Centre for Environmental Management
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Gladstone Campus

PORT CURTIS MACROBENTHOS 1995 - 1996

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GLADSTONE CAMPUS

PORT CURTIS MACROBENTHOS 1995 - 1996

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INTRODUCTION

General

Long term marine environmental monitoring programs commenced in 1995, in Port Curtis, Gladstone with the initiative and financial support of the Gladstone Port Authority (GPA), and Gladstone Industry. These programs involve benthos, seagrasses and mangroves and are being undertaken by the Centre for Environmental Management, Faculty of Applied Science, Central Queensland University (CQU), from its Gladstone Campus under the direction of Dr Michael Walker.

CQU has also been contracted by Boyne Smelters Limited (BSL) to carry out two marine faunal and floral surveys in the vicinity of South Trees adjoining the wharves servicing BSL and Queensland Alumina Limited (QAL). The first of these was carried out January, 1996 in South Trees Inlet, adjacent to the South Trees Bridge Conveyer prior to commencement of the installation of a gas pipeline. The second survey took place in November 1996, within "Pitch Bay" at South Trees between the QAL and Comalco Wharf, prior to consideration by the Queensland Government of a reclamation proposal by BSL, in order to comply with government environmental protection laws and regulations. BSL proposed the reclamation of tidal lands to extend the existing metal storage pad on South Trees Wharf.

Macrobenthic Monitoring Port Curtis

Animals that live attached to or in the sediment (mud, sand, etc.) of the seabed are the best indicators available of long term environmental change. These sessile or sedentary macrobenthic organisms provide the researcher with a suite of organisms that must adapt or perish with the onset of environmental change. The Port Curtis macrobenthic monitoring program has been designed to establish a baseline information on species diversity and abundance for a series of anthropogenic and control stations/sites and to monitor any changes in these suites over time. The program design involved the capacity to add further stations as required . This occurred in November 1995 when Stuart Energy Limited joined the program and funded an additional anthropogenic site at Fisherman's Landing.

The use of specific indicator species from benthic communities has historically become less widely used in the detection of pollution. In the past, species chosen for this purpose have been usually tolerant of such conditions and are often simply found in different abundance in non polluted areas. They can, however, be used in that they may provide warnings, expressed as a lowering in diversity and changes in abundance, for example, species which feed on bacteria and are able to tolerate low oxygen and high silt load conditions, may increase. Today a better approach is to utilise 'clean' species which disappear under specific pollution or environmental conditions, rather than more tolerant species.

The Port Curtis macrobenthic monitoring program is designed to ultimately select a suite of 'clean' species as well as monitoring changes in species diversity and abundances of the more tolerant species and the total species assemblage.

Macrobenthic monitoring commenced in November 1995 and was repeated in April and November 1996. This report documents the results of these three GPA macrobenthic samplings, as analysed to March 1997.

Boyne Smelters Limited Contract Research

Vegetation Survey across South Trees Inlet : Proposed Pipeline:

The survey was undertaken during the period 3 - 7 January 1996 and involved sampling in a continuous line across South Trees Inlet, adjacent to the proposed pipeline route. A number of sampling techniques were used in order to comprehensively survey the various marine faunal and floral components (Walker, 1996). Voucher specimens collected during the survey were retained for taxonomic classification/identification and are now housed as a reference collection within the Centre for Environmental Management at CQU's Gladstone Campus.

Proposed Reclamation of Tidal Lands - South Trees Point

In November / December, 1996 CQU was commissioned by BSL to carry out a second marine faunal and floral survey in accordance with Section 51 of the Fisheries Act. This survey involved a number of sampling regimes including: benthic sampling, fisheries resources, crustacean sampling, mangrove survey, mudflat community survey. Similar procedures were employed as for first marine survey for BSL (Walker 1996) and voucher specimens were also retained. These techniques mostly follow marine survey techniques outlined in English et al. 1994. The report for this survey has been reported in (Walker 1997).

This report also documents the results of these BSL surveys so that comparisons can be made between GPA /Stuart Energy Ltd Port Curtis Macrobenthic samplings and BSL surveys can be made if required.

Overall results and an analyses are over too short a time frame for comparison, discussion and conclusions. They are presented for documentary purposes. The macrobenthic monitoring program is of a long term nature and trends and conclusions can not be anticipated inside a period of five years.

METHODOLOGY

To detect changes field observations must be made that are: compatible with the model to be used in the monitoring program; allow assessment of error associated with the measurement and time and space scale; compatible throughout the study; compatible where possible with similar work undertaken by others; and finally dynamic and able to cope with change that may occur because of environmental catastrophes, political change, advances in scientific collection and processing techniques and changes in objectives.

Previous statistical analyses conducted by initial consultants on macrobenthic data indicated that the minimum number of replicates per station should be ten. This number or replicates will be effective in detecting significant differences between communities in disturbed and undisturbed areas at an 80% level of success.

Further replication would increase the power to detect differences between individual stations within sites, as well as between different sites, however this would require a greater cost and somewhere a balance between the two must reached.

The Port Curtis macrobenthic monitoring program commenced in November 1995 and consists of the following regime: a total of five sites, four stations per site, exist within the Gladstone Harbour, Port Curtis.

Site 1: Auckland Point Wharf / Auckland Creek.
Site 2: Clinton Coal Wharf and Channel.
Site 3: Curtis Island.
Site 4: Graham Creek, The Narrows.
Site 5: Fisherman's Landing / QCL (Proposed Oil Shale Development)

Sites 1, 2, 5 are treatment sites influenced by a range of anthropogenic conditions. Sites 3 and 4 have been chosen as undisturbed control sites in that no industry or harbour activities, excluding commercial and recreational fishing, are common in these areas.

During November (pre wet season) and April (post wet season) benthic sampling using a $0.1m^2$ van Veen grab is used to take 10 samples at each station. A small portion of sediment is collected form each sample and retained for grain size analysis. Samples are sieved through 1mm sieves and preserved in 5% formalin / seawater solution for 48 hours. The samples are then changed into 70% ethanol and stored until sorting. Samples are identified in the laboratory using dissection microscopes and macrobenthic species identified, preserved, and their abundance recorded.

The macrobenthic component of the Boyne Smelters Limited Vegetation Survey across South Trees Inlet was conducted on 3-7 January 1996, and consisted of 14 stations from QAL to BSL. The samples were taken at high tide starting from the shoreline adjacent to QAL and the sub station, and from the seabed adjacent to the bridge over South Trees

Inlet. Samples were taken every 2 ½ pylons with the last sample taken halfway between the end of the bridge on the BSL side and the shoreline.

