Preliminary ecological investigations of the Poriferan community in Marmion Marine Park, Western Australia.

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Firstly I would like to thank my wife, Elaine and my children, Jessie and Leeuwin, for their never ending patience and tolerance of the time I spend absorbed in my studies. I am very grateful to Dr Hugh Kirkman and CSIRO for giving me logistical support. I must also thank Dr Graham Edgar and Dr Gary Kendrick for their advice and encouragement.

Thanks to my supervisor Associate Professor Michael Borowitzka for his advice, guidance, and for finding funds when it was sorely needed. Special thanks to Mike Mouritz for again proofreading another of my reports and for his invaluable words of wisdom.

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Preliminary ecological investigations of the Poriferan community in Marmion Marine Park, Western Australia.

1.0 General Introduction

1.1 Purpose

This report has been prepared for Industry Practicum N203 which is part of an undergraduate degree in Biological Sciences currently being undertaken at Murdoch University. It presents the findings of ecological investigations into the Poriferan community within the Marmion Marine Park. This report has three sections which focus on different aspects of sponge ecology. These investigations have been conducted within the guidelines of CSIRO's Filter Feeder Sub-project of the Marine and Estuarine Eutrophication Project (MEEP).

The objectives of the Filter Feeder Sub-project of MEEP are:

(i) To determine the relationships between filter feeders and increased phytoplankton and organic particulate in the water column and,

(ii) To determine if increased growth rates in filter feeders are sensitive indicators of the effects of eutrophication.

1.2 Study site description

Marmion Marine Park, Perth Western Australia, encompasses an area extending from Trigg Island in the South to Burns Beach in the North (Figure 1.1). It is a body of water semi enclosed by fringing offshore reefs in the northern metropolitan waters. This fringing aeolinite limestone reef is one of three parallel reef lines which is typical of this part of the Western Australian coastline (Seddon, 1972). The reef lines are representative of relict dunes on this submerging coastline. Marmion Marine Park is approximately 17 km long, 5.5 km in width, with a mean depth of 5.5 m (Hatcher, 1987).

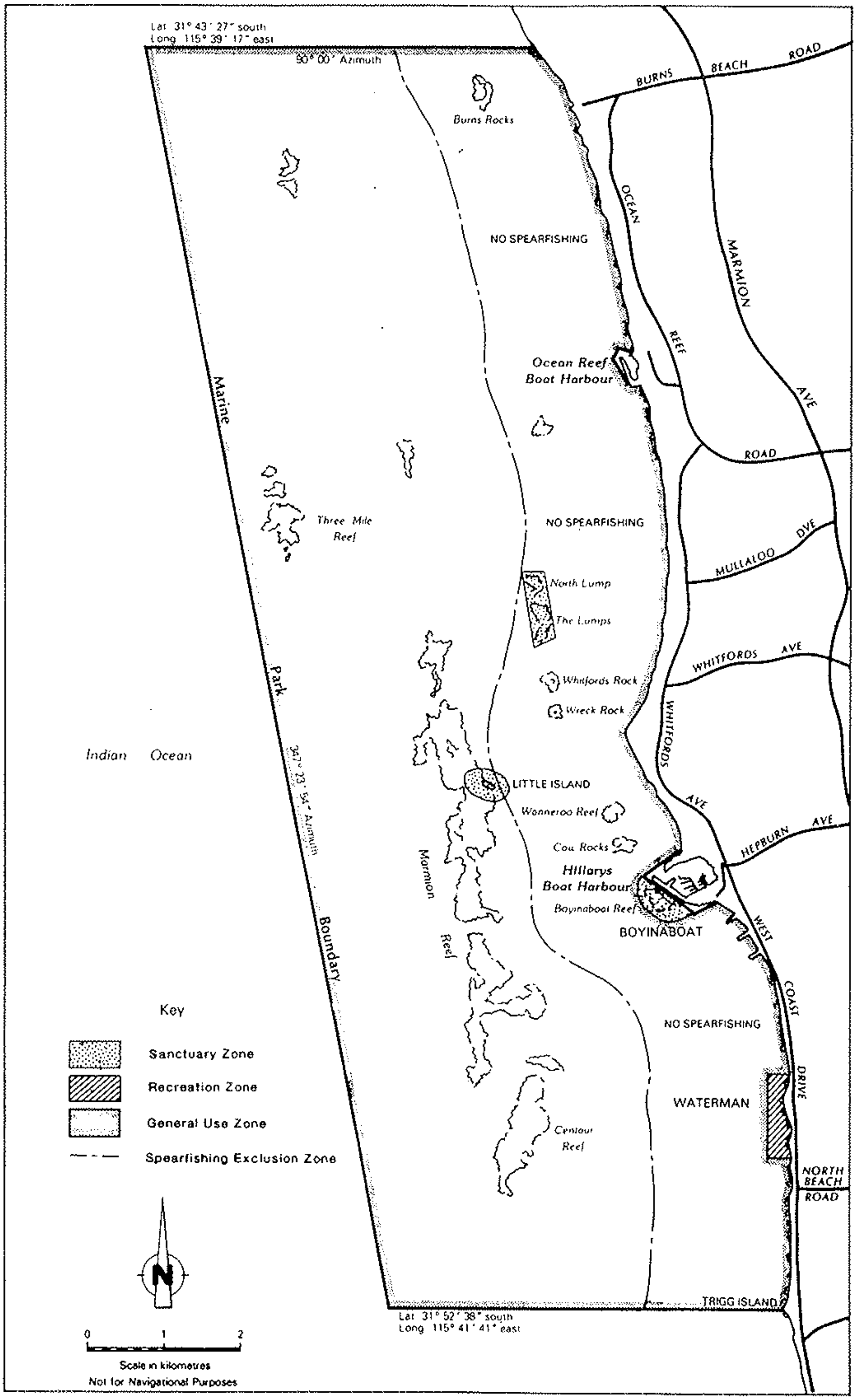

Figure 1.1: General study site: Marmion Marine Park. (*after* Ottaway & Simpson, 1986).

1.3 Aim

The aim of this report is to present the results of investigations into the ecology of the Poriferan community in the Marmion Marine Park. These investigations covered the following areas:

(a) Review of historical data,

(b) Investigations into a sampling strategy of sponges in *Amphibolis griffithii* seagrass beds,

(c) Preliminary identification of sponges sampled in *A. griffithii* seagrass beds and,

(d) A report on the reef and macroalgae habitat components of the pilot study of the Filter Feeder Sub-project.

2.0 Sampling Strategies in *Amphibolis griffithii*

This section presents the findings of an independent study aimed developing a sampling strategy to quantify the Poriferan community present in *A. griffithii* patches in Marmion Lagoon.

2.1 Site description

The site was chosen through anecdotal information [1] concerning the location of a large patch of *A. griffithii*. The study was performed in a area just north of the southern marker buoy of a north-south transect laid by CSIRO-Division of Fisheries, at Wreck Rock, Marmion Lagoon (31°48.850' S 115°42.450' E) (Figure 2.1). The site was just off Lal Bank in an average depth of 5.4 metres.

[1] Dr Hugh Kirkman, CSIRO Division of Fisheries. *Personal Communication*, July 1993.

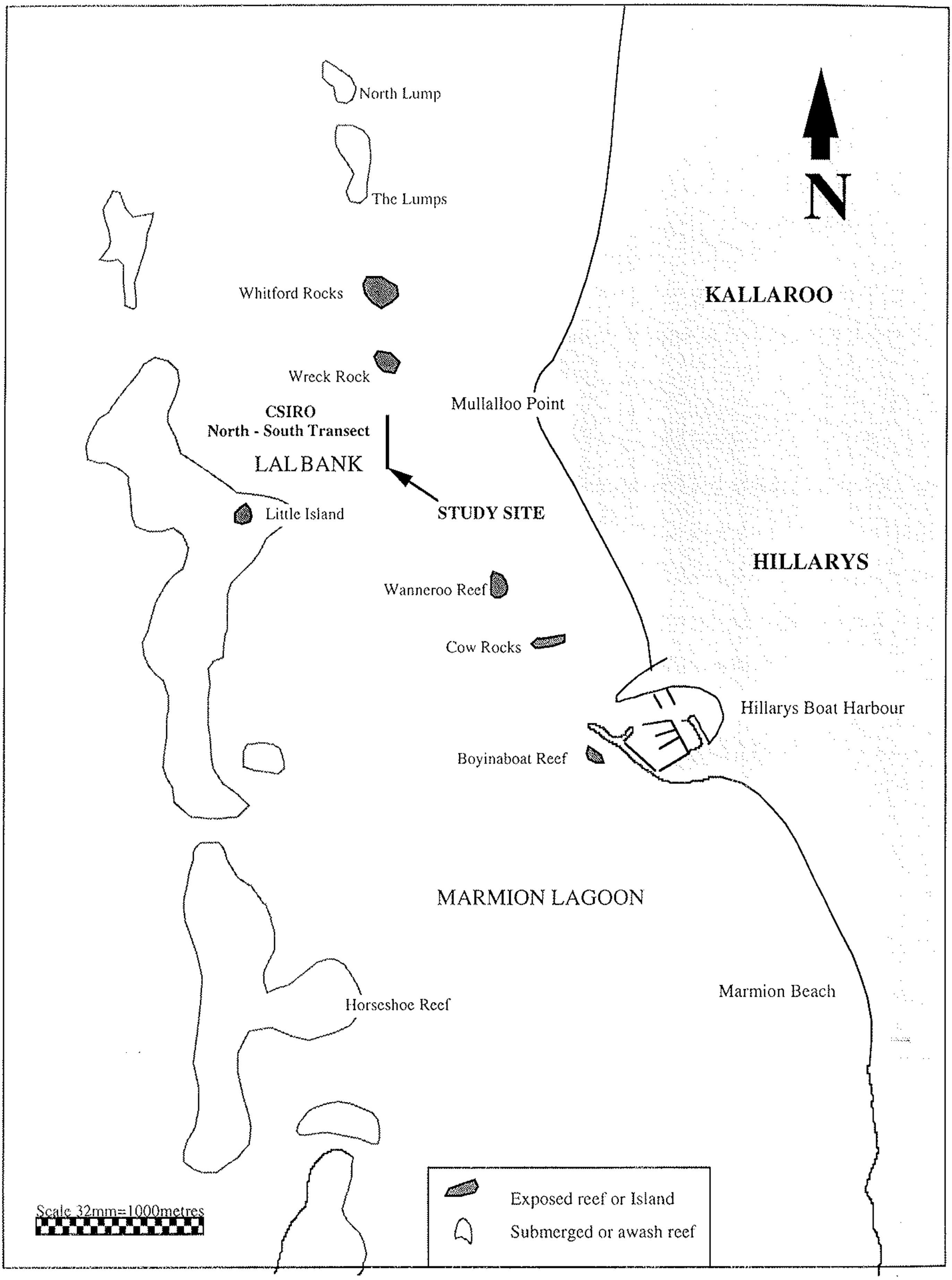

Figure 2.1: North - South transect at Lal Bank, Marmion Marine Park.

