllospora/ Ecklonia* canopy is absent. These sites are visually characterised by the fucoid algae *Cystophora*, *Sargassum*, *Seirococcus* and *Acrocarpia*, but with many other brown, red and green algae are interspersed (including *Ecklonia* and *Macrocystis*). This assemblage is present to at least 15 m along much of the Bunurong coast to the east of Cape Paterson, but this survey also found it in small sheltered patches elsewhere (eg Refuge Cove). King (1972) recorded similar assemblages from Waratah Bay and Queenscliff. The species richness is approximately the same as for *Phyllospora/Ecklonia* (Figure 5.11).

The larger "slimy" kelps (eg *Phyllospora*, *Ecklonia, and Macrocystis*[1]) support a relatively species-poor epiphytic community compared with *Cystophora* and *Sargassum* species (O'Hara personal observations). On the other hand, *Ecklonia* and *Macrocystis* have large branching holdfasts that provide shelter to many large cryptic animals and provide a stable substratum for many sessile invertebrates and smaller algae (Edgar 1987; Smith *et al* 1996).

[1] *Macrocystis angustifolia* was rarely recorded during this survey. Patches of tall canopy forming *Macrocystis* were relatively uncommon during 1996 within Victoria. Occurrences included off Point Campbell, Cape Patten, Barwon Heads, Point Nepean, Harmers Haven and along the west coast of Wilsons Promontory (O'Hara personal observations).

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5.7 Appendix

Description of Sites

The following site descriptions are based on dive notes, identification of flora and fauna in the field, and identification of preserved material.

Lady Julia Percy Island vicinity

Dingy Cove

Dive conditions. Dive conditions were good, visibility was 7-10 m, and the cove was sheltered from the prevailing south-westerly swell. Seals were an occupational hazard.

Site description. Lady Julia Percy Island is a flat-topped basalt island bounded by cliffs on all sides. The cliffs descend to at least 20 m on the south-east side of the Island. At the north-east corner there is a small cove (called "Dingy Cove" or "Landing Place" on local maps) with a sandy bottom. On either side of the cove there are shallow rocky reefs.

The reef on the eastern side of Dingy Cove at 15 m was covered in 2 m high *Phyllospora comosa* and to a lesser extent *Cystophora platylobium*, other *Cystophora* species, *Seirococcus axillaris* and *Ecklonia radiata*. Nearer shore at 10 m, the reef was in patches ("bommies"), surrounded by sand and gravel. There was very little understorey.

The reef on the western side of Dingy Cove continues to the shore where it emerges from the shore to form an exposed line of rocks. From water depths of between 5 m to at least 15 m there was continuous reef made up of large stones covered with a dense covering of 2-3 m high kelp (*Phyllospora* and *Ecklonia*). The dense kelp provided a considerable amount of shade, suppressing other smaller algae and allowing a rich sessile fauna to become established. There were lots of seals and very few fish - only wrasses were seen.

Biota. The understorey of the eastern reef at 10 m consisted of occasional red algae, sponges and colonial ascidians, often associated with the *Ecklonia* holdfasts. The red algae included *Plocamium patagiatum*, *P. cartilagineum*, *Callophyllis rangiferina*, *Jeannerettia lobata*, *Dictymenia harveyana*, *Wrangelia nobilis*, *Haloplegma presissii* and coralline algae.

A few larger molluscs were lying exposed (*Turbo undulatus*, *Amblychilepas oblonga*), but the majority of the invertebrates were mainly found under the cobbles or associated with the *Ecklonia* holdfasts. This included the common shallow water holothurians (*Staurothyone inconspicua*; *Neoamphicyclus lividus*, *Pentacta ignava*), ophiuroids (*Ophiactis resiliens*), chitons (*Ischnochiton* spp), and other gastropods. Bryozoans and hydroids were neither common nor diverse. The algal epifauna consisted of small molluscs (*Mitrella*, *Cantharidus*, *Phasianotrochus*) and errant polychaetes (nereids, eunicids). A few specimens of the small native sabellid polychaete *Branchiomma* were collected from one quadrat.

The understorey on the western reef was dominated by sessile invertebrates. Sponges were numerous and diverse with as many as 15 species within a quadrat. There were also many ascidians and anemones. Eighteen species of bryozoan and 3 species of hydroid were recorded including the large erect species *Amathia wilsoni* and *Costaticella solida* (bryozoans) and *Stereotheca elongata* (hydroid).

Understorey algae included foliose red algae (*Plocamium angustum*, *Rhodymenia australis*, *Melanthalia obtusata*, *M. concinna*, *Ballia callitricha*), brown algae (*Dictyopteris muelleri*,

Zonaria turneriana), erect corallines, the common crustose red alga *Sonderopelta coriacea* (formerly known as *Sonderophyces australis*), and the apple-shaped green alga *Codium pomoides*. .

On the western reef at 5 m a rich motile invertebrate fauna was present, sheltering under rocks and amongst the understorey species. In contrast to the eastern side of the cove, black lip abalone (*Haliotis rubra*) were abundant. Other large molluscs included *Turbo undulatus* and *Astralium aureum*. Echinoderms were typical of a subtidal rocky environment and included echinoids (*Heliocidaris erythrogramma*), seastars (*Nectria ocellata, Plectaster decanus, Petricia vernicina, Tosia australis*), crinoids (*Cenolia* spp, *Antedon* spp) and brittle-stars (*Clarkcoma canaliculata, Ophiomyxa australis, Ophionereis schayeri, Ophiactis resiliens, Ophiothrix caespitosa*). Polychaetes included small sabellids and large scale worms (Polynoid spp). Few crustaceans were collected.

Comments. The near-shore subtidal reefs of Dingy Cove support an exposed open ocean species assemblage, dominated by canopy forming *Phyllospora* and *Ecklonia*. Further offshore the reef is reduced to cobbles, often covered by a layer of sediment, with a sparse cover of red algae. The south-east coast of the island is fringed by near vertical cliffs that descend to almost 20 m in depth.