These samples were collected using a $0.1m^2$ van Veen grab (PLATE 1) and were sieved using a 1mm sieve (PLATE 2). Once samples were sieved they were preserved in 5% formalin / seawater solution for 48 hours, and then changed into 70% ethanol, and stored until they were sorted, identified and the abundance recorded.

Samples are further sorted in the laboratory and ultimately classified to family level and where possible genus and species. One of each taxa collected is drawn , given a classification number and filed for later comparative purposes. Plates 3 - 14 provide examples of some drawings. Ultimately it is planned to incorporate all drawings in a monograph on the marine flora and fauna of Port Curtis.

The second marine floral/faunal survey conducted for BSL for the proposed reclamation of tidal lands South Trees Point, also consisted of a macrobenthic component. This survey was conducted on the 13th November 1996 and was located in a bay between BSL and QAL wharves. The same sampling regime was used, only there were 20 samples taken at regular intervals through out the bay.

RESULTS

1 BENTHIC GRAB SAMPLING FOR THE GLADSTONE PORT AUTHORITY - PORT CURTIS

A total of 225 species, Table 1 with an abundance of 3908 macrobenthic organisms were found in Auckland Creek. The dominating taxa for this area being gastropods with 78 species, Figure 1. Also found were 49 species of polychaetes, 41 species of bivalves, 23 species of crustaceans and 34 species of miscellaneous taxa.

The abundance of organisms (Figure 2), in Auckland Creek was dominated by gastropods 57%, followed by crustaceans 19%. Bivalves, polychaetes and miscellaneous taxa (Figure 2) also occurred.

The abundance of various taxa in the area of the Clinton Coal Wharf was the gastropods (~86%, dominating the macrobenthos) (Figure 4), followed by 5% both bivalves and the miscellaneous taxa and 2-2.5% of polychaetes and crustaceans.

At Clinton Coal Wharf 265 species were found, (Table 2). The breakdown of number of species found at Clinton Coal Wharf is given in Figure 3. The dominating taxa of the Clinton Coal Wharf was molluscs, 44% of the total species count and consisting of 105 species of gastropods and 38 species of bivalves. The remainder comprised of 59 species of polychaetes, 23 species of crustaceans and 40 species of miscellaneous classes.

Curtis Island is one control site for the macrobenthic monitoring program. Species numbers and abundance for Curtis Island found are shown in Figures 5 and 6. Gastropods were the dominating species at the Curtis Island sites with approximately 42% of the total number of species occurring in that area, Table 3. The remainder of the fauna was composed of 20% miscellaneous taxa, 16% polychaetes, 13% bivalves and 9% crustaceans. Figure 6 shows the abundance of the various taxa for Curtis Island. In this area gastropods comprise 82% of the total abundance of individuals present. Other taxa present are miscellaneous taxa 7%, bivalves 5%, polychaetes 3.5% and crustaceans, 2.5%.

At Graham Creek another control site, the total number of species was less than the other stations, there being to date 68 different species, Table 4. The breakdown of species is shown in Figure 7. Gastropods comprised 44% of the total number of species present. The remainder was composed of 20% polychaetes, 16% of miscellaneous taxa, 13% of bivalves and 7% of crustaceans.

The total abundance of organisms at Graham Creek was also lower than elsewhere (Figure 8), with the total number of organisms being 713. Gastropods comprised of 65% of this total along with polychaetes (16%), bivalves (13%), crustaceans 2%) and miscellaneous taxa (4%).

At Graham Creek another control site, the total number of species was less than the other stations, there being to date 68 different species, Table 4. The breakdown of species is shown in Figure 7. Gastropods comprised 44% of the total number of species present. The remainder was composed of 20% polychaetes, 16% of miscellaneous taxa, 13% of bivalves and 7% of crustaceans.

The last site in the present Port Curtis Macrobenthic Monitoring Program (PCMMP) is the Oil Shale Development Site, at Fisherman's Landing. A total of 213 species were found at this site, (Table 5). There were 81 species of gastropods, (38% of the total number of species), 52 species of polychaetes, (25% of the total species number), 35 species of bivalves (17% of the total number), 23 species of crustaceans (10% of the total number) and 22 miscellaneous species (a further 10% of the total number) (Figure 9). Abundance of the various taxa is shown (Figure 10). Macrobenthos was predominantly made up of the gastropods 80% followed by miscellaneous taxa 16%, bivalves and polychaetes 2-2.5%, and crustaceans 1%.

2 BENTHIC GRAB SAMPLING AT SOUTH TREES INLET

The number of species in each broad classification group, (flora and fauna), adjacent to the bridge at South Trees Inlet are shown (Table 7). The highest number of species found was 18 at Station 10, and the lowest number of species was 7 at Station 14. The average number of species per station can be calculated from this table, in this case the average number of species is 13 per station.

Macrobenthic organisms, found in the South Trees Inlet classified by broad groupings, are given Table 7. The groups are divided into 5 classes, consisting of gastropods, bivalves, polychaetes, crustaceans and a miscellaneous class which includes echinoderms, bryozoans and ascidians among others. The dominating group of organisms for this area were the polychaetes, followed by gastropods, miscellaneous classes and crustaceans. The least abundant species were the bivalves.

3 BENTHIC GRAB SAMPLING AT PITCH BAY

The total number of species found in Pitch Bay South Trees was 159. The dominating species were the gastropods (79 species, Table 6). The remainder included 25 species of polychaetes, 19 species of both crustacea and bivalves and 17 species of miscellaneous taxa.

Breakdown (by major taxa) of species number and abundance of individuals are shown (Figures 11 & 12). The marine fauna of Pitch Bay, South Trees, was dominated in terms of abundance by gastropods (~80%). Gastropods combined with bivalves, form ~90% of the macrobenthos volume. The actual species suites, however, are not as dominated by these groups. For the polychaetes (15%), crustacea (11%) and other taxa being are more prominent in the samples in terms of occurrence.

The various flora and fauna found in Port Curtis including South Trees Inlet at various sites can be seen as species sheets in Appendices 1 and 2. These sheets show classes of organisms found in the area and abundance of organisms. A summary table is also included, Table 7. This shows the total number of species and there abundances from all macrobenthic monitoring programs carried out by the Centre for Environmental Management. The areas are divided into five main areas. Auckland Creek, Clinton Coal Wharf, Curtis Island, Graham Creek, Oil Shale Development at Fisherman's Landing and the two macrobenthic studies carried out in the South Trees Inlet and Pitch Bay. A comparison of the two sampling seasons, can also be seen.

Results from each station are given in terms of taxa identification and abundance (Appendices 3 - 8).