2.2 Methods and Materials

Three sampling methods were employed on different occasions:

(a) 0.25 m^2 quadrat strip harvesting,

(b) 1 m^2 quadrat strip harvesting, and

(c) A non-destructive sampling of 1 m^2 quadrats.

Initial observations showed that all sponges that occur in *A.griffithii* have small, stem encrusting morphology therefore in all three methods, sponge abundance was measured discretely, (ie. one sponge = one score), regardless of biomass.

2.2.1 *Strip harvested 0.25 m^2 quadrats*

Plot sampling was undertaken using Ten 0.25 m^2 quadrats (500 mm x 500 mm),which were laid into a structured pattern at a random location within the *A.griffithii* patch (Figure 2.2). The intention of this sampling method was to determine what size quadrat was required for good representation and if there was any orientational influence. These quadrats were strip harvested, separately bagged and the sponges were quantified later in the laboratory.

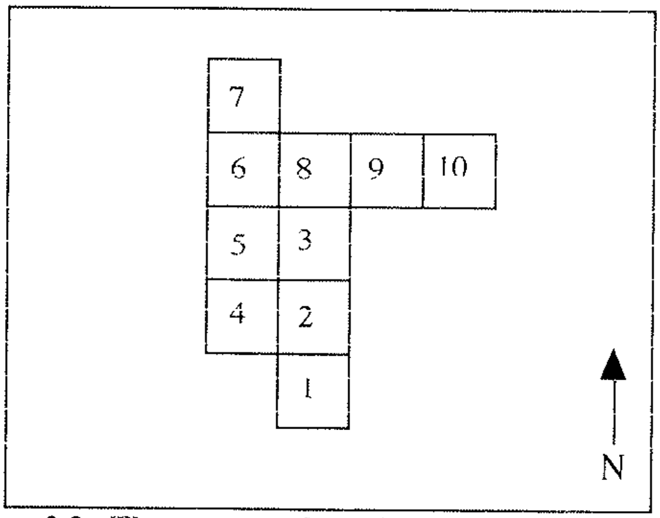

Figure 2.2: The structured quadrat pattern utilized in the 0.25 m^2 strip harvest quadrat sampling.

2.2.2 *Strip harvested 1 m^2 quadrats*

Ten 1 m^2 quadrats (1 m x 1 m) were selected at random sites. These sites were determined by initially selecting and marking a start-point in approximately the centre of the *A. griffithii* patch. Direction (compass bearing) and distance (fin kicks) were determined from random number tables. Each bearing and distance was measured from the start point (Figure 2.3). These quadrats were strip harvested, separately bagged and the sponges were later quantified in the laboratory.

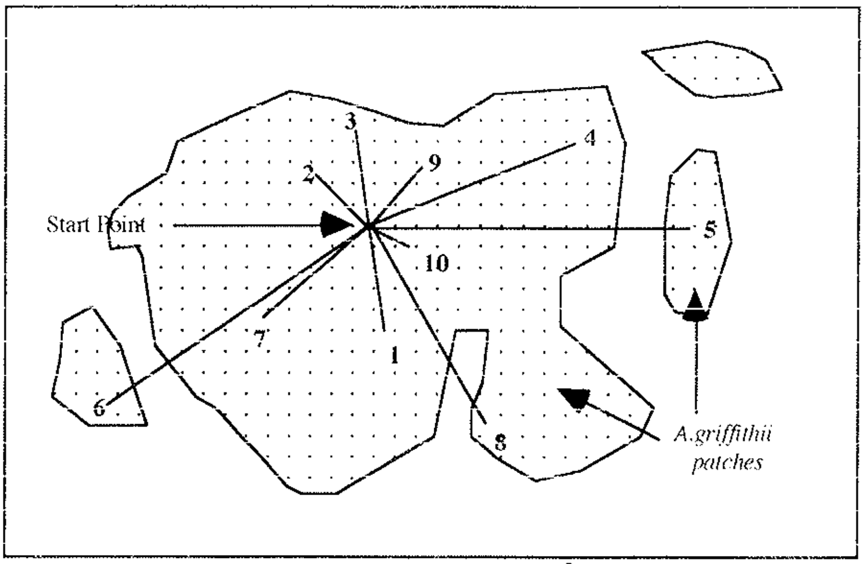

Figure 2.3: Random site selection of 1 m^2 strip harvested quadrat sampling.

2.2.3 *Non-destructive 1 m^2 quadrats*

The sample sites for this sampling method were selected by broadcasting the 1 m^2 quadrat frame into the *A.griffithii* patch. These were then manually searched in situ and all sponges removed within a 20 minute period. The reasoning behind the time standardization is that the longer the search period, greater the chance of finding more of the smaller sponges.

2.3 Results

2.3.1 *Strip harvested 0.25 m^2 quadrat sampling*

A total of five sponges were sampled out of all ten quadrats strip harvested (Table 2.1). Seven quadrats contained no sponges, two quadrats contained two sponges and one quadrat contained one sponge. This result represents a mean sponge population of 2 m^2 ±SE 1.07 There were few sponges obtained by this method and this tends to have made the data insufficient to see any patterns. What this trial did indicate was that 0.25 m^2 quadrats were too small and it was necessary to utilize a larger size, thus the 1m^2 quadrat trials.

Table 2.1: Results of sponge census using the strip harvested 0.25 m² quadrat sampling method sampled on 3/8/93.

Quadrat Number	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
N° of Sponges	-	-	-	-	2	2	-	-	1	-

2.3.2 *Strip harvested 1 m² quadrat sampling*

In this method, sponges were recorded in each quadrat(Table 2.2). The mean sponge population was 6.60 m² ±SE 0.5 and the geometric mean was 6.42 m². The cumulative mean abundance versus quadrat number curve (Figure 2.4), suggests that the asymptote of the curve indicates the number of 1m² quadrats required to give reasonable representation of the sponge population in *A.griffithii* patches is five (Loya, 1978).

Table 2.2: Results of sponge census using the strip harvested 1 m² quadrat sampling method sampled on 10/9/93.

Quadrat Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
N° of Sponges	7	7	4	8	8	5	6	7	9	5
								Mean	**6.60**	±SE 0.5
								Geo Mean	**6.42**	

2.3.3 *Non-destructive 1 m² quadrat sampling*

Only three quadrats were surveyed using this method. All three quadrats had sponges present (Table 2.3). The mean sponge population was 9.33 m² ±SE 3.18 and the geometric mean was 7.76 m². During the sampling, the diving conditions were very surgy and visibility was low, therefore making in situ surveying of these small sponges very difficult.

Table 2.3: Results of the non-destructive 1 m² quadrat sampling method sampled on 14/8/93.

Quadrat N°	*N° of Sponges*
Z1	12
Z2	13
Z3	3
Mean	**9.33** ±SE 3.18
Geo mean	**7.76**

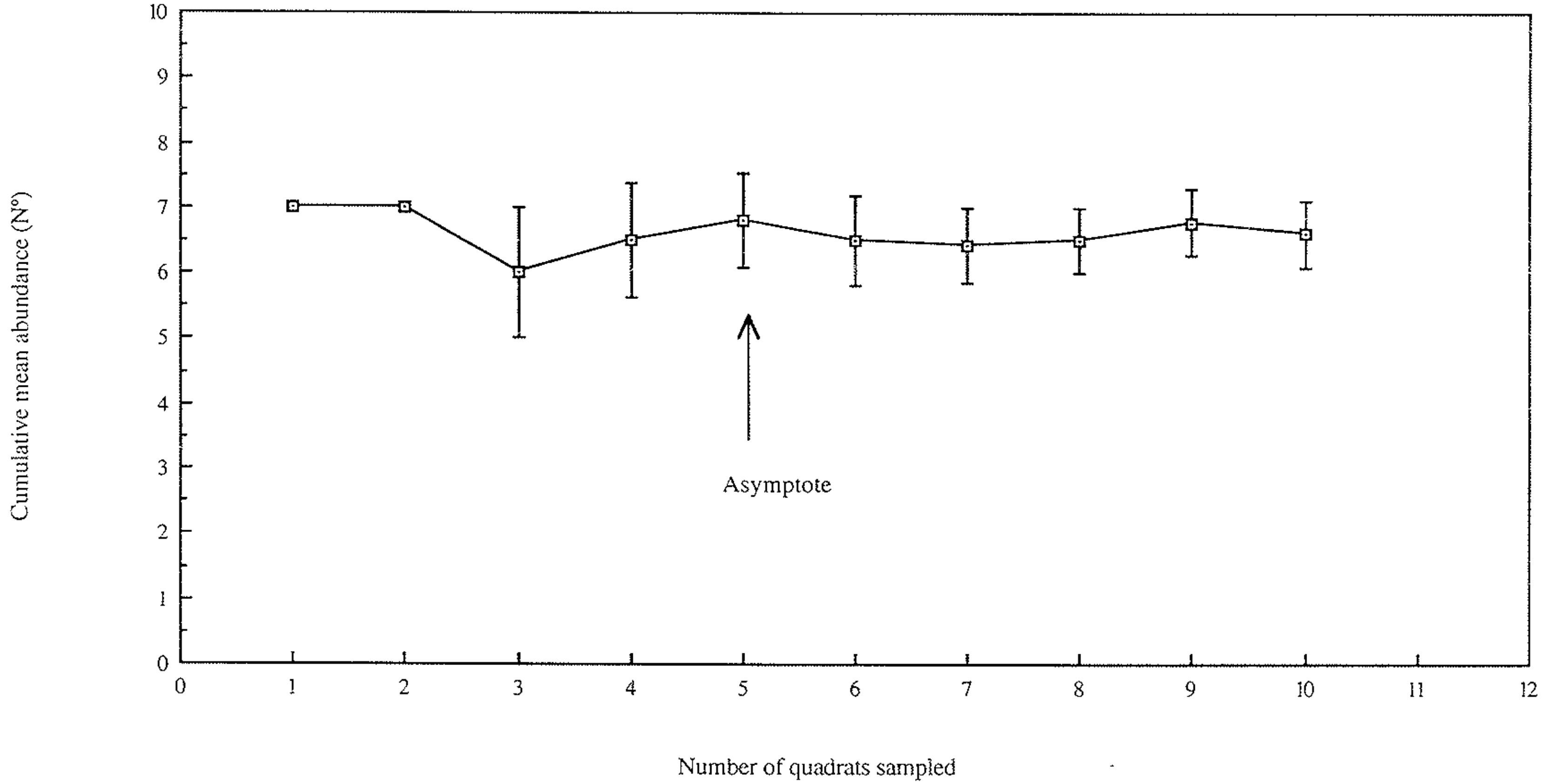

Figure 2.4: Cummulative mean abundance / quadrat number curve for sponges in Marmion Marine Park sampled 10/9/93. Bars represent ± SE

2.4 Discussion

Out of all the trials conducted, the most successful method was the strip harvested 1 m^2 quadrat sampling. It indicated that to obtain a representative sample of sponge abundance in *A.griffithii* at a particular sampling location, it would be necessary to take five $1m^2$ quadrats. This represents half of the ten quadrats taken at each habitat in the Dongara study (Pettit, 1984). However, it was difficult to make comparisons of sampling techniques of sponge abundance with other studies as only a couple deal with *A.griffithii* patches (LeProvost, *et al.*, 1981; Pettit, 1984).