The natural history of the marine environment around Lady Julia Percy Island was previously known only from a summer long study by the McCoy Society in 1935-6 (McCoy Society 1937).

Port Campbell vicinity

Mutton Bird Island

Dive conditions. Dive conditions were generally good. The channel between of Mutton bird Island and the nearby coast is protected from the swell; visibility was over 4 meters.

Site description. Mutton Bird Island is a large freestanding arch near the Loch-Ard Gorge. To the north-west of the Island in front of The Arch there is a small cove, relatively sheltered by the close proximity of the Island and the nearby mainland cliffs. The cove is bounded by the steep cliffs of the Island and mainland which continue to 5 m deep. The seafloor , which gradually falls to 10 m near the mouth of the cove, is covered with limestone boulders with small patches of sand between. The boulders support a continuous canopy of kelp (*Phyllospora* and *Ecklonia*) with some *Acrocarpia paniculata* and *Caulerpa flexilis*. Under the kelp, foliose and crustose coralline algae and sponges predominate but were not present in great quantities. Rock lobster and anemones were common.

Biota. The algal understorey consisted of foliose reds (e.g., *Plocamium* spp, *Hymenena* spp, *Ballia callitricha, Nizymenia australis, Phacelocarpus peperocarpos*), coralline algae, the encrusting red *Sonderopelta coriacea* and tufty brown algae (*Zonaria* spp, *Halopteris* spp). Sessile invertebrates were not numerous. Three species of bryozoan were collected, including one large colony of *Schizoretepora tessellata*. Seven species of hydroids were collected but most were small and inconspicuous, growing on the tips of various algae. The hydroids included *Eudendrium ritchei* which is the only athecate hydroid collected by this survey. Sponges and ascidians were generally smaller and less numerous than for other sites dominated by kelp.
The larger invertebrates collected are typical of rocky habitats along the Victorian open coast. They include the seastar *Plectaster decanus*, black lip abalone, and large turbinate gastropod *Turbo undulatus*. The latter two species were host to numerous bonnet limpets

(*Sabia australis*). Several chitons were collected including large specimens of *Ischnochiton elongatus*. Amongst the tufting algae were a few small bivalves and micro-gastropods; several small echinoderms; 5 species of polychaetes, including the rarely seen *Nereis jacksoni*; and 3 species of pycnogonids, one of which is an undescribed species (Callipallenid sp).

Port Campbell Harbour

Dive conditions. Dive conditions were good in the sheltered environment of Port Campbell harbour.

Site description. The Port Campbell Harbour is a small sheltered cove which experiences some ocean swell. On the west side some loose rocks and shipwreck debris were covered by a brown algal canopy. There is a small patch of sand with seagrass (*Amphibolis* and *Heterozostera*), brown algae (*Cystophora, Sargassum*) and green algae (*Caulerpa*). The *Amphibolis* was covered in numerous epiphytes. Under the rocks ophiuroids (*Clarkcoma* and *Ophionereis*) and echinoids (*Heliocidaris*) were common.

Biota. The seagrass bed in Port Campbell harbour was not a uniform stand, but more a mixed assemblage of seagrasses, brown and green algae. The green algae included *Caulerpa brownii, C. flexilis, C. scalpelliformis* and *C. cactoides*, with the last being particularly common. The brown algae include *Cystophora moniliformis*, *Sargassum*, *Zonaria*, *Halopteris*, *Perithalia* and *Bellotia*. The *Amphibolis* stems were substrata to various algal epiphytes, including large plants of the twirled brown algae *Lobospira bicuspidata*, the flat bifurcating *Dictyopteris muelleri*, the long cylindrical fronds of *Polycerea nigrescens* and the rare species *Cystophora cymdoceae*, which is the only epiphytic species of *Cystophora*. Red algae were comparatively uncommon, an exception is *Lenormandia prolifera* which was present in most quadrats.

Sessile invertebrates were relatively inconspicuous. A few small epiphytic sponges and colonial ascidians, only five species of bryozoans and two small hydroids.

The varied vegetation harbours a correspondingly numerous and diverse assemblage of motile invertebrates. Over 15 species of polychaetes from ten families of polychaetes were collected, including the common shallow water epiphytic species *Platynereis antipoda* and the small native sabellid *Branchiomma*. Many of the polychaetes were from quadrat 6 which included a piece of rotting wood. The ophiuroids included two uncommon epiphytic species (*Amphistigma minuta* and *Ophiacantha shepherdi*). Gastropod molluscs were common, including *Cantharidus pulcherrimus* and *Runcina australis* which are often found on *Amphibolis*. No bivalves were collected. Crustaceans were also common particularly amphipods, but crabs, shrimps, isopods, ostracods were also present.

Many of the usual invertebrate associates of *Amphibolis* seagrass were absent at this site, perhaps because of the small size of the patch. Absent are the bryozoan *Electra flagellum* and the molluscs *Stenochiton cymodocealis* and *Asteracmea stowae*.

Comment. The small patch of seagrass in Port Campbell harbour is the only known seagrass in the Port Campbell area east of Peterborough (M. O'Toole *pers comm*).

Port Campbell Arches

Dive conditions. Dive conditions were adequate. The area experiences some swell, however, inside the canyons it is relatively protected. No biota was collected.

Site description. Offshore of Port Campbell Harbour there is a series of rocky canyons and arches in 19-25 m of water. The upper surface of the arches (19 m) are covered in *Ecklonia* kelp with an understorey of red algae. The underneath of the arches and on the sides of the canyons is dominated by a diverse sessile faunal assemblage usually characteristic of some deeper Bass Strait waters. The large sessile animals included sponges, bryozoans, gorgonians and hydroids. The seastars *Petricia vernicina*, *Formia polypora*, *Nectria* spp, and *Plectaster decanus* were common.

Further to the east the surface canopy of a tall *Macrocystis angustifolia* kelp was seen growing from a rocky seafloor at 10 m.