DISCUSSION

Two macrobenthic samplings are taken each year in November (pre wet/dry) and April (post wet). Populations of macrobenthic animals are greatest pre wet in forms of both abundance and species diversity(Table 8). For example for the Auckland Creek area there was approximately a 50% difference in the number of species found pre and post wet season. This phenomena has been reported previously by Saeger *et al*, 1980; Stephenson *et al*, 1979; and WBM Oceanics 1990 and 1991. These authors have suggested that increased river discharge seasonally reduces macrobenthic population levels due to a combination of reduced salinity, oxygen and physical scouring of the aquatic environment. It is also likely that turbidity, sedimentation and toxicity factors caused by wet season runoff containing pesticides, herbicides, hydrocarbons and other chemicals also play their part in reducing macrobenthic populations both in terms of species diversity and abundance. It is planned to investigate this phenomena further in the future.

The highest diversity of species was encountered at the Curtis Island control site. This site was affected by few anthropogenic influences. The Graham Creek site was selected for supposedly the same reason. However, it seems to suffer anthropogenic effects from farming, fishing both commercial and recreational and a camping area adjacent to the sampling area. Auckland Creek and the Clinton Coal Wharf sites were selected because of an estimated strong anthropogenic effect eg runoff down Auckland Creek and the Calliope River and port activities. Further sampling in successive years will allow extensive investigation of these factors. Time will allow further taxonomic identification of collected macrobenthic animals. The collected macrobenthic samples are taken back to the laboratory and identified to the family level and where possible to the genus and species. Identification ability is limited by the unavailability of taxonomic identification keys. In general the identification of these organisms can take anywhere from 1 day to 1 week to process, depending on the size, taxa and number of organisms in the sample, streamlining of the sorting and identification process is continually occurring. The process however, is labour intensive and time consuming. To date no species introduction from ballast water are apparent.

Methodology and statistical approaches for data analysis are being investigated prior to further analyses in successive sampling years.

Additional to the flora and fauna collected , a sediment sample is collected from each site. These sediment samples are used to determine the grain size of the sediment. Grain size is an important determinant in the distribution and abundance of certain species of organisms. The analysis for these sediment samples has not been carried out to date, due to the lack of equipment and space. The completion of construction of the new building for the Centre for Environmental Management, will enable the analyses of the sediment samples to be undertaken.

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English, S., Wilkinson, C. and Baker, V. (1994), 'Survey manual for tropical marine resources', Australian Institute Marine Science, Townsville.

Walker, M.H. (1996), 'Vegetation survey across South Trees Inlet: proposed pipeline', Report for Boyne Smelters Ltd. (CQU, Faculty of Applied Science) mimeo 33 pages.

Walker, M.H. (1997), 'Marine Survey Pitch Bay, South Trees Port Curtis', Report for Boyne Smelters Ltd. (CQU, Centre for Environmental Management, Gladstone Campus) mimeo 94 pages

Table 1 : Species and Abundances as % for Auckland Creek

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	78	34.7	2212	56.6
Class Bivalvia	41	18.2	657	16.8
Class Polychaeta	49	21.8	256	6.5
Miscellaneous	34	15.1	61	1.6
Phylum Crustacea	23	10.2	722	18.5
TOTALS	225	100	3908	100

Table 2 : Species and Abundances as % for Clinton Coal Wharf

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	105	39.6	10247	86.1
Class Bivalvia	38	14.3	524	4.4
Class Polychaeta	59	22.3	268	2.3
Miscellaneous	40	15.1	556	4.7
Phylum Crustacea	23	8.7	301	2.5
TOTALS	265	100	11896	100

Table 3 : Species and Abundances as % for Curtis Island

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	105	41.8	6052	81.7
Class Bivalvia	34	13.6	391	5.3
Class Polychaeta	42	16.7	248	3.4
Miscellaneous	51	20.3	513	6.9
Phylum Crustacea	19	7.6	200	2.7
TOTALS	251	100	7404	100

Table 4 : Species and Abundances as % for Graham Creek

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	30	44.1	461	64.7
Class Bivalvia	7	10.3	95	13.3
Class Polychaeta	14	20.6	115	16.1
Miscellaneous	11	16.2	26	3.65
Phylum Crustacea	6	8.8	16	2.25
TOTALS	68	100	713	100

Table 5 : Species and Abundances as % for Oil Shale Development

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	81	38.1	13284	79.2
Class Bivalvia	35	16.4	396	2.4
Class Polychaeta	52	24.4	337	2
Miscellaneous	22	10.3	2642	15.7
Phylum Crustacea	23	10.8	121	0.7
TOTALS	213	100	16780	100

Table 6 : Species and Abundances as % for Pitch Bay

Taxa	Species No.	Species %	Abundance	% Abundance
Class Gastropoda	79	49.7	1135	78.1
Class Bivalvia	19	11.9	129	8.9
Class Polychaeta	25	15.7	49	3.4
Miscellaneous	17	12	93	3.2
Phylum Crustacea	19	10.7	47	6.4
TOTALS	159	100	1453	100

TABLE 7

Occurrence (number of species) by broad classification group, flora and fauna grab samples
South Trees Inlet 6.1.96

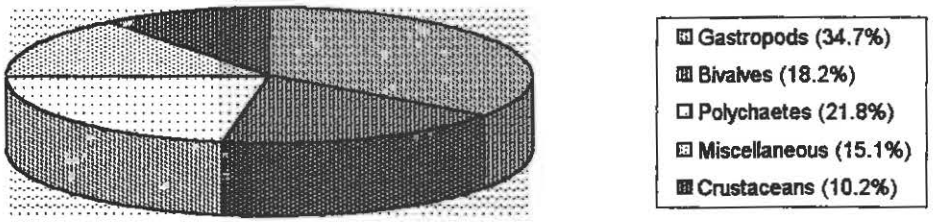
	Station													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Halophila ovalis	A													A
Zostera capricornia	A													A
Red Algae (unident)														
Bryozoans				1			2	1		2	3			
Sponges-Porifera											2			
Polychaetes-worms	2	2	3	5	3	4	4	5	3	5	7	4	5	2
Annelids			1											
Nematodes			1	1			1						1	
Platyhelminthes							1							
Gastropods	5	4	5	8		3		7	1	4			6	
Bivalves	2	2	1	2	1	2	1		1	1	1	1	2	1
Nudibranch														
Prawns and Shrimps			1		2	1	1	2	1	1	2		1	1
Amphipods			1		1	1	1			1				
Isopods			1					1	1		1		1	
Crabs	1						1		1	1	1			
Stomatopods												1		
Barnacles										1				
Ascidians						1			2			1		
Echinoderms		3			1		2	1	1	2			1	1

Table 8 : Species and Abundance for Port Curtis Macrobenthic Surveys.