An additional factor to consider in further studies to consider, is the season in which sampling occurs, not because there may a seasonal difference in distribution, but because of the difficulty of strip harvesting in bad surge and visibility conditions.

3.0 Preliminary Identification of Sponges

3.1 Historical background

There has been little taxonomic investigation into the assemblage of Porifera within the Marmion Marine Park or any other Western Australian marine environment. During the biodiversity surveys performed by the Environmental Protection Authority of Western Australia prior the declaration of the Marmion Marine Park(Simpson & Ottaway, 1987; Wells, *et al.*, 1987),, there were ≈50-60 sponge specimens collected. These specimens were recorded but not identified or quantified [2].

Various other biological workshops (Wells, *et al.*, 1990/91; Wells, *et al.*, 1993) and faunal surveys (Berry, 1986; Berry, *et al.*, 1990) performed in Western Australia actually omitted the Poriferan community. A separate study conducted by Alistair Robertson in Dongara (Pettit, 1984), was focused on the role of sponges as a food source for potential prey of the Western Rock Lobster (*Panulirus cygnus*), sampled 23 sponges. In this study, sponges were separated into different morphological groups rather than dealing with the taxonomy.

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[2] Jenny Carey, Marine Impacts and Assessment, Environmental Protection Authority. *Personal Communication*, October 1993.

The biological survey for the Cape Peron Ocean Outlet Marine Environmental Study resulted in 67 genera collected (LeProvost, *et al.*, 1981). This appears to be the only survey in Western Australian waters which actually identified most of the sponges collected and also gave arbitrary cover values for abundance. Thus indicating that sponge taxonomy is very poorly developed in Western Australia.

Observations indicated that sponges in the *A.griffithii* patches are small colonies, mainly attached to the stems and sometimes attached to exposed rhizomes. Their gross morphology does not differ markedly overall, therefore this investigation into sponge identification was undertaken to evaluate the diversity of species involved in this study.

3.2 Methods and Materials

The methods used were based similarly on those described in Bergquist & Skinner (1982), Bergquist (1978) and Mather & Bennett (eds) (1984). All the specimens for this taxonomic investigation were preserved in 70% ethanol. Most of the specimens were frozen prior to preservation in an attempt to retain any pigmentations.

3.2.1 *Spicule digestion*

To obtain representation of the spicule content, small pieces of sponge from different parts of the sponge were placed into a centrifuge tube. Approximately 5 ml of sodium hypochlorite (bleach), was added to dissolve away the organic matter. The samples were allowed to stand over night and then the bleach was washed out by the following procedure:

(a) Tubes were centrifuged at 2500 rpm for 3 min.

(b) Supernatant then removed and ≈5 ml of deionized (DI) water forced into the pellet with a Pasteur pipette then gently vortexed to facilitate rinsing.

(c) Procedures (a) & (b) were repeated.

(d) All supernatant was removed leaving cleaned spicules and other siliceous matter.

The spicules were semi-permanently mounted on slides with Karo syrup. Karo is a non-toxic water-based mounting medium, thus negating the need to pre-dry spicules prior mounting.

3.2.2 *Fibre digestion*

To inspect those sponges with a fibre skeleton, the sample was placed into 1 N (0.04 $g.ml^{-1}$) sodium hydroxide (NaOH) for at least 4 hours. Then using a pair of forceps, the fibre was carefully washed in DI water. Permanent slide mounts were prepared in the same fashion as for the spicule mounts.

3.2.3 *Identification*

The sponges which were identified, with the use of taxonomic keys (Bergquist, 1978; Bergquist & Skinner, 1982; Mather & Bennett, 1984). These keys were created for eastern Australian marine sponges and were restrictive in their use.

3.3 Results

3.3.1 *Overview*

All the sponges sampled in *A.griffithii*, were keyed out to various levels of taxonomic status, revealing nine sponge species. All sponges are representatives of the Class Demospongiae (Table 3.1). Descriptions and drawings of all sponges sampled are in the following section.

Table 3.1: Systematic list of Porifera sampled in *A.griffithii* seagrass patches in Marmion Lagoon

Class Demospongiae
- **Order *Haplosclerida sp.* (1)**

- Order Haplosclerida
  - Family Callospongidae
    - **Genus *Callospongia sp.* (2)**
  - **Family *Dactylia sp.* (3)**
  - **Family *Halichonidae sp.* (4)**

- Order Homosclerophorida
  - **Family *Oscarella sp.* (5)**

- **Order *Poecilosclerida sp.* (6)**

- Order Poecilosclerida
  - **Family *Myxillidae sp.* (7)**
  - Family Myxillidae
    - **Genus *Lissodendonyx sp.* (8)**
  - Family Psammoscidae
    - **Genus *Psammopemma sp.* (9)**

3.3.2 *Descriptions and drawings*

(1) Class Demospongiae
Order *Haplosclerida sp.* (Figure 3.1)

-yellow / khaki colour
-soft spongy
-reticulate fibre
-no spicules in fibre skeleton
-many spicules and sand entrapped within sponge
-stem wrapping 1-2 mm thick

(2) Class Demospongiae
Order Haplosclerida
Family Callospongidae
Genus *Callospongia sp.* (Figure 3.2)

-beige / yellow-khaki
-spongy
-oscules 0.5-1.0 mm
-spicules enclosed in fibre skeleton
-spicules mainly diactine oxea
- microscleres absent
-stem wrapping 1-2 mm thick

(3) Class Demospongiae
Order Haplosclerida
Family *Dactylia sp.* (Figure 3.3)

-khaki / yellow
-no obvious larger oscules
-firm but compressible
-no spicules enclosed in fibre skeleton
-few spicules entrapped
-reticulate fibre
-many spicules and sand entrapped within sponge
-stem wrapping 1-2 mm thick

(4) Class Demospongiae
Order Haplosclerida
Family *Halichonidae sp.* (Figure 3.4)

-bluey / grey to green hues
-some oscules obvious ≈0.5-1.0 mm
-many diactine macroscleres
-predominant spicule skeleton with fibre cementation at ends
-few entrapped spicules and sand
-firm but compressible
-roughly reticulate skeletal pattern
-stem wrapping 3-4 mm thick

(5) Class Demospongiae
Order Homosclerophorida
Family *Oscarella sp.* (Figure 3.5)

-whitish / cream
-very spongy
-some small openings present
-many spicules entrapped with in sponge
-no fibre skeleton with in body

-stem wrapping 5-6 mm thick

(6) Class Demospongiae
Order *Poecilosclerida sp.* (Figure 3.6)

-off yellow / khaki
-stem wrapping 1-2 mm thick
-spicules mainly oxea (both diactine and monactine)
-many different spicules entrapped in body
-spicules enclosed in fibre skeleton
-reticulate fibre
-small oscules visible

(7) Class Demospongiae
Order Poecilosclerida
Family *Myxillidae sp.* (Figure 3.7)

-buff / yellow khaki
-stem wrapping 1-2 mm thick
-spicules enclosed in fibre skeleton
-spicules monoactinal, diactinal and tylostyles
-skeleton reticulate and organized
-some entrapped spicules and sand

(8) Class Demospongiae
Order Poecilosclerida
Family Myxillidae
Genus *Lissodendonyx sp.* (Figure 3.8)

-whitish / yellow with sand obviously incorporated
- firmish
-attached to rhizome and wraps stems
-many large (1-1.5 mm), oscules
-fibre skeleton absent
-spicule are tylostyles and diactine oxea
-microscleres are chelate and sigmas

(9) Class Demospongiae
Order Poecilosclerida
Family Psammoscidae
Genus *Psammopemma sp.* (Figure 3.9)

-whitish / sandy texture
-medium to firmish
-ridged and gullied
-wraps stems 1-3 mm thick
-sand obviously incorporated into fibre (as well as other calcareous and siliceous materials)
-reticulate fibre
-no spicules
-no obvious oscules

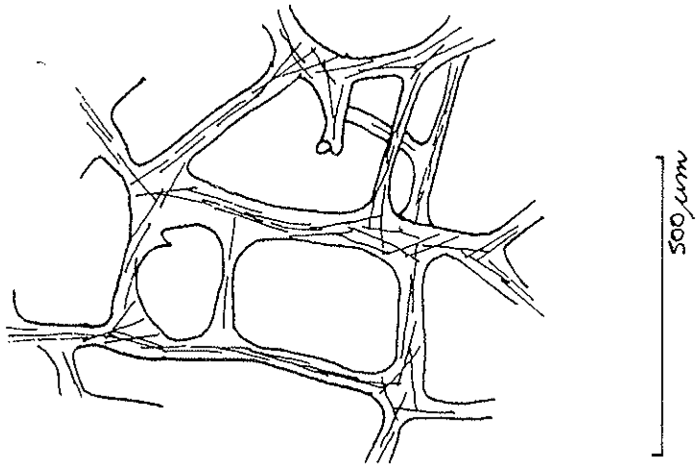
Figure 3.1: (1) Class Demospongiae

Order *Haplosclerida sp.*

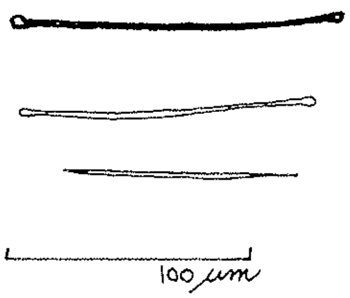
Family............................