Glenaire vicinity

Rotten Point

Dive conditions. Dive conditions were very difficult. The point is directly exposed to a south-westerly swell. There was considerable wave surge as deep as 15 m. Only two quadrats were sampled and the airlift mechanism was smashed against a rock ledge after one sample was taken. The dive was then abandoned. Visibility was 2 m.

Site description. Rotten Point is a small sandstone rocky promontory east of Johanna Beach near Dinosaur Cove. At 200 m south-east of the point 15 m of water there is some rocky reef consisting of a series of rocky ledges. This site is very exposed.

Biota. The bull kelp (*Durvillaea potatorum*) was found growing at the top of this ledge (13 m) and is an unusual at this depth. Other brown algae included the kelp *Ecklonia radiata*, smaller reds (e.g., *Plocamium* spp, *Phacelocarpus*, *Ballia*, *Rhodymenia* spp, *Gelidium*) and the green algae *Caulerpa obscura*.

The sheltered part of the ledges are covered in a rich sessile fauna. In the two quadrats that were sampled, there were over 15 species of sponges, 10 species of ascidian (including solitary, stalked and colonial forms), 27 bryozoans, 4 hydroids and a large colony of the octocoral *Capnella*. The larger bryozoans included *Steginoporella truncata, Celleporina* spp and *Amathia woodsii* which harboured numerous other smaller bryozoans. The collection of the rare bryozoan *Escharoides excavata* is only the third known record for this species. The larger hydroids included colonies of *Stereotheca elongata*, *Aglaophenia divaricata* and *Gymnangium longirostrum*.

Motile invertebrates were not numerous. The large crinoid *Cenolia trichoptera* was present, no doubt utilising the strong water movement to feed. Other larger animals included the gastropods *Pseudamycla dermestoidea* and *Thais orbita*. The small bivalve *Notomytilus rubra* was common.

Comment. It is rare to see the bull kelp *Durvillaea potatorum* growing at 13 m as it is more common in shallower waters.

Point Addis vicinity

Dive conditions. The dive conditions were difficult, with considerable swell and poor visibility. The first dive to the south of the point was aborted as only sand and drift algae ware present. A full range of samples were obtained from the *Amphibolis* seagrass bed at 6 m on the south-east of the point.

Site description. There is some limestone reef in shallow water around Point Addis. To the east and to the south the inshore reef is surrounded by sand at 10 depth. The main reef is covered by kelps (*Phyllospora*) and other brown and red algae. Near the sand this is replaced by an *Amphibolis* seagrass bed with associated brown (*Sargassum, Cystophora, Zonaria*) and green (*Caulerpa*) algae.

Biota. Large brown, green and red algae were interspersed amongst the seagrass, including 4 m long *Cystophora retorta,* 2 m long *C. moniliformis, Sargassum paradoxa, S. sonderi, Zonaria* spp, *Caulerpa flexilis, C. scalpelliformis* and *Nizymenia australis*. The seagrass also supported over 10 algal epiphytes, including *Dictyopteris muelleri*, *Mychodea hamata*, other red algae and corallines.

Amphibolis stems and fronds also supported sessile invertebrates, including large colonies of *Amathia woodsii* (bryozoan) , *Stereotheca elongata*, and *Amphisbetia minima* (hydroids). The bryozoan *Electra flagellum*, which is obligate on Amphibolis stems, was common, while *Electra pilosa* was present on the tips of *Cystophora* fronds. Sponges and ascidians were not common.

The motile invertebrates were numerically dominated by epiphytic micro-molluscs including *Musculus nanus, Macrozafra atkinsoni, Pseudamycla dermestoidea, Micromytilus crenatuliferus, Notomytilus rubra, Stenochiton cymodocealis* and *Asteracmea stowae*. The last two species are restricted to *Amphibolis* seagrass. There were four species of pycnogonids (sea spiders). Relatively few species of polychaetes, echinoderms or crustaceans were collected. Small majid (decorator) crabs were common amongst the bryozoans.

Point Nepean vicinity

Dive conditions. Dive conditions were poor at this site. Surge was significant making collection difficult. Visibility was restricted to 2 m. No quadrats were sampled due to the rough conditions. The biota was sampled by airlift, and a general collection of the major algae and invertebrates was obtained.

Site description. The exposed southern shoreline of Point Nepean is fringed by a series of calcarenite reefs. On the oceanic side of the surf break the seafloor at 10-12 m is covered in bommie-type reefs surrounded by sand. Large bommies (4 m high) were covered in *Phyllospora* and *Ecklonia* kelps with red algae, sponges, ascidians and bryozoans common as an understorey.

Biota. *Phyllospora comosa* was the dominant algae. Secondary species included *Ecklonia radiata, Acrocarpia paniculata, Sargassum* spp, *Dictyopteris acrostichoides, Caulerpa longifolia, Plocamium angustum, Plocamium dilatatum* and *Hymenena* spp. Large bryozoan colonies included *Scuticella plagiostoma* and *Paracribricellina cribraria*. Smaller hydroids and other bryozoans were also present.

Larger invertebrates include seastars (*Nectria*), sea-urchins (*Heliocidaris*), crinoids (*Cenolia*) and molluscs (*Turbo undulatus*). Fish are common.

Flinders vicinity

Two sites at Flinders were surveyed by airlift as part of a trial of the diving equipment. No quadrats were sampled.

Mushroom Reef

Site description. Mushroom Reef is an extensive rock platform on the south coast of Flinders near the golf course. There are large sheltered rock pools and coves protected by a shallow reef on the ocean side. The seafloor within the coves (2-3 m) are covered in a diverse carpet of algae and seagrasses. The larger rocks are covered in kelps, and smaller brown and red algae. The sandy bottom supports large beds of *Amphibolis* seagrass and patches of green algae (*Caulerpa brownii*).

Flinders Pier

Site description. South of Flinders Pier, on the south-western corner of Western Port Bay, the sandy seafloor is covered in extensive beds of *Amphibolis* seagrass with large patches of green algae (*Caulerpa brownii*) and smaller bare areas grazed by sea-urchins (*Heliocidaris*). The area is sheltered from the south-westerly swell.