AREA	Station No.	Nov-95		Apr-96		Nov-96	
		Species No.	Abundance	Species No.	Abundance	Species No.	Abundance
Auckland Creek	1	80	1162	40	263		
	2	77	654	50	457		
	3	87	402	46	166		
	4	81	298	70	447		
Clinton Coal Facility	5	97	1158	116	2230		
	6	139	3036	126	2372		
	7	94	811	86	658		
	8	85	782	80	781		
Curtis Island	9	129	950	111	1823		
	10	110	791	107	2805		
	11	103	876	10	149		
	12						
Graham Creek	13						
	14	68	711				
	15						
	16						
Oil Shale Development	17	92	3840				
	18	90	9064				
	19	146	2624				
	20	88	1253				
South Trees	1	12					
	2	11					
	3	14					
	4	17					
	5	8					
	6	12					
	7	14					
	8	17					
	9	12					
	10	18					
	11	17					
	12	7					
	13	17					
	14	7					
Pitch Bay	1					46	142
	2					49	107
	3					62	186
	4					18	40
	5					21	51
	6					25	58
	7					12	22
	8					6	14
	9					13	109
	10					7	23
	11					13	43
	12					20	43
	13					13	25
	14					20	203
	15					17	76
	16					37	141
	17					17	47
	18					10	33
	19					24	127
	20					8	19

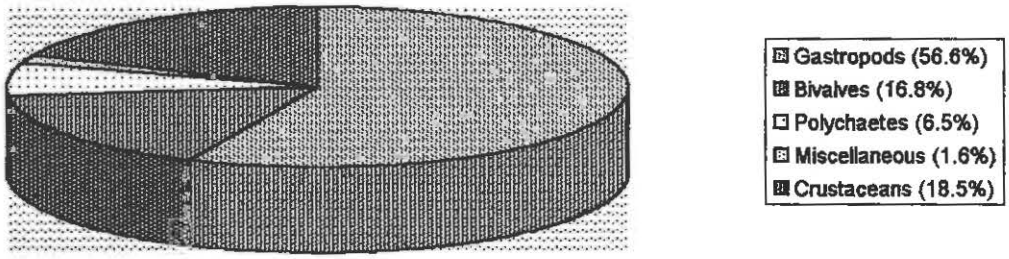
Gastropods (34.7%)	78
Bivalves (18.2%)	41
Polychaetes (21.8%)	49
Miscellaneous (15.1%)	34
Crustaceans (10.2%)	23

Figure 1 : Macrobenthic Species of Auckland Creek



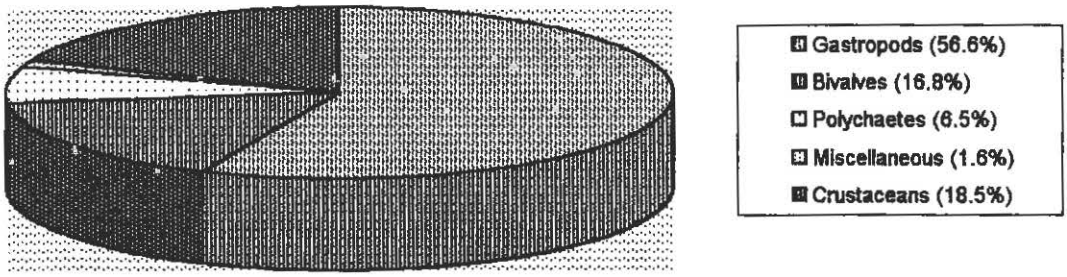
Gastropods (56.6%)	2212
Bivalves (16.8%)	657
Polychaetes (6.5%)	256
Miscellaneous (1.6%)	61
Crustaceans (18.5%)	722

Figure 2 : Abundance of Macrobenthos of Auckland Creek



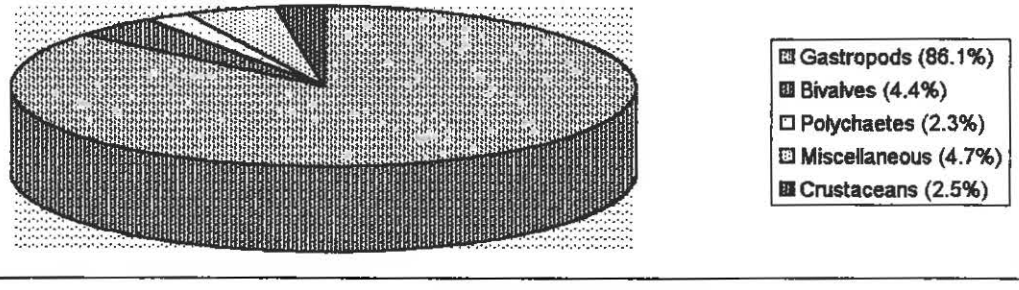
Gastropods (39.6%)	105
Bivalves (14.3%)	38
Polychaetes (22.3%)	59
Miscellaneous (15.1%)	40
Crustaceans (8.7%)	23

Figure 3 : Macrobenthic Species of Clinton Coal Wharf



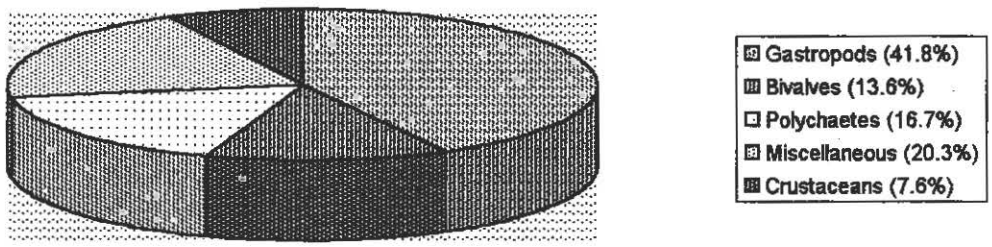
Gastropods (86.1%)	10247
Bivalves (4.4%)	524
Polychaetes (2.3%)	268
Miscellaneous (4.7%)	556
Crustaceans (2.5%)	301