Genus............................

Fibre



Spicules



Entrapped Spicule types

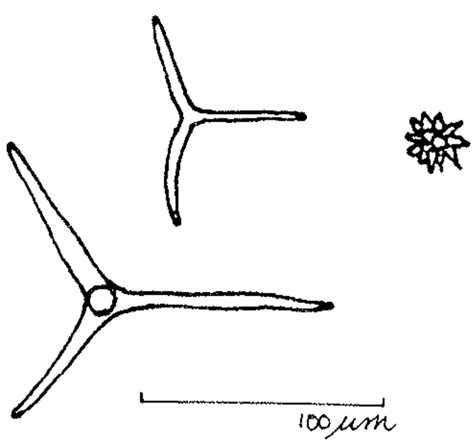


Figure 3.2: (2) Class Demospongiae
Order Haplosclerida
Family Callospongidae
Genus *Callospongia sp.*

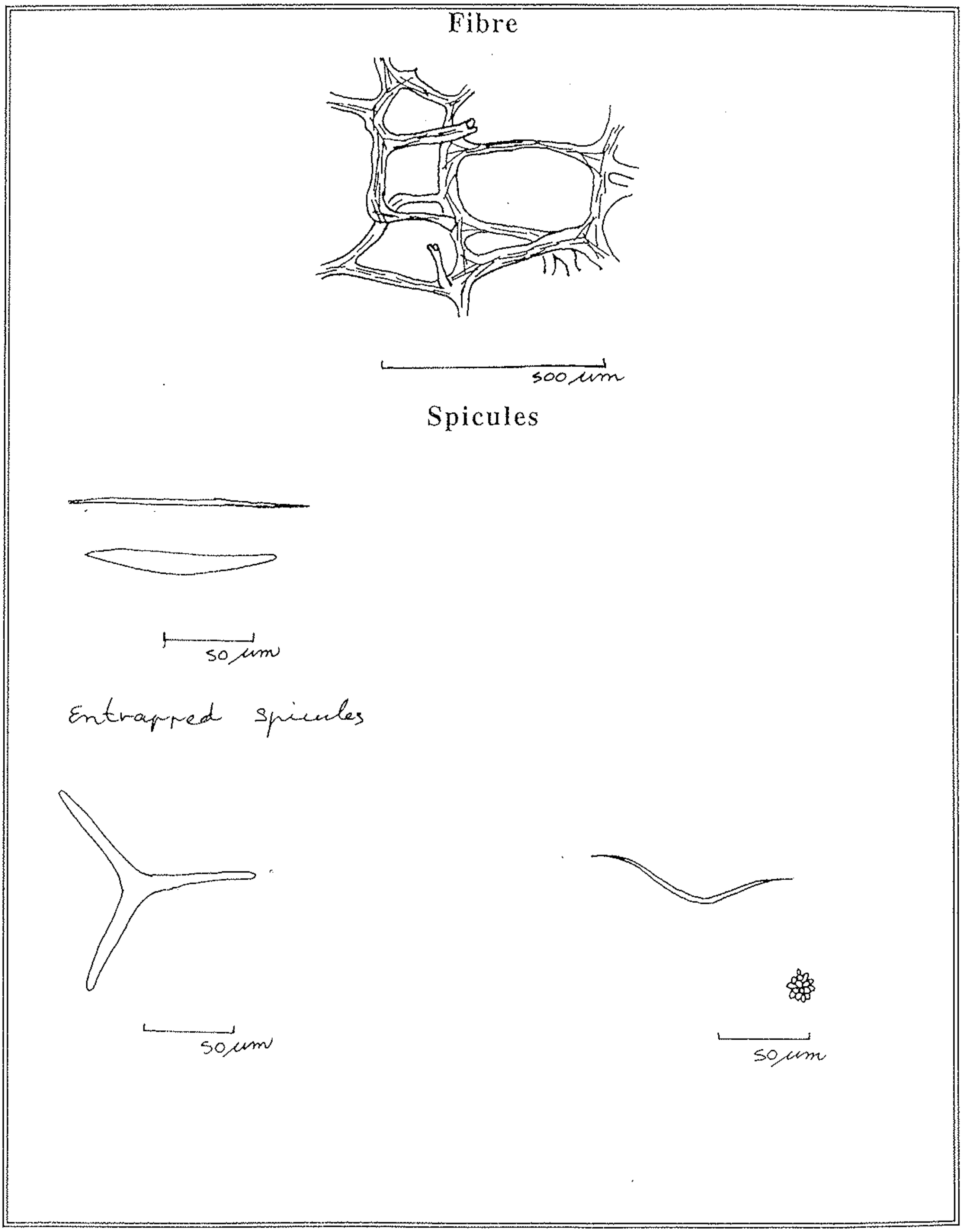
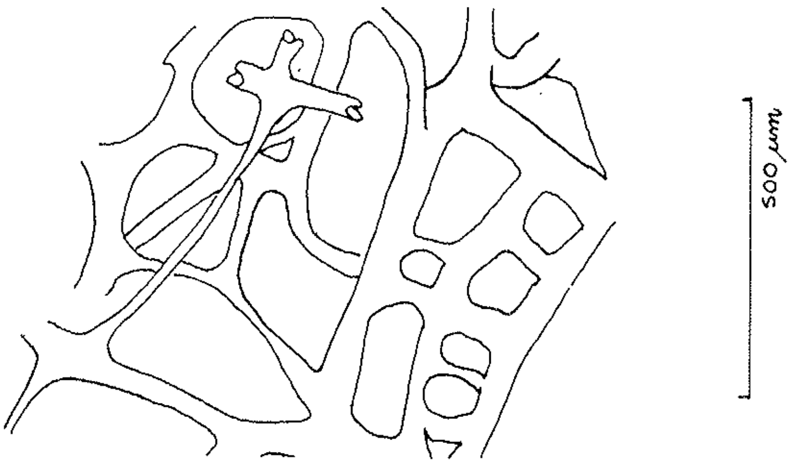


Figure 3.3: (3) Class Demospongiae
Order Haplosclerida
Family *Dactylia sp.*
Genus.............................

Fibre



Spicules

No spicules incorporated in fibre but many different types entrapped.

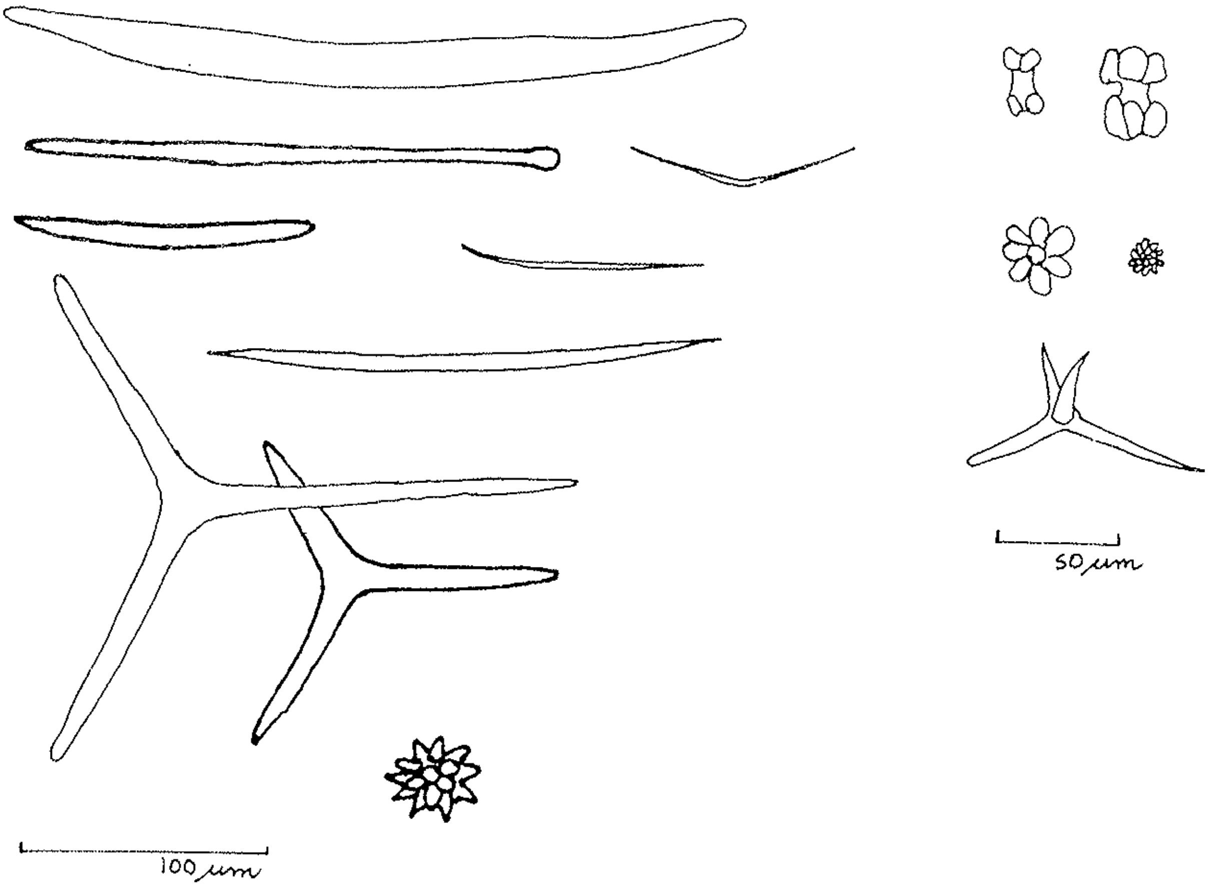


Figure 3.4: (4) Class Demospongiae
Order Haplosclerida
Family *Halichonidae sp.*
Genus..............................