Bunurong vicinity

Cape Paterson, boat ramp

Cape Paterson was sampled extensively by airlift in May 1995 as part of a pilot study to study the effectiveness of airlift sampling and develop a sampling program for the rest of the coast.

Dive conditions. Dive conditions were good.

Site description. A rocky subtidal reef continues offshore of the shore platform at Cape Paterson. Between 2 and 5 m deep there are several different floral assemblages, notably large red/brown algae (e.g., *Cystophora*, *Sargassum* and *Perithalia*), *Amphibolis* seagrass, algal turf (e.g., *Zonaria*, *Laurencia*, *Botryocladia obovata*, corallines and other red algae), and *Caulerpa* spp (*C. brownii*, *C. flexilis*, *C. obscura*).

Biota. A rich and varied assemblage of invertebrates were collected from the red/brown algal turf. This included various crabs, shrimps, echinoderms and molluscs. Fewer animals were collected from the other habitats. The majority of animals identified from the *Amphibolis* seagrass samples were living in or just over the sandy sediment near the rhizomes. This includes various shrimps, ostracods, holothurians, worms and molluscs. Many of these species can live in unvegetated conditions. In contrast, the chitons, *Stenochiton cymodocealis* and *S. pilsbryanus*, are known to prefer *Amphibolis* habitats where they live coiled amongst the rhizomes. The fauna amongst the *Caulerpa* species was intermediate in species richness.

Overall the most abundant invertebrates were small widespread shallow water species that inhabit a number of habitats. This includes the crabs *Halicarcinus ovatus* and *Pilumnus acer*; the shrimp *Hippolyte australiensis*; various ostracods; the holothurians *Trochodota allani*, *Cucuvitrum rowei* , *Pentacta ignava*; the ophiuroid *Amphipholis squamata*; and the micro-mollusc *Musculus nanus*. On the other hand almost half of the species were found only in one sample. Two of the molluscs that were collected from this site, the gastropod *Chrysallida vincula* and the bivalve *Mysella lactea*, are very rarely found.

Shack Bay

Dive conditions. Good: visibility 5 m and moderate wave action.

Site description. Shack Bay is a small sandy bay between Eagles Nest and Twin Reefs. Fifty metres offshore at 5 m the seafloor is low reef covered with red (corallines, foliose reds), brown (*Zonaria*, *Sargassum* spp, *Seirococcus*, *Cystophora* spp) and green algae (*Codium*, *Caulerpa*) growing to 0.25-0.5 m in height. *Amphibolis* beds grow to the east of the Bay. These beds were not pure stands and contained similar brown algae to the rocky sites. The *Amphibolis* supported numerous epiphytes. There are some patches of sand. Crabs, chitons, abalone, anemones, seastars (*Patiriella*), ophiuroids (*Ophionereis*, *Clarkcoma*, *Ophiothrix*), crinoids (*Cenolia*), holothurians (*Lipotrapeza*) and sea-urchins (*Heliocidaris*) were observed.

Biota. The algae at the site was very diverse. The brown algae included 3 species of *Cystophora* (*C. retorta, C. platylobium, C. monilifera*), at least 4 *Sargassum* species, 2 *Zonaria* species, *Xiphophora chondrophylla*, *Seirococcus axillaris*, *Acrocarpia paniculata* and a few isolated plants of *Ecklonia radiata*. *Phyllospora comosa* was not present. The *Amphibolis* epiphytes supported several epiphytes including *Lobospira bicuspidata*, *Dicranema revolutum* and other red algae. Patches of turf included several more species of algae including the greens *Caulerpa flexilis*, *C, brownii*, *Codium duthieae*, the browns *Halopteris* spp, *Bellotia eriophorum* and the reds *Botryocladia obovata*, *Rhodymenia*, *Sonderopelta*, various coralline algae. Five species of the foliose red algae *Plocamium* (*P angustum, P. cartilagineum, P. costatum, P. dilatatum, P. mertensii*) were present at this site.

In contrast to the abundance of plants, sessile invertebrates were less common. Only one or two sponges, colonial ascidians, hydroids and bryozoans were collected.

The motile invertebrates were dominated by molluscs and small crustaceans. This included the common small epiphytic bivalves (*Micromytilus crenatuliferus*, *Notomytilus rubra* and *Musculus nanus*) and the gastropods (*Cantharidus pulcherrimus* and *Asteracmea stowae*). As with most of the Bunurong, chitons were numerous and diverse. The brown algal sites contained large holothurians. Polychaetes were not common. Several epiphytic nereids were present, particularly the widespread *Platynereis dumerilii antipoda*.

Eagles Nest

Dive conditions. Good: visibility 5 m and moderate wave action. An alternative site at Twin Reefs was abandoned due to unfavourable conditions.

Site description. Near the shore, 80 m from Eagles Nest in 5 m, there were larger patches of sand. *Amphibolis* seagrass grows in long broad strips, perpendicular to the shore. Rocks emerging from the seagrass bed, and rocks nearer the shore, are covered in brown (*Cystophora*, *Sargassum*, *Seirococcus*, *Macrocystis*) and red algae. Rolls of loose red and brown algae lie in the sand hollows.

At 10-12m, 200 m off Eagles Nest, the reef was covered by a diverse algal assemblage. Again there were no dominant kelps. Some *Caulerpa flexilis* was present.

At 300m west-south-west of Eagles Nest at 15-17 m the seafloor was a continuous low sandstone reef, with some loose rocks, and small areas of coarse sand. The reef was covered in red and brown algae to 0.5 m in height. No dominant kelps. Abalone and seastars (*Nectria*, *Echinaster*) were obvious.