Figure 4 : Abundance of Macrobenthos of Clinton Coal Wharf



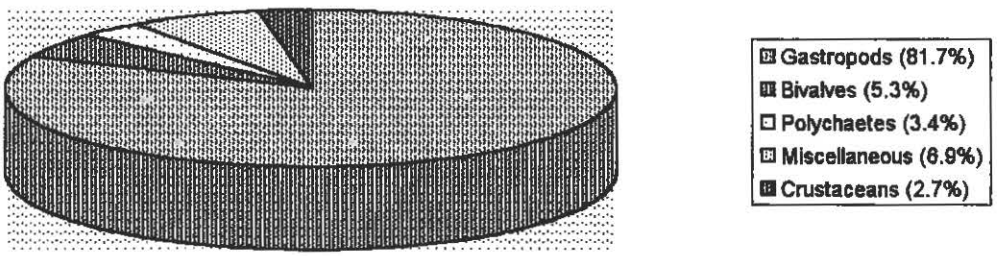
Gastropods (41.8%)	105
Bivalves (13.6%)	34
Polychaetes (16.7%)	42
Miscellaneous (20.3%)	51
Crustaceans (7.6%)	19

Figure 5 : Macrobenthic Species of Curtis Island



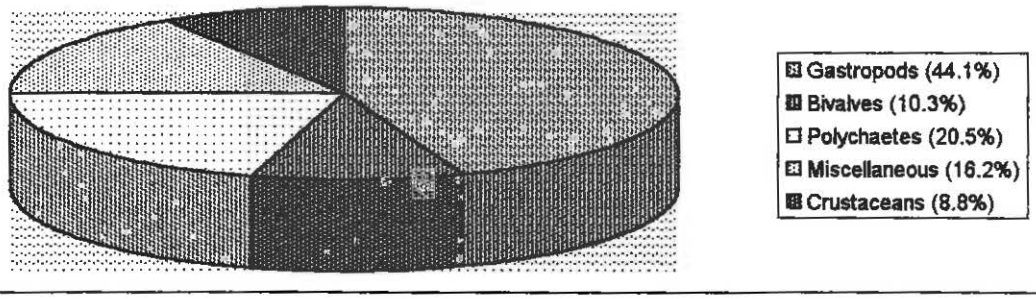
Gastropods (81.7%)	6052
Bivalves (5.3%)	391
Polychaetes (3.4%)	248
Miscellaneous (6.9%)	513
Crustaceans (2.7%)	200

Figure 6 : Abundance of Macrobenthos of Curtis Island



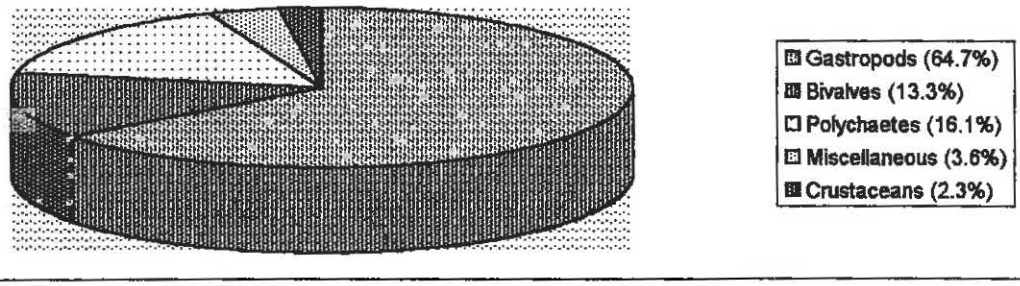
Gastropods (44.1%)	30
Bivalves (10.3%)	7
Polychaetes (20.5%)	14
Miscellaneous (16.2%)	11
Crustaceans (8.8%)	6

Figure 7 : Macrobenthic Species of Graham Creek



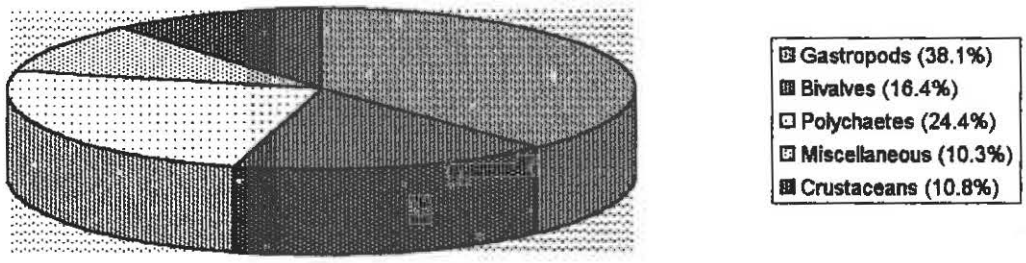
Gastropods (64.7%)	461
Bivalves (13.3%)	95
Polychaetes (16.1%)	115
Miscellaneous (3.6%)	26
Crustaceans (2.3%)	16

Figure 8 : Abundance of Macrobenthos of Graham Creek



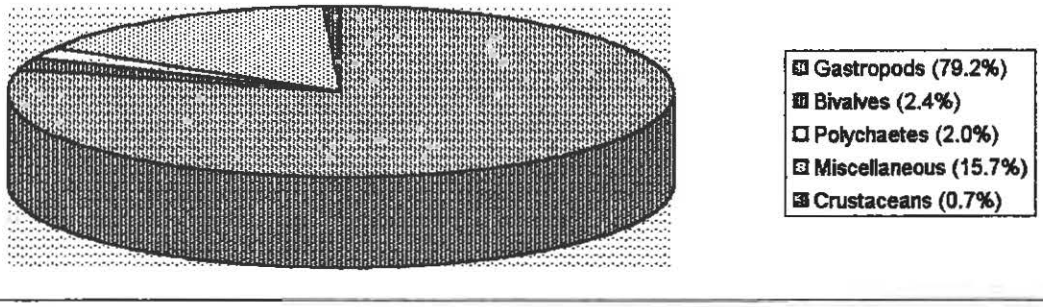
Gastropods (38.1%)	81
Bivalves (16.4%)	35
Polychaetes (24.4%)	52
Miscellaneous (10.3%)	22
Crustaceans (10.8%)	23

Figure 9 : Macrobenthic Species of Oil Shale Development



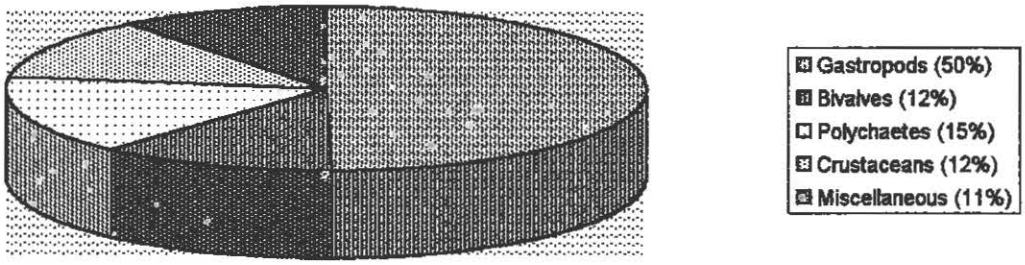
Gastropods (79.2%)	13284
Bivalves (2.4%)	396
Polychaetes (2.0%)	337
Miscellaneous (15.7%)	2642
Crustaceans (0.7%)	121