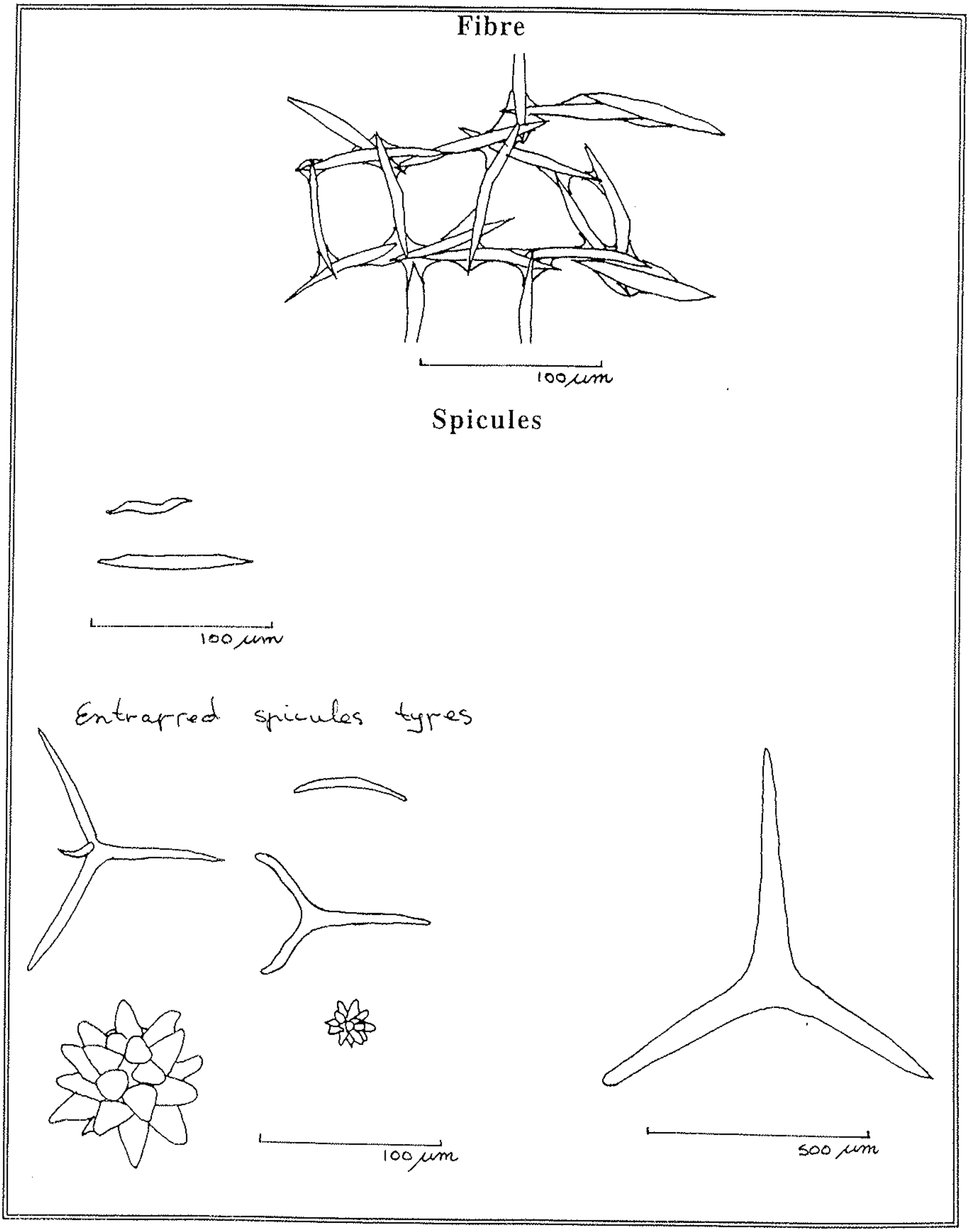


Figure 3.5: (5) Class Demospongiae

Order Homosclerophorida

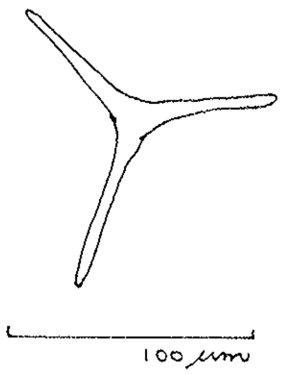
Family *Oscarella sp.*

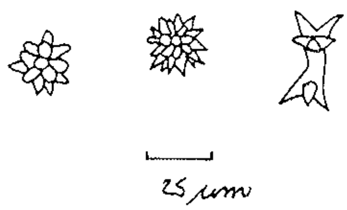
Genus.............................

Fibre

Spicules

Entrapped spicules





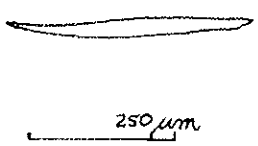


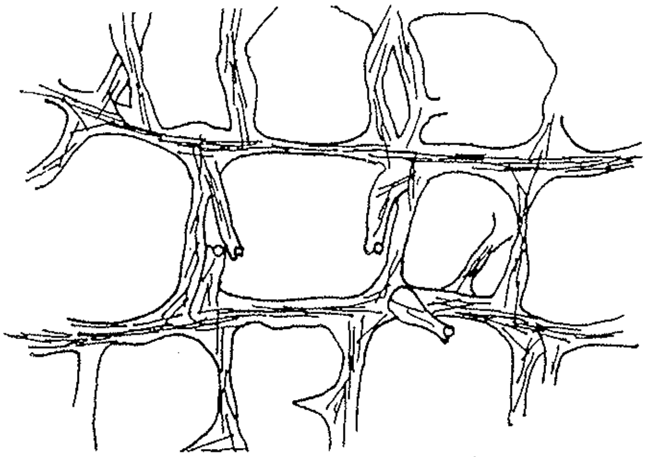
Figure 3.6: (6) Class Demospongiae

Order *Poecilosclerida sp.*

Family.............................

Genus.............................

Fibre



Spicules

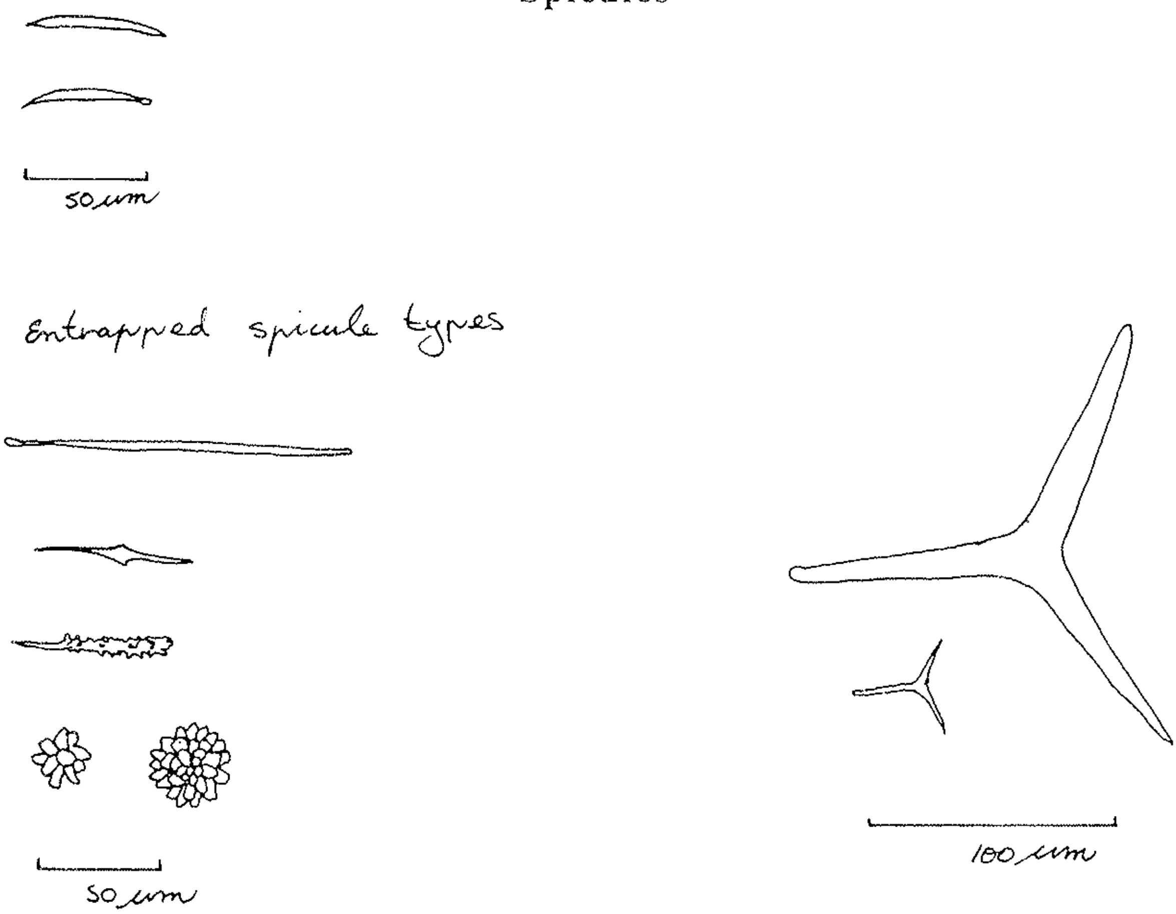


Figure 3.7: (7) Class Demospongiae

Order Poecilosclerida

Family *Myxillidae sp.*

Genus............................