Biota. The *Amphibolis* bed (5m) near Eagles Nest was superficially similar to nearby Shack Bay. The site was dominated by plants and invertebrates were few. The *Amphibolis* bed was interspersed with species of brown, green and red algae. There were some notable differences however, including the presence of the bubble kelp *Macrocystis angustifolia*. Fewer species of *Sargassum* and *Cystophora* were present. Conversely, the diversity of algal epiphytes on the *Amphibolis* was considerable with over 30 species being present in one quadrat. Sessile invertebrates were restricted to small ascidians and hydroids that were mostly growing on the brown algae. No sponges were collected. The number of motile invertebrates was relatively low, mostly restricted to epiphytic species of molluscs, polychaetes and amphipods. Large invertebrates included the seastar *Patiriella brevispina*, the sea urchin *Holopneustes porosissimus* and the common gastropod *Turbo undulatus*.

At 10 m the reef is a diverse mix of algae and sessile invertebrates. *Phyllospora* and *Ecklonia* were absent. The larger brown algae included *Cystophora platylobium, Sargassum* spp, *Acrocarpia paniculata,* and *Seirococcus axillaris*. The tufting algae included the green *Caulerpa flexilis,* the browns *Zonaria* spp and *Perithalia caudata,* and numerous reds including 5 species of *Plocamium*, *Sonderopelta*, *Hymenena multifida* and associated epiphytes. The sessile invertebrates were dominated by bryozoa, with 35 species being recorded from the four quadrats sampled. Larger colonies included *Crisia acropora, Scuticella plagiostoma, Cribricellina rufa,* and *Canda arachnoides*. There were on average five species of sponges and ascidians in each quadrat, although few reached any size. Four small epiphytic hydroids were collected. The tufting algae supported a range of motile invertebrates including several micro-molluscs (particularly *Musculus nanus* and *Notomytilus rubra*), representatives of 7 families of polychaetes, several common holothurians and ophiuroids, and small crustaceans. The larger animals included the asteroid *Plectaster decanus*, the cryptic ophiuroid *Ophionereis schayeri*, and several species of chiton.

A similar suite of algae existed at 15 m, supplemented by species known to favour deeper water, such as *Carpoglossum confluens*, *Dilophus fastigiatus*, *Nizymenia australis*, and *Hemineura frondosa*. *Ecklonia radiata* was also present although not forming a canopy. There were numerous small colonies of sponges, ascidians and bryozoans. Twelve species of polychaete were identified, mostly cirratulids, sabellids, polynoids (scale worms) and syllids. The molluscs were mostly small, but included 7 species of chiton. Asteroids were common at this depth and large specimens of *Nectria ocellata*, *N. multispina*, *N. macrobrachia* and *Patiriella gunnii* were observed.

Comment. The subtidal environment at the Bunurong is marked by the absence of the usual kelp canopies. *Phyllospora comosa* is completely absent east of Cape Paterson. *Ecklonia radiata* is present as isolated plants but does not form a canopy. In the absence of the usual canopy, a rich assemblage of subdominant brown algae, algal turfs and sessile invertebrates is present on the rocky reefs. A similar assemblage was recorded from the Bunurong in the early 1980s (Wilson *et al*, 1983). Nearer the shore, the *Amphibolis* seagrass supports numerous epiphytes. The chiton fauna is also rich and numerous in the region.

Cape Liptrap vicinity

Maitland Beach

Dive conditions. Unfavourable: the swell made entry and exit difficult over the intertidal reef. Visibility was poor (< 2 m) and only the near-shore seagrass habitat was sampled.

Site description. The shore at Maitland Beach, to the east of Cape Liptrap, is bordered by a series of rock outcrops, interspersed with large rock pools and patches of sandy beach. The rock pools are covered in seagrasses, including *Amphibolis* and *Heterozostera*. The seaward side of the shore reef at 5 m is also covered in *Amphibolis*. This area is exposed and on the day of collection was subject to strong wave action.

Biota. The *Amphibolis* beds were relatively pure at this site and algae were restricted to smaller epiphytic plants (*Pachydictyon*, *Polysiphonia*, *Dicranema revolutum*, *Plocamium angustum*, *Champia*, and corallines) on the seagrass. Sessile invertebrates were uncommon and restricted to several small species of hydroid and sponge on the seagrass, and a single bryozoan, the *Amphibolis*-obligate *Electra flagellum*. Motile invertebrates were not diverse, but the species that were present were often abundant. This included the molluscs *Stenochiton cymodocealis* and *Asteracmea stowae*, the common nereid worm *Platynereis antipoda* and several species of small sabellid worms. Majid crabs and amphipods were also present.

Comment. This study only surveyed the subtidal seagrass habitat that was present. Additional habitats, such as subtidal kelp beds, are probably present at Cape Liptrap, but were not encountered during the dive because of unfavourable conditions. Bennett and Pope (1953: 123) detail a diverse fauna associated with *Hormosira* beds further to the north near Walkerville and the Marine Research Group has recorded over 200 species of littoral invertebrates from the region (Handreck and O'Hara, 1994).

Wilsons Promontory vicinity

Great Glennie Island

Dive conditions. Good, visibility was excellent and the site was sheltered from the prevailing south-westerly swell.

Site description. A small sheltered cove is present on the north-east point behind Ramsbotham Point. *Amphibolis* seagrass is present on the bottom of the cove (5 m) covered in numerous algal epiphytes.

Biota. The *Amphibolis* supported red and brown epiphytic algae (*Dictyopteris muelleri*, *Lobospira bicuspidata*, *Laurencia forsteri*, *Champia* and numerous corallines). There were some sessile invertebrates, including a large sponge on one *Amphibolis* stem and some bryozoans on the epiphytic red algae. Motile invertebrates were not common in the samples. They included two large eunicid worms, several gastropods, and several species of small echinoderms (asteroids, ophiuroids and crinoids). The most common invertebrate was the viviparous ophiuroid *Amphipholis squamata*.

Shellback Island

Dive conditions. Excellent: visibility was more than 10 m and the island protected the site from the prevailing south-westerly swell.

Site description. A small sheltered cove lies on the east side of the island. Submerged granite boulders lie in a line going north-east of the point. These boulders are covered in kelps with a red algal understorey. In the shelter of the boulders at 5 m is a mixed seagrass bed. Common sea dragons were observed.