Figure 10 : Abundance of Macrobenthos of Oil Shale Development



Gastropods (50%)	79
Bivalves (12%)	19
Polychaetes (15%)	25
Crustaceans (12%)	19
Miscellaneous (11%)	17

Figure 11 : Macrobenthic Species of Pitch Bay



Gastropods (78%)	1135
Bivalves (9%)	129
Polychaetes (3%)	49
Crustaceans (3%)	47
Miscellaneous (7%)	93

Figure 12 : Abundance of Macrobenthos of Pitch Bay

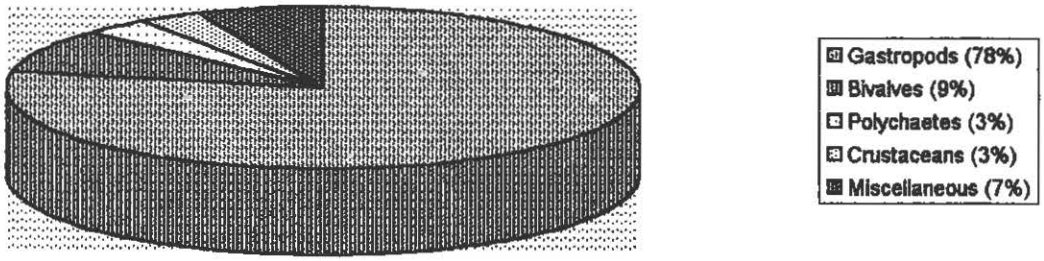
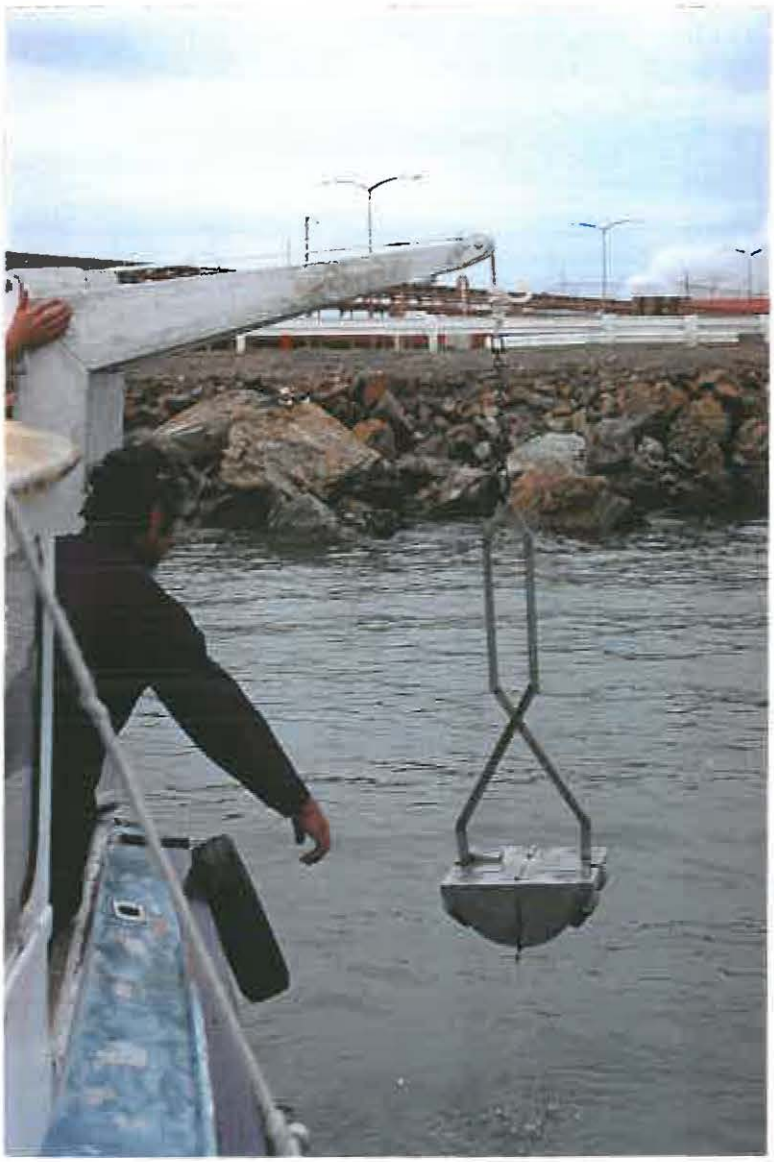