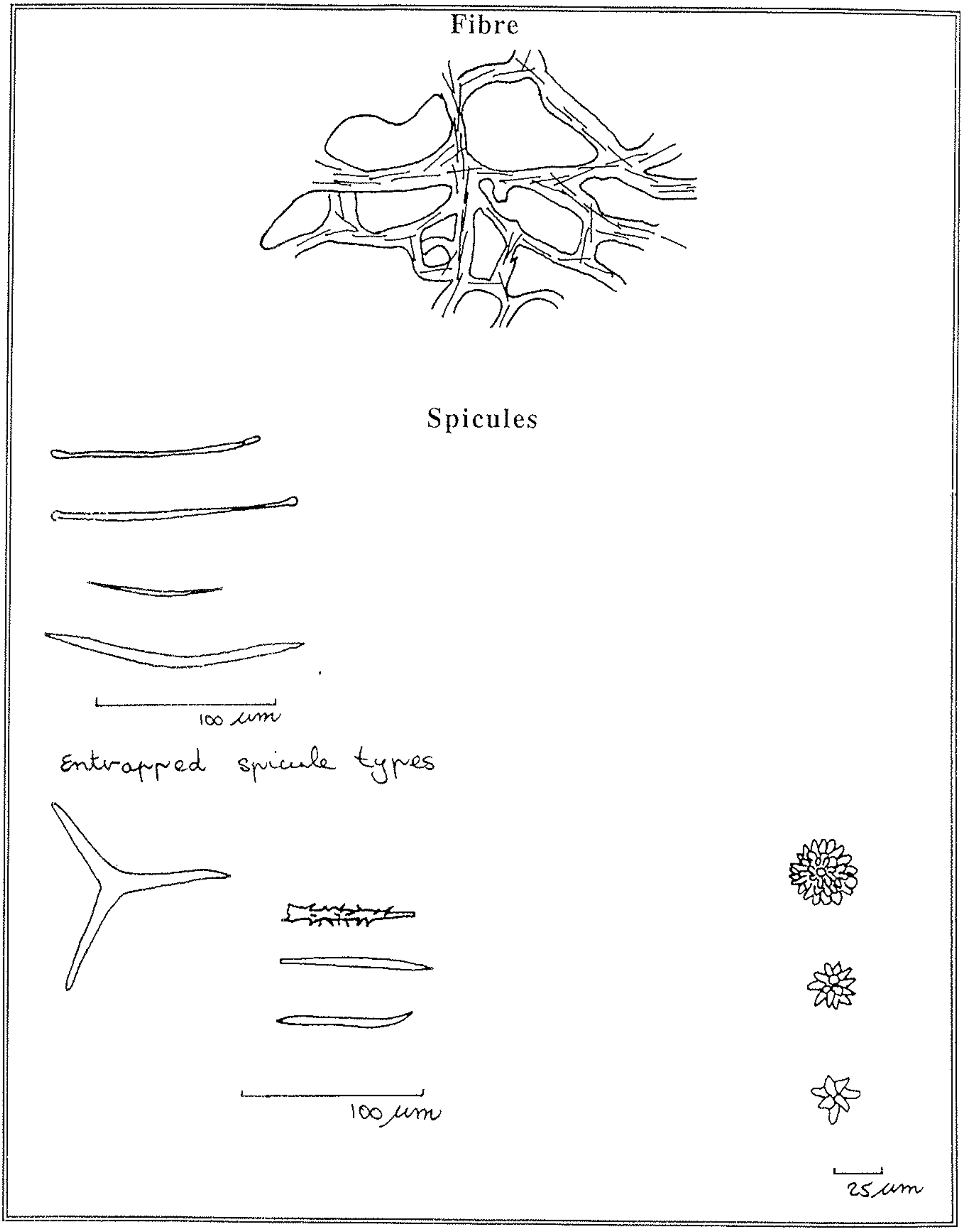


Figure 3.8: (8) Class Demospongiae
Order Poecilosclerida
Family Myxillidae
Genus *Lissodendonyx sp.*

Fibre

Spicules

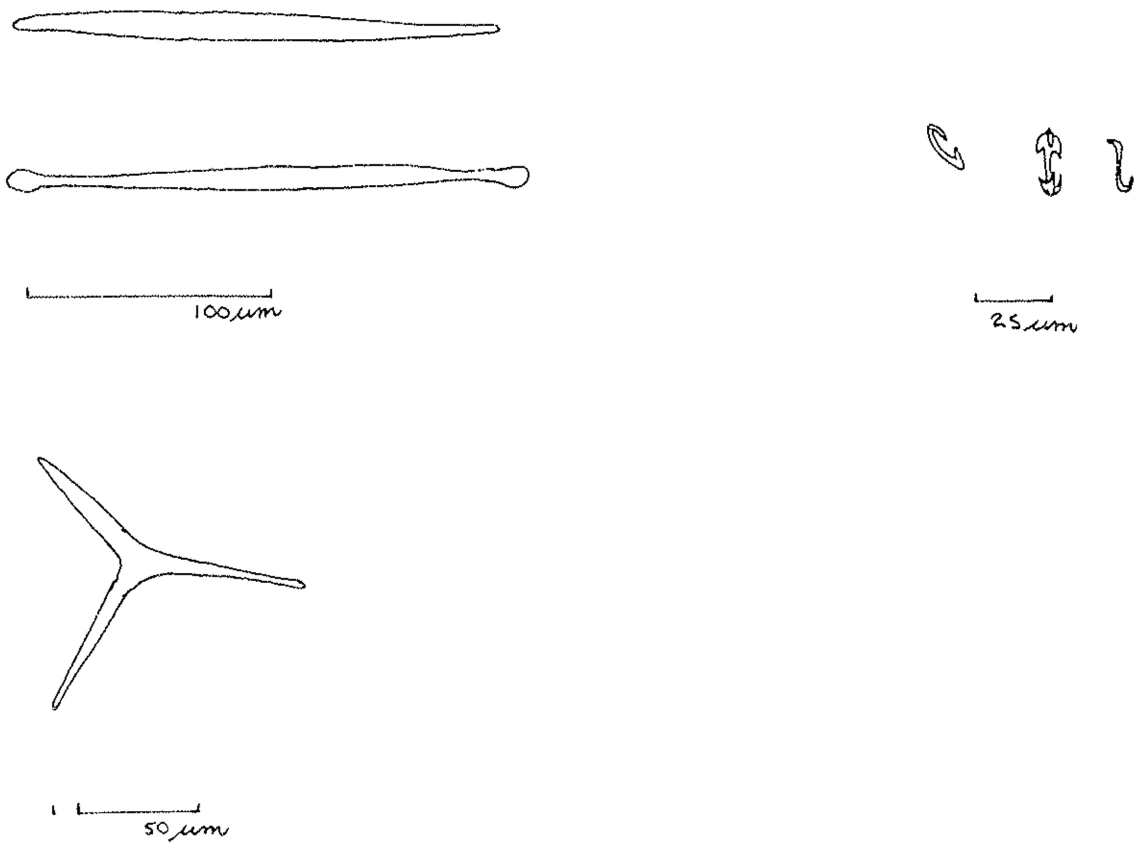
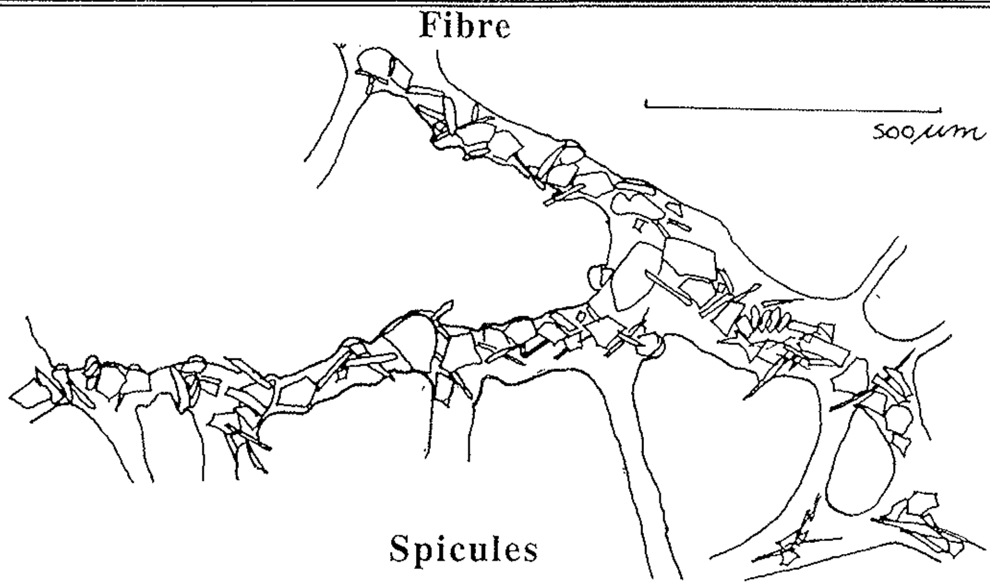


Figure 3.9: (9) Class Demospongiae
Order Poecilosclerida
Family Psammoscidae
Genus *Psammopemma sp.*



no spicules
Sand & other siliceous fragments incorporated into fibre.

3.4 Discussion

Even though all care was taken in the identification of the sponges sampled, this was only a provisional attempt, and there is a need for further investigation and confirmation. It also must be noted that hardly any taxonomic studies have been done on sponges in seagrass meadows in Western Australia, therefore it is quite possible that some of the sponges sampled in this study, are species that have never been described. Only three of the nine species identified in this study were found in seagrass habitats in the Point Peron Ocean Outfall Marine Environmental Study (LeProvost, *et al.*, 1981), and they also concluded that all sponges found in seagrass habitats also occur in reef habitats. None were the same as those mentioned by Hatcher (1987), in her study in Marmion Lagoon and Petitt (1984), also found two unidentified species in *A.griffithii* patches at Dongara.

Some of the problems related to the identification of sponges are:

1/. Sponges are capable of filtering out other spicule and siliceous "space junk" and then incorporating the inorganic particles into its fibre structure (Bergquist, 1978; Bergquist & Skinner, 1982; Simpson, 1984; Willenz, *et al.*, 1986). This makes it difficult in some cases to identify the specimen.

2/. Both spicule and fibre digests by the methodology chosen were time consuming and in some cases histology may be required. For future studies in sponge taxonomy, there is a need to seek or consult with relevent specialists.

3/. There is a obvious lack of taxonomic information on temperate Western Australian sponges in all habitats. They have been side stepped in the past because sponges are considered by some, a taxonomic nightmare and are in fact, difficult to identify.

4.0 Pilot study of Marmion Lagoon

4.1 Introduction

The objective of this pilot study was to investigate the filter feeder community to gain some information as to what taxa were present and to estimate their abundance. This would give some indication their diversity and abundance, which in turn helps to determine if the filter feeders could be dealt with as a single group or what would be the best way of dividing the groups. The sampling for this pilot study was conducted under the direction of Dr Graham. Edgar [3] and covered habitats and macroinvertebrate species other than those which are discussed in this section.

This section discusses only the sponge components of the hard substrate habitats investigated within this pilot study. The main areas of interest are the spatial variation of sponge abundance (between quadrants), variation between habitat types, and an approximation of their filtration capacity.

4.2 Methods and Materials

4.2.1 *Site selection*

Marmion Marine Park was divided into four sections: NE, NW, SE, and SW Quadrants (Figure 4.1). These were used to determine the spatial variation within the park (North, South, Inshore, and Offshore). Within each quadrant, four sampling sites were selected by latitudes and longitudes determined from random number tables (Table 4.1 and Figure 4.1).