Biota. The seagrass beds at the site are a mixture of *Amphibolis* and *Heterozostera* with some *Halophila australis* interspersed. Amphibolis was covered in epiphytes as usual. The more common epiphytes included *Dictyopteris muelleri, Lobospira bicuspidata, Jeannerettia pedicellata, Rhodophyllis membranacea*, *Craspedocarpus* spp, *Mychodea hamata* and several species of *Plocamium*. The uncommon seasonal red algae *Kraftia dichotoma* was also present as an epiphyte. The *Heterozostera* epiphytes included *Lobospira, Pachydictyon polycladum*, *Halopteris* spp and *Mychodea*.

The kelp beds consisted of canopy forming *Phyllospora* and *Ecklonia*, with an understorey of smaller browns and reds such as *Cystophora*, *Sargassum*, *Zonaria*, *Rhodymenia australis*, *Pterocladia lucida* and *Phacelocarpus* spp (including the uncommon *P. sessilis*).

The sessile fauna was dominated by bryozoans, with over 40 species having been identified from the samples collected. The kelp areas also supported a rich ascidian fauna. The hydroid *Stereotheca elongata* was common.

Motile invertebrates were uncommon in the seagrass beds, particularly from areas dominated by *Heterozostera*. These consisted of three epiphytic bivalves, a undescribed crinoid species, a few ophiuroids and several polychaetes (including the common species *Platynereis* and *Trypanosyllis*). Many more animals were amongst the rocky kelp beds, including trochid and turbinid gastropods, chitons and echinoderms. The South Australian species of ophiuroid *Ophiactis tricolor* was collected here, an unusual occurrence in Victoria.

Black Reef

Dive conditions. Poor: visibility was poor and the exposed site was subject to swell.

Site description. There is a calcarenite reef half way between Shellback Island and adjacent shore of Wilsons Promontory in about 10 m of water, This is locally known as Black Reef. The reef consisted of bommies surrounded by sand. The larger rocks were covered in *Phyllospora* and *Ecklonia* with red algae and sponges growing underneath. The reef is very exposed and subject to wave surge. In crevices and under rocks were blacklip abalone, seastars (*Paranepanthia*, *Formia*), ophiuroids (*Ophionereis*, *Ophiothrix spongicola*), and crinoids (*Cenolia* spp).

Biota. The canopy of kelps included *Phyllospora*, *Ecklonia*, *Cystophora moniliformis* and various *Sargassum* species. The diverse algal understorey included *Zonaria*, *Halopteris*, *Cladostephus spongiosus*, *Carpomitra costata*, *Rhodophyllis multipatita*, *Pterocladia lucida*, 6 species of *Plocamium* and many others.

Sessile invertebrates were less common or diverse, although some large hydroid and bryozoan colonies were present (*Stereotheca elongata*, *Amphisbetia minima*, *Aglaophenia divaricata*; *Amathia* spp).

Motile invertebrates were generally uncommon. The larger invertebrates consisted of several seastars (*Paranepanthia grandis, Formia polypora*) and brittle-stars, including the warm temperate species *Ophiothrix spongicola* which is rarely seen in Victoria to the west of Wilsons Promontory. The smaller invertebrates that were collected in the quadrats consisted of small epiphytic molluscs (mostly *Musculus nanus*), a single polychaete, one holothurian and several ophiuroids.

South-east coast

Dive conditions. Good; visibility was fair and the site protected from swell.

Site description. There is a unnamed small cove to the north of the Lighthouse boat ramp. (The locals call it "Fenwick Bight", but this is not the official Fenwick Bight near the southern tip of the Promontory). The bottom is granite covered with an *Ecklonia* kelp bed, overlying foliose red algae.

Biota. Underneath the canopy of *Phyllospora* and *Ecklonia* the biota was algal dominated. Tufting or epiphytic algae included the browns *Dictyota dichotoma*, *Zonaria, Halopteris* and *Pachydictyon*, and the reds *Rhodymenia australis, Ballia callitricha, Plocamium* and *Phacelocarpus* spp, *Dasyclonium incisum* and several corallines (*Corallina officinalis, Haliptilon, Metagoniolithon*). The green algae *Codium australicum* was also present.

There were some sponges or ascidians. The bryozoans were diverse with some large colonies (e.g., *Canda arachnoides, Amathia plumosa, Amathia woodsii*) on the rock or on the *Ecklonia* holdfasts and several smaller colonies on the *Ecklonia* fronds. Despite the presence of *Ecklonia* holdfasts the numbers of motile invertebrates collected was low. Several gastropods, anemones, polychaetes and echinoderms were collected, including several large seastars (*Plectaster decanus, Nectria macrobrachia).*

South Waterloo Bay, Home Cove

Dive conditions. Good: visibility exceeded 10 m and the cove was protected from the swell.

Site description. Home Cove is a small bay at the very south of Waterloo Bay. The seafloor drops rapidly from the shore, so that 20 m from shore the depth is 7-12 m. Huge granite boulders lie in the water at that depth rising towards the surface. The top of the boulders are covered with the kelp *Phyllospora*. The sides are covered with *Ecklonia, Acrocarpia*, and large expanses of *Caulerpa obscura*. Beneath the *Ecklonia* the rock is covered with encrusting and foliose coralline algae. The seastar *Plectaster* was present. In sheltered areas between the boulders the diminutive seagrass *Halophila* can be found in small patches of sediment. In the crevices seastars (*Nectria*), sea-urchins (*Heliocidaris*) and crinoids (*Cenolia*) are common.

Biota. The upper reef (5 m) is dominated by the brown algae *Phyllospora, Cystophora, Sargassum, Zonaria* and the green algae *Caulerpa* (*C. brownii, C. flexilis, C. cactoides, C. obscura*) and *Codium australicum*. Red algae include *Jeannerettia, Polysiphonia, Laurencia* and various foliose corallines. At 10 m *Ecklonia* is the dominant brown, along with *Acrocarpia paniculata*, and *Seirococcus axillaris*. The common reds include *Rhodymenia australis, Rhodophyllis multipatita, Sonderopelta coriacea* and *Plocamium angustum*.