PLATE 1
METHODOLOGY - GRAB SAMPLING, PORT CURTIS



1.1 0.1m2 van Veen grab sampler coming aboard

PLATE 2
METHODOLOGY - GRAB SAMPLING, PORT CURTIS

2.1 Grab sample ex Station 1, showing seagrass and fine silty mangrove and clay sediment

2.3 Researchers sorting sediment through 4mm and 1mm sieves

2.4 Seagrass and other material retained after washing through 4mm sieve, ex Station 1

2.2 Grab sample, ex Station 3, showing sediment of mangrove mud, sand, clay and shell

2.5 Grab sample, ex Station 7. Sediment of coarse shell with some sand and mud

PLATE 3

P. Mollusca
C. Gastropoda

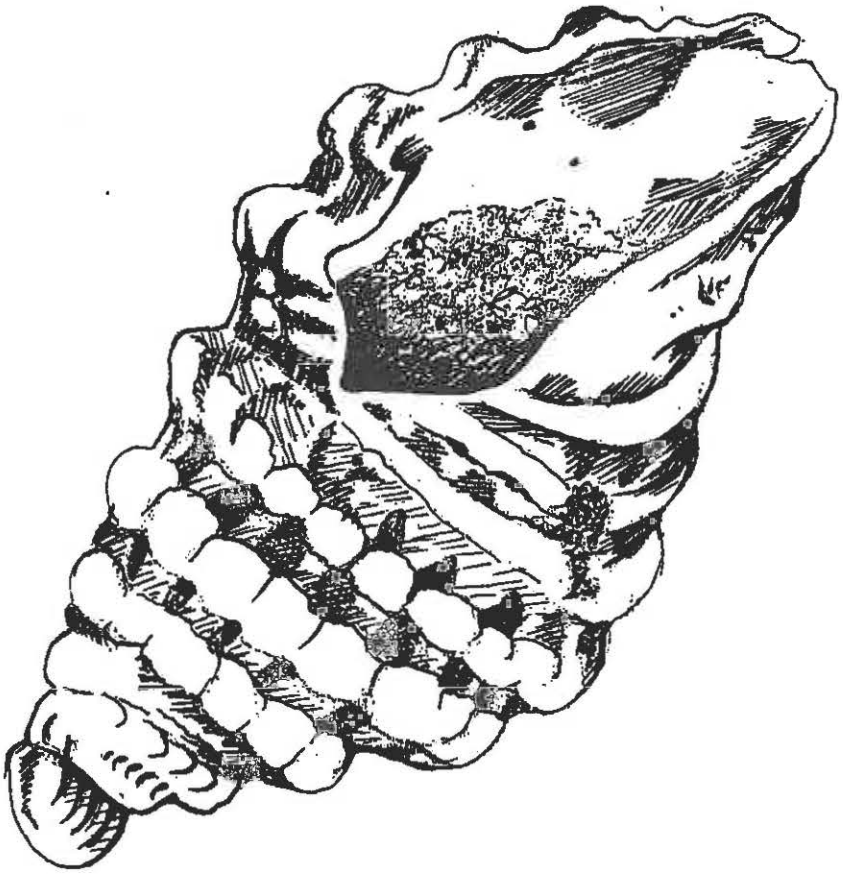


PLATE 4

P. Mollusca
C. Gastropoda
F. Trichotropidae
Separatistista blainvilliana

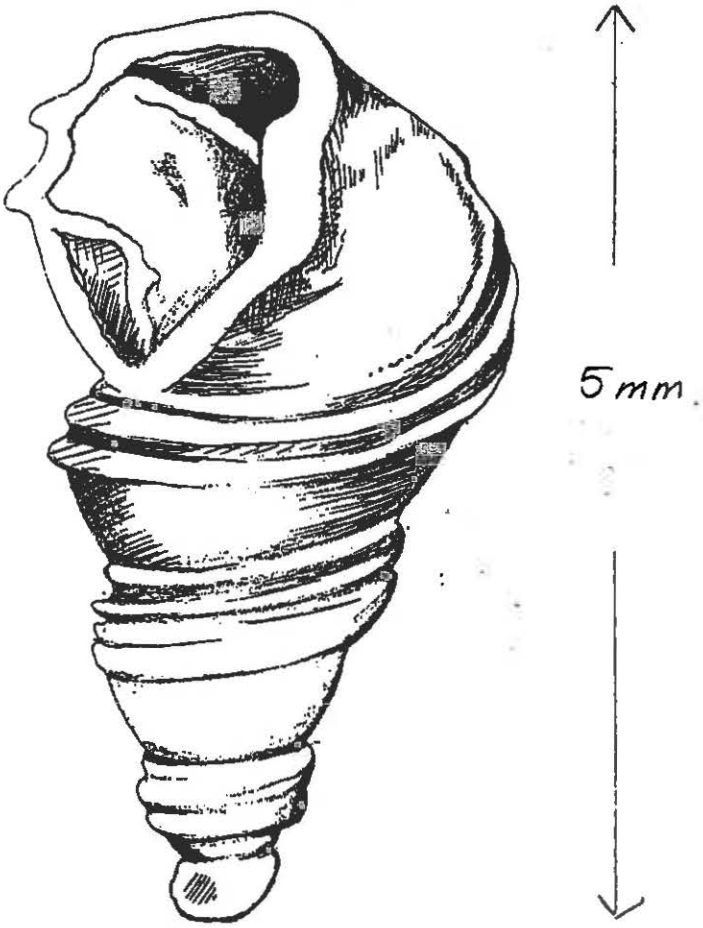


PLATE 5

P. Mollusca
C. Bivalvia

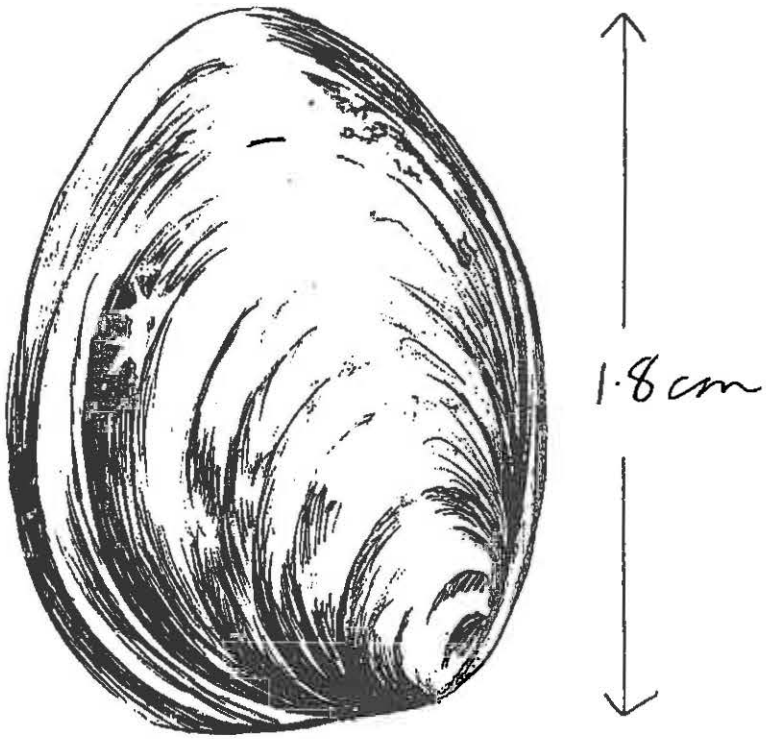


PLATE 6

P. Annelida
C. Polychaeta
F. Cirratulidae

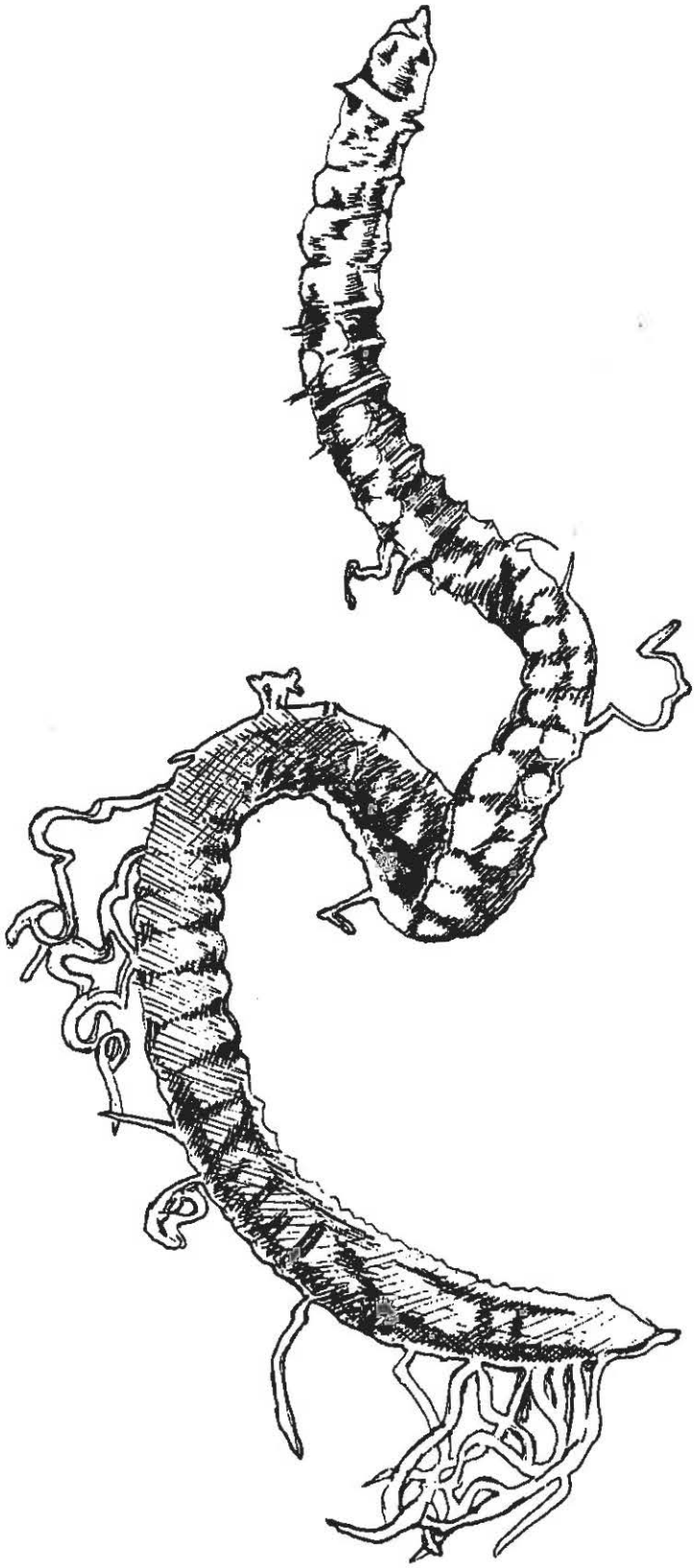


PLATE 7

P. Annelida
C. Polychaeta
F. Cirratulidae

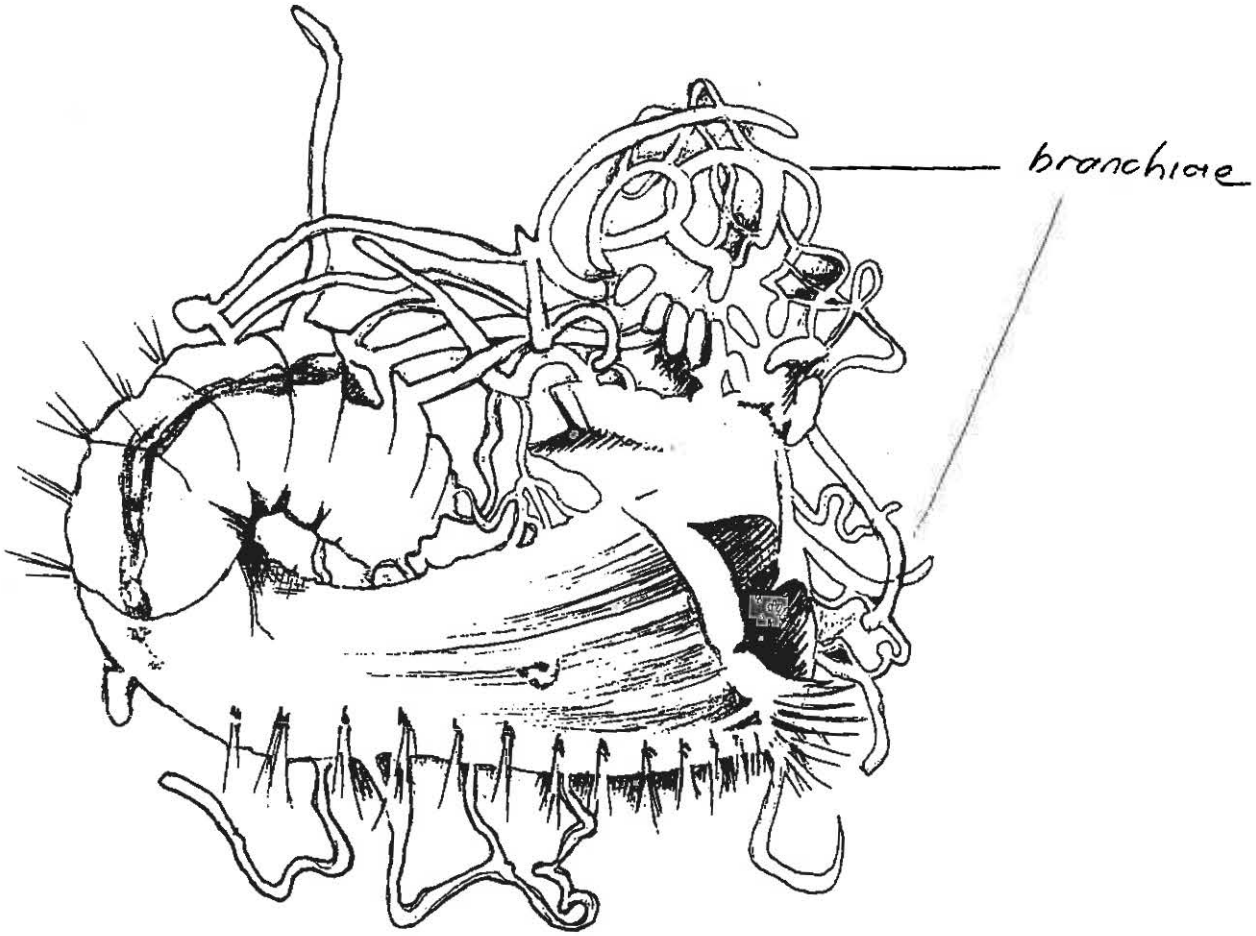