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[3] Filter Feeder Project Leader. CSIRO, Division of Fisheries.

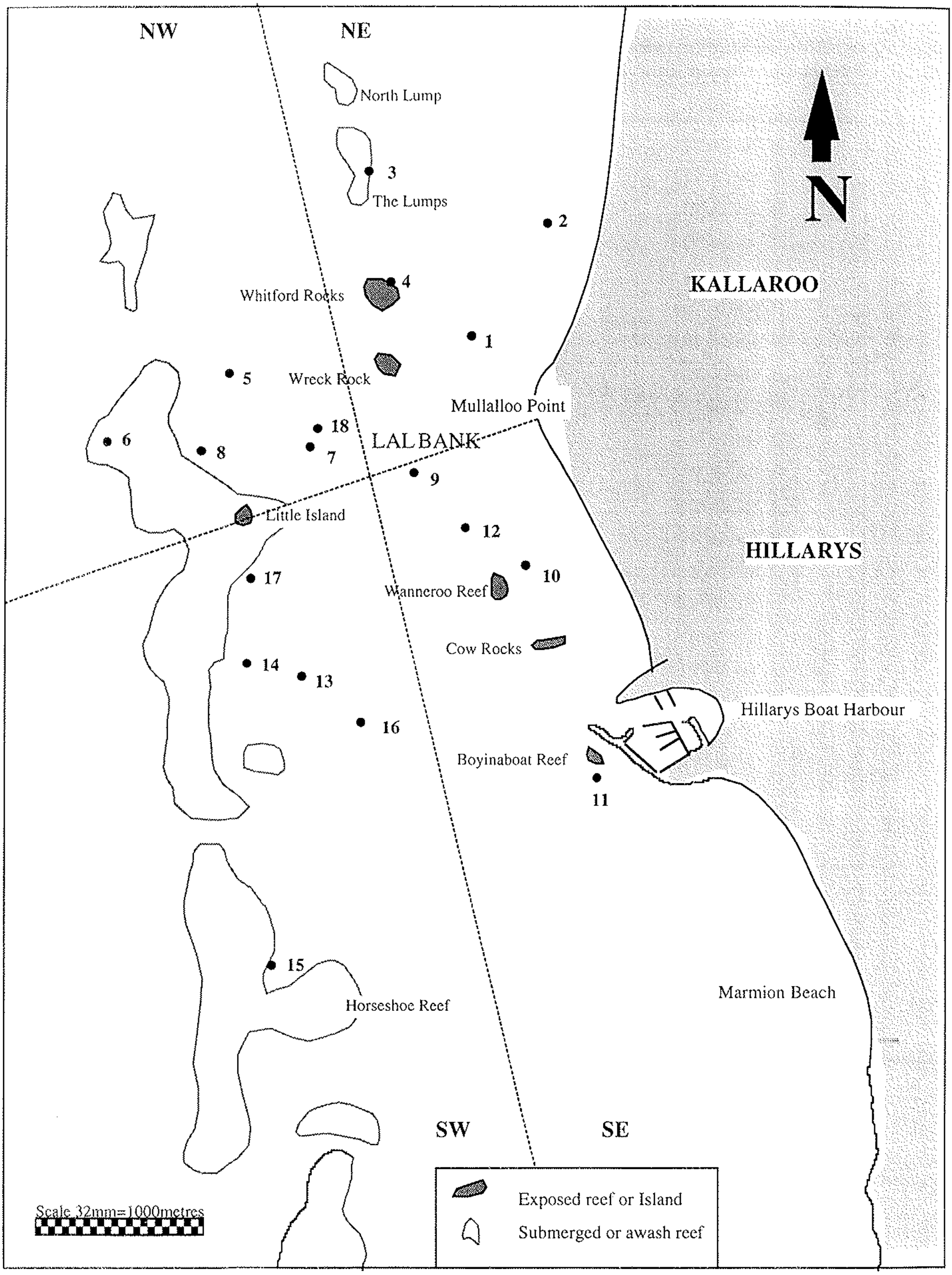

Figure 4.1: Map of Marmion Marine Park showing the locations of the pilot study sample sites.

Table 4.1: Latitudes and longitudes of the sampling sites in Marmion Marine Park utilized for the filter feeder pilot study. Sites sampled 11-15/10/93

Site N°	Latitude	Longitude
1	31° 48.270' S	115° 43.250' E
2	31° 47.740' S	115° 43.558' E
3	31° 47.656' S	115° 42.923' E
4	31° 48.040' S	115° 43.006' E
5	31° 48.308' S	115° 42.450' E
6	31° 48.544' S	115° 41.904' E
7	31° 48.590' S	115° 42.694' E
8	31° 48.578' S	115° 42.288' E
9	31° 48.662' S	115° 43.123' E
10	31° 48.973' S	115° 43.458' E
11	31° 49.637' S	115° 43.870' E
12	31° 48.853' S	115° 43.328' E
13	31° 49.352' S	115° 42.692' E
14	31° 49.311' S	115° 42.485' E
15	31° 50.327' S	115° 42.566' E
16	31° 49.507' S	115° 42.921' E
17	31° 49.022' S	115° 42.491' E
18	31° 48.513' S	115° 42.735' E

4.2.2 *Sampling strategy*

For the overall pilot study, a total of ten habitats where chosen:

(1) *Posidonia* species,

(2) *Amphibolis antarctica*,

(3) *A.griffithii*,

(4) *Heterozostera tasmanica*,

(5) *Halophila ovalis*,

(6) Edge of seagrass patches,

(7) Bare sand,

(8) Bare reef / hard substrate,

(9) *Ecklonia* on hard substrate, and

(10) *Sargassum* on hard substrate.

This report considers only the sponge component of the hard substrate habitats, which are the latter three: Reef, *Ecklonia* and *Sargassum* habitats. It is necessary to note that the cryptic, cavern and under ledge dwelling sponge community were not sampled in the "reef" habitat.

Within each habitat, a total of four 0.25 m2 quadrats were sampled. The quadrats were randomly broadcasted onto the habitat, then stripped of all macroinvertebrates (including sponges). These were then bagged, labelled and once back at the laboratory frozen until they were required for quantifying.

4.2.3 *Ash free dry weights*

The sponges were dried in an oven at 90° C for 48 hours, then dry weights recorded. The dry sponges were then placed into a muffle furnace at 550° C for three hours, after which the ash weight was measured and recorded. The ash free dry weight (AFDW) was calculated by subtracting the ash weight (AW) from the dry weight (DW), ie. :

$$\mathbf{DW - AW = AFDW}$$

No allowance was made for loss of H_2O from siliceous spicules.

Ash free dry weights have been used in many studies concerning sponges (Pettit, 1984; Barthel, 1986; Riisgård, *et al.*, 1993; Wilson, *et al.*, 1993), and is considered to be a more meaningful measure of biomass because of the large amount of inorganic material (eg. sand, diatom frustules & spicules) incorporated into the sponge structure (Bergquist, 1978; Bergquist & Skinner, 1982; Simpson, 1984; Willenz, *et al.*, 1986).

4.2.4 *Filtration rate*

To estimate filtration rates, historical data was used. As seen in Table 4.2, the rates vary markedly between the species. For the purpose of this report, an estimation of filtration rates will be determined through the mean of the historical data (Table 4.2):

$$\textbf{Mean AFDW g.m}^{-2} \times \textbf{1.579 ml H}_2\textbf{O.g}^{-1}\textbf{ AFDW.sec}^{-1} = \textbf{filtration rate ml H}_2\textbf{O. m}^{-2}\textbf{. sec}^{-1}\textbf{.}$$

Table 4.2: Filtration rates of sponges.

Reference	*Species*	*Filtration rates* ($ml\ H_2O.g^{-1}\ AFDW.sec^{-1}$)
(Putter, 1914) [4]	*Suberites domuncula*	0.0324
(Jørgensen, 1955) [4]	*Grantia compressa*	0.165
(Riisgård, *et al.*, 1993)	*Halichondia panicea*	0.93
(Reiswig, 1971) [5]	*Verongia gigantea*	1.165
(Bidder, 1923) [4]	*Leucandra aspersa*	1.24
(Jørgensen, 1955) [4]	*Halichondia panicea*	1.33
(Reiswig, 1971) [5]	*Tethya crypta*	2.76
(Reiswig, 1971) [5]	*Mycale sp.*	5.01
	Mean Filtration rate	**1.579**

4.3 Results

4.3.1 *Sponge distribution within the quadrants and habitats*

Variation was high for the data collected, therefore the assumptions for ANOVA (normal population distribution and same variance), cannot be maintained therefore for all statistical analysis subsequently performed, data was transformed using log(x+1) (Sokal & Rohlf, 1969).

A two factor ANOVA with replication was performed on the log transformed data (Table 4.3), resulting in the following:

(i) There was no significant difference between quadrants ($p=0.768$). This implies that all data for each habitat can be looked at collectively.

(ii) There was three star statistically significant difference in sponge biomass between the habitats ($p=0.00072$), implying that there is large variation between the habitats.

(iii) Interaction between the habitats and quadrants was not critical ($p=0.482$), suggesting that there was no trend or constant relationships between the two treatments.

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[4] *In* Berquist, 1978.

[5] Also cited in Berquist, 1978.

Table 4.3: ANOVA: Two factor with replication comparing quadrats and habitats

Habitat	*log (1+Eck)*	*log(1+Sarg)*	*log(1+Reef)*	*Total*		
Quadrant						
NE						
Count	4	4	4	12		
Sum	2.207	0.84	2.652	5.699		
Average	0.55175	0.21	0.663	1.42475		
Variance	0.15721225	0.04479933	0.32565467	0.52766625		
NW						
Count	4.000	4.000	4.000	12.000		
Sum	3.002	0.840	3.382	7.224		
Average	0.751	0.210	0.846	1.806		
Variance	0.197	0.067	0.080	0.345		
SE						
Count	4	4	4	12		
Sum	1.381	1.292	5.336	8.009		
Average	0.34525	0.323	1.334	2.00225		
Variance	0.330	0.392	0.290	1.012		
SW						
Count	4.000	4.000	4.000	12.000		
Sum	2.723	1.038	3.495	7.256		
Average	0.681	0.260	0.874	1.814		
Variance	0.203	0.155	0.238	0.596		
Total						
Count	16	16	16			
Sum	9.313	4.01	14.865			
Average	2.32825	1.0025	3.71625			
Variance	0.88677375	0.65921767	0.93397925			
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Quadrants	0.2347965	3	0.0782655	0.37870851	0.76890114	2.86626545
Habitats	3.68286538	2	1.84143269	8.91026356	0.00071843	3.25944427
Interaction	1.15933512	6	0.193222252	0.93495874	0.482132	2.36374831
Within	7.439912	36	0.20666422			
Total	12.516909	47				

4.3.2 *Sponge abundance between habitats*

As a result of the statistically significant differences between the habitat types, pairwise multiple comparisons in the form of a Student - Newman - Keuls Test, was performed to isolate which group or groups differ from the others (Table 4.4). This test showed that all comparisons were critical ($p<0.05$) and implies there is significant difference between all biomass means of the habitat types.