Sessile invertebrates were common at 10 m. Large sponges and solitary ascidians were present. There were also numerous bryozoans many forming large colonies (*Orthoscuticella, Euthyroides episcopalis* and *Triphyllozoon munitum*).

Motile invertebrates included several large seastars (*Tosia australis, Plectaster decanus, Allostichaster polyplax* and an undescribed form that can divide by fission), some small gastropods, and several polychaetes, crustaceans and ophiuroids.

Refuge Cove

Dive conditions. Good; conditions in the cove are calm and visibility generally good

Site description. Refuge Cove is a sheltered bay with a diverse range of underwater habitats. The bay in front of the beach is sandy with some *Heterozostera* present at 2-3 m. Large Stingrays patrol the beach. At 5 m there are beds of *Amphibolis* seagrass. Towards the rocky point on the north side, there are underwater granite boulders covered in *Ecklonia, Caulerpa obscura*, and *Cystophora,* with sandy patches in between. A large 1m *Octopus Maorum* was observed amongst the boulders at night.

Biota. *Amphibolis* and *Heterozostera* dominate the sandy areas and algae here are restricted largely to epiphytes. *Amphibolis* epiphytes include *Dictyopteris muelleri, Pachydictyon, Rhodymenia australis,* and corallines (*Haliptilon*, *Jania*, *Metagoniolithon*). The algae on rocks are more diverse. *Ecklonia*, *Cystophora* and *Sargassum* are the dominant algae. There are also numerous greens including *Caulerpa brownii*, *C. obscura*, *C. geminata*, *Codium pomoides* and *C. fragile*. The reds are typical of those from kelp habitats and include *Areschougia congesta*, *Nizymenia australis*, *Sonderopelta coriacea* and *Plocamium* species.

Sessile invertebrates include some sponges, solitary corals, several species of ascidian and a handful of bryozoans. Large invertebrates includes the bivalve *Modiolus areolatus* and the limpet *Astralium aureum.* Few motile invertebrates were collected.

Rabbit Island

Dive conditions. Dive conditions on the east coast was difficult due to the poor visibility and strong surge experienced. In contrast, the north-east was calm and clear.

Site description. Rabbit Island lies on the north-east side and is one of the last rocky outcrops at the south of the large shallow muddy bays of Corner Inlet and Nooramunga. There is a little cove on the east side surrounding a large cave in the cliffs. The cliffs continue under the water to about 10 m. At the base of the wall lies a pile of granite boulders with tiny patches of sand in between. *Ecklonia* forms a 1.5 m high dense canopy over sponges, coralline algae and a few foliose red algae. The site is very exposed and subject to wave surge. Some red-bait crabs and crinoids (*Cenolia*) were present. The north side of the island is sheltered. The seafloor 50 m from the shore at 3 m is sandy with patches of eelgrass (*Heterozostera*).

Biota. The reef at 10 m on the exposed eastern side of the island was covered in canopy forming *Ecklonia radiata* with some *Sargassum* and unusually some *Heterozostera* plants. The understorey was typical of rocky reefs with numerous sponges, colonial ascidians, bryozoans, octocorals (*Capnella*), hydroids and red algae. Seven species of hydroids were collected including large colonies of *Aglaophenia divaricata, Aglaophenia plumose* and *Stereotheca elongata*. The South African hydroid, *Monotheca spinulosa*, was collected from this site, its first known occurrence in Australia. Motile invertebrates were limited to small molluscs, echinoderms, polychaetes, and small crustaceans.

The Heterozostera bed at 3 m on the north coast supported epiphytic algae and some sessile invertebrates. Epiphytes included *Craspedocarpus venosus, Polysiphonia decipiens, Griffithsia teges* and numerous smaller corallines and filamentous red and green algae.

Sessile invertebrates on the seagrass included three hydroid species, 19 bryozoans, and a few small sponges. Motile invertebrates were not diverse. Two molluscs were present, *Diala suturalis* and *Thalotia conica*, a crab, caprellid isopods and numerous tube building amphipods (*Cerapes*) which fix themselves perpendicular from the seagrass frond.

Point Hicks vicinity

Point Hicks

Dive conditions. Perfect. Visibility was good and the swell relatively calm.

Site description. Offshore of Point Hicks are a series of granite reefs continuing to a large rock, locally called the Whaleback, which lies approximately a kilometre offshore. Half way between the point and the Whaleback, at 10 m, the seafloor consists of large granite boulders, rising to 6 m, surrounded by clusters of smaller rocks and stones. The predominant kelp was *Ecklonia*, with *Phyllospora* also present on top of the larger boulders. The *Ecklonia* had a thick central stipe to 1.5 m with canopy forming foliage restricted to the apex. The understorey was spectacular - a diverse and colourful assemblage of sponges, bryozoans, corals, gorgonians and ascidians. Large invertebrates include the seastar *Nectria*, several ophiuroids, crinoids, gastropods, fan worms and nudibranchs. Large sea-urchin barrens, known locally as "white rocks" are present and are formed by the large purple urchin *Centrostephanus rodgersii*. Reef fish are abundant.

Biota. Under the continuous *Ecklonia* and *Phyllospora* canopies, sessile invertebrates covered the substratum. Algae were restricted to smaller epiphytic and epizoic species including *Halopteris* spp, *Delisea plumosa* and *Plocamium costatum*. Sponges and ascidians (stalked, solitary and colonial) were abundant on the rock surface. The octocoral *Capnella* was present. The *Ecklonia* holdfasts supported a rich assemblage of bryozoans (47 species) and hydroids (8 species).