Table 4.4: Pairwise multiple comparisons: Student - Newman - Keuls Test comparing sponge distribution in habitat types

Comparison	*Diff of mean*	*p*	*q*	*p<0.05*
Reef vs *Sargassum*	0.678	3	6.125	yes
Reef vs *Ecklonia*	0.347	2	3.133	yes
Ecklonia* vs *Sargassum	0.331	2	2.992	yes

Comparison of AFDW of sponges between the habitat types show that the reef has the largest mean biomass (58.892 ±SE 18.619 $g.m^{-2}$), which is approximately two and a half times larger than *Ecklonia* habitats (21.159 ±SE 6.682 $g.m^{-2}$), and approximately eight times the biomass of *Sargassum* habitats being 7.597 ±SE4.389 $g.m^{-2}$ (Figure 4.2 & Table 4.5).

Table 4.5: Mean sponge biomass in all habitats sampled with Standard Errors ($g.m^{-2}$)

	Ecklonia	*Sargassum*	*Reef*
Mean	21.159	7.597	58.892
±SE	6.682	4.389	18.619

4.3.3 *Estimation of filtration volumes*

The historical data on filtration rates of various sponge species (Table 4.2), has a mean filtration rate of 1.579 ml $H_2O.g^{-1}AFDW.sec^{-1}$. Using this mean rate, the filtration rates for each habitat were calculated (Table 4.6), suggesting:

(i) One square metre of an *Ecklonia* habitat has the theoretical capacity to filter 288.6 L of water per day,

(ii) *Sargassum* has the capacity of 103.6 $L.m^{-2}.day^{-1}$, and

(iii) $1m^2$ of Reef habitat has the capacity of filtering 803.5 L of water in a day.

Table 4.6: Estimate filtration rates for habitats in Marmion Marine Park.

Habitat	**Filtration capacity ($ml\ H_2O.m^{-2}.sec^{-1}$)**	**Filtration capacity ($L\ H_2O.m^{-2}day^{-1}$)**
Ecklonia	33.4	288.6
Sargassum	11.985	103.6
Reef	92.99	803.5
Total	**138.375**	**1195.7**

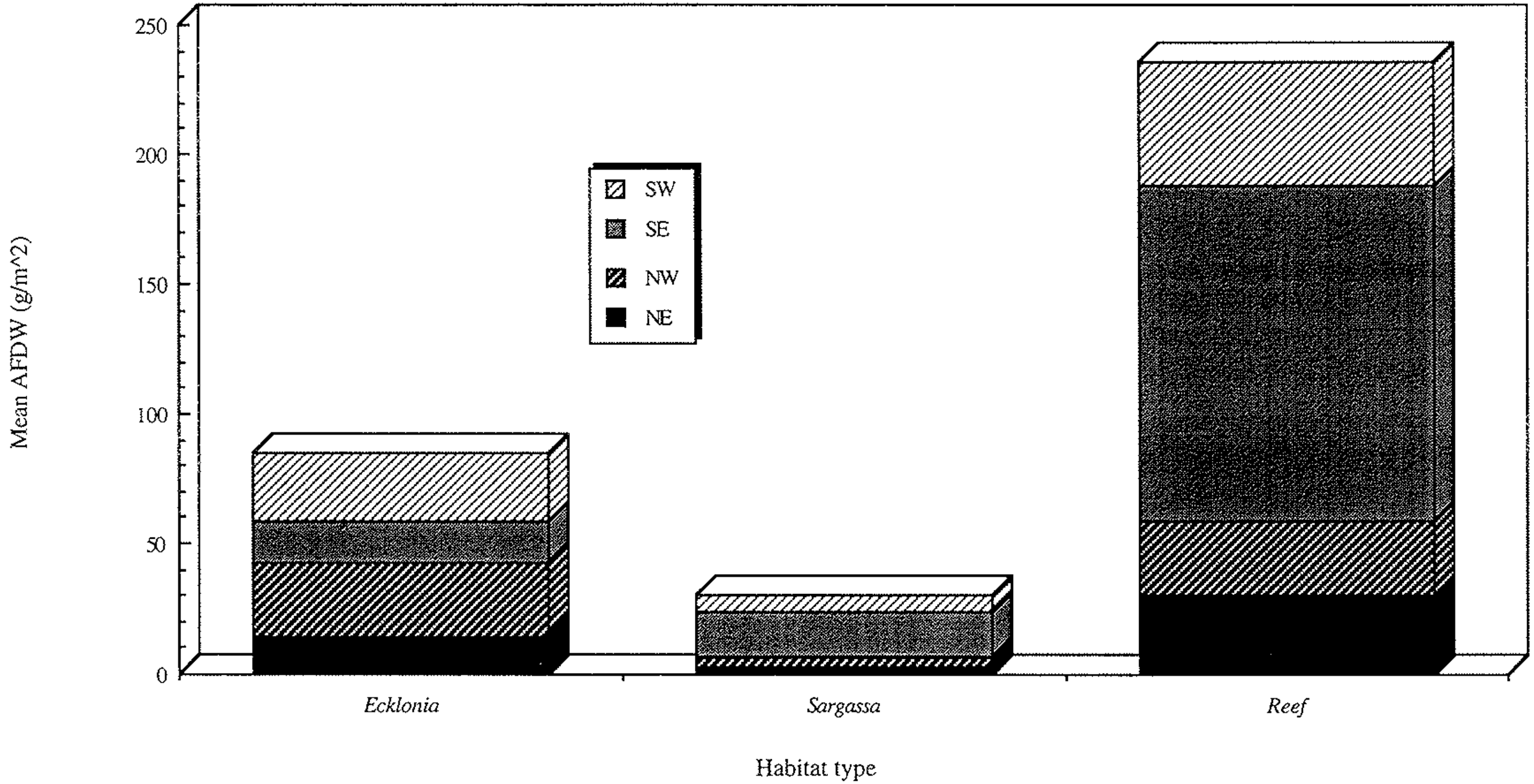

Figure 4.2: Mean sponge Ash Free Dry Weight (g/m^2) comparison between habitat types

4.4 Discussion

This pilot study clearly shows that sponges are abundant in the hard substrate habitats especially the reef habitats. The low abundance in the other two habitats could be the result of the sweeping action of the macroalgae, subsequently removing settling larvae and juveniles[6].

Even though the reef habitat showed the greatest abundance, it did not include the cryptic, cavern dwelling and under ledge communities. It was erroneous to omit these habitats as they house larger communities of filter feeders, of which are mainly sponges (Jaubert & Vasseur, 1974; Vasseur, 1974; Uebelacker, 1977; Vacelet & Vasseur, 1977; LeProvost, *et al.*, 1981; Wilkinson & Evans, 1989).

The hard substrate habitats are a fairly large component of benthic ecosystem of Perth's nearshore marine environments. A review of past surveys conducted in the northern metropolitan waters, describe the major marine habitats as being mainly bare sand, with hard substrates and seagrass meadows having similar coverage:

(a) Ottaway and Simpson(1986), describe the Marmion Marine Park as having 16% hard substrate and 40 % seagrass habitats,

(b) From Two Rocks to Trigg Island, hard substrates are 17 - 24 % and seagrass 19 - 38 % of the marine environment (Hansen, 1984; Johannes & Hearn, 1985; Paling, 1991), and

(c) In the Marmion Lagoon, the hard substrate habitats represent 41 % (9.7 km^2), and seagrass only 23 % (Kirkman, 1981).

Sponges are very efficient filter feeders and are capable of processing large volumes of water daily (Bergquist, 1978; Bergquist & Skinner, 1982; Simpson, 1984; Willenz, *et al.*, 1986).. When considering the theoretical filtering rate calculated above, of 103-804 $L.m^{-2}.day^{-1}$ (Table 4.2), and the expanse of the hard substrate habitats, for example, an area of 9.7 km^2 in

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[6] Dr Gary Kendrick, CSIRO Division of Fisheries. *Personal Communication*, November 1993.

Marmion Lagoon (Kirkman, 1981), it suggests that the sponge community has the capacity for filtering vast volumes of water in the range of 9.9×10^8 - 7.8×10^9 $m^3.day^{-1}$.

This range would obviously be higher, if the cryptic, cavernous and under ledge sponge communities were considered. If the hard substrate community was quantified more representatively, it is certain that the sponges as part of the filter feeder community would be considered as a major contributor to the regulation of organic and inorganic particulates (Cloern, 1982; Hily, 1991), within the Marmion lagoon.

5.0 Conclusions

1/. To representatively sample sponge abundance in *Amphibolis antarctica* seagrass meadows in Marmion Marine Park, the following methodology would be necessary:

(a) Strip harvesting of randomly placed $1 m^2$ quadrats.

(b) At least five replicates would be required.

(c) Quantification through either discrete counts or Ash Free Dry Weights.

2/. There is an obvious lack of taxanomic information on sponges in temperate Western Australian marine environments, therefore more research is required in this area.

3/. For future studies in sponge taxonomy, there is a need to seek or consult with relevent specialists.

4/. The reef habitats have the greatest sponge abundance of the hard substrate habitats.

5/. Personal observations and other studies in the metropolitan area (LeProvost *et al*, 1981; Pettit,1984), suggest that sponges are more abundant in the hard substrate habitats than in segrass meadows.

6/. Further investigations into sponge abundance in the cryptic, cavern and under ledge habitats is required to representatively quantify the sponge community on hard substrates.

7/. When quantifying sponges on hard habitats, it is recommended that either more replicates and or larger quadrats are taken. This may lower variation between the sites.

8/. Sponges as a component of the filter feeder community, may be a major contributor to the regulation of particulates within the Marmion Marine Park.

* * *

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