A species rich and abundant motile fauna was found between the numerous sponges and ascidians and within the large *Ecklonia* holdfasts. Thirty-seven species of polychaetes have been identified from 14 families. The most numerous were *Nereis maxillodentata*, a polynoid worm (scale worm), *Branchiomma* (a sabellid worm) and several syllid worms, most notably a purple *Trypanosyllis* species. Terebellids were also abundant (although not identified for this survey). Ophiuroids were very abundant, particularly the suspension feeding *Ophiactis resiliens* and the sponge associate *Ophiothrix caespitosa*. Other echinoderms included several crinoids (*Cenolia* spp, *Antedon* spp), holothurians (*Pentacta ignava*, *Cucuvitrum rowei*) and a common predatory asteroid *Coscinasterias muricata*. Molluscs were also species rich. Blacklip abalone were present. Other molluscs included 6 species of chiton, 5 trochids and several gastropods. Several mussels were present under the *Phyllospora* on top of the boulders. The NSW species *Chiton* (*Rhyssoplax*) *jugosus* was found here. Hermit crabs (*Paguristes*) made use of the numerous large dead gastropod shells. Other abundant invertebrates included sipunculids, isopods, amphipods and anemones.
Comments. This site is spectacular for the range and colour of the sessile invertebrates and for the total species-richness of its fauna. More species were collected here from several of the 1.0 m^2 quadrats than anywhere else on the coast.

Rame Head vicinity

Skerries

Dive conditions. The sherries were briefly visited on the return trip from Point Hicks to Mallacoota. Dive conditions were good. However the limited air supply prevented the collection of biological specimens.

Site description. The Skerries are a small group of exposed rocks that support a large Australian fur seal colony. To the West of the rocks the seafloor at 5 m is covered in boulders, supporting dense stands of *Phyllospora* and *Ecklonia* kelps, interspersed with patches of coarse sand. The large fan worm *Sabellastarte* was common.

Cape Howe vicinity

Gabo Island Harbour and Spit

Dive conditions. Dive conditions were good, visibility was greater than 5 m.

Site description. Gabo Island Harbour is a small sheltered cove on the north-west corner of the Island. There are a series of pink granite reefs around the jetty and down the eastern side of the cove along the spit. A small sandy beach is present in the south-eastern corner of the cove. The reefs consist of a series of boulders surrounded by smaller rocks and stones. Towards the west the bull kelp *Durvillaea* dominates the shoreline. Along the spit, the larger boulders are covered in canopy-forming large brown algae (*Phyllospora* and *Cystophora*). The understorey at 5 m depth is mixed red and brown algae and sponges. Larger invertebrates include brittle-stars (*Ophionereis*, *Ophiactis*) and sea-urchins (*Amblypneustes*) Urchin barrens, formed by the large purple sea urchin (*Centrostephanus*), are present in slightly deeper water.

A night dive revealed an abundant fish life including garfish, squid, shrimps and sharks (Wobbegong) and rays (sparsely-spotted stingarees). Dolphins were observed in the cove.

Biota. Apart from *Phyllospora* and *Cystophora* the other brown algae present at the site included *Acrocarpia paniculata*, *Dictyota dichotoma*, *Zonaria* spp and *Halopteris* spp. The red algae were typical of *Phyllospora* dominated habitats, and included *Gelidium*, *Ballia*, *Delisea* and two *Plocamium* species.

Of the sessile invertebrates, six hydroids and 13 bryozoans have been identified. Most of these were tiny, except some larger colonies of the hydroid *Stereotheca elongata*. Of the motile invertebrates, polychaetes were particularly species rich, with 16 species being identified. Many of these belonged to the families Sabellidae and Syllidae. The molluscs included *Astralium squamiferum, Turbo undulatus, Musculus nanus, Phasianotrochus eximius*, *Modiolus areolatus*, *Scutellastra chapmani*, *Ischnochiton elongatus crispus* and *Notoplax speciosa*.

Gabo Island, west side

Dive conditions. Good, visibility was greater than 10 m and swell insignificant.

Site description. The west coast of Gabo Island drops fairly rapidly to 10 m deep. Near-shore (3 m) the boulders were covered in *Phyllospora* kelp. Extensive urchin barrens were present at lower depths (5-15 m) caused by the large purple urchin (*Centrostephanus*) which occurs in large numbers. The rocks were covered in a film of encrusting coralline algae. Fish were numerous and included moray eels.

Biota. Except for a limpet *Patelloida alticostata*, macrofauna and flora was scarce and largely limited to the crevices between the rocks. In the crevices bryozoans (*Adeonellopsis*, *Celleporaria*), sponges, hydroids (*Stereotheca elongata*), hermit crabs, large sabellid worms (*Sabellastarte*) and brittle-stars (*Ophiothrix spongicola*, *Ophiactis resiliens*) were present.

Gabo Island Lighthouse

Site description. The shore near the lighthouse consists of extensive pink granite rock platforms. The coast here is very exposed to the prevailing easterly swell. Large, deep channels occur perpendicular to the shore. *Durvillaea* kelp dominates the low water line with *Phyllospora* common underneath (5 m). Red algae cover the bottom of the channels (10 m). Diving at this site was with snorkel only and no biological samples were taken.

Iron Prince

Dive conditions. Difficult. There was a strong swell from the south-east and visibility was poor.

Site description. The Iron Prince is an offshore reef near the New South Wales-Victorian border. The subtidal reef on the south (Victorian) side consists of a series of rock ridges and crevices running parallel to the shore at 5 m depth. The reef is exposed to the prevailing easterly swell. The ridges are covered in a dense stand of 2 m high *Phyllospora* kelp. The understorey consists of *Pyura* ascidians, foliose red algae, coralline algae, brown algae (*Zonaria*) and sponges. The ascidians were quite dense in some areas. Larger invertebrates consisted of some seastars (*Patiriella calcar*), large gastropods and red sea tulips. Adjacent to these *Phyllospora* beds were low algal turf.

Biota. Algae were very sparse under the dense *Phyllospora* canopy. Other species included *Ulva*, *Zonaria*, *Cladostephus spongiosus*, *Halopteris* spp, *Galaxaura maginata*, *Plocamium angustum*, *P. leptophyllum* and various corallines. Sessile invertebrates were common, particularly sponges, ascidians and bryozoans. The large ascidians supported a diverse epifauna.

The motile invertebrates included several polychaetes (mostly syllids), gastropods (including numbers of the large edible *Cabestana spengleri*), several ophiuroids and crabs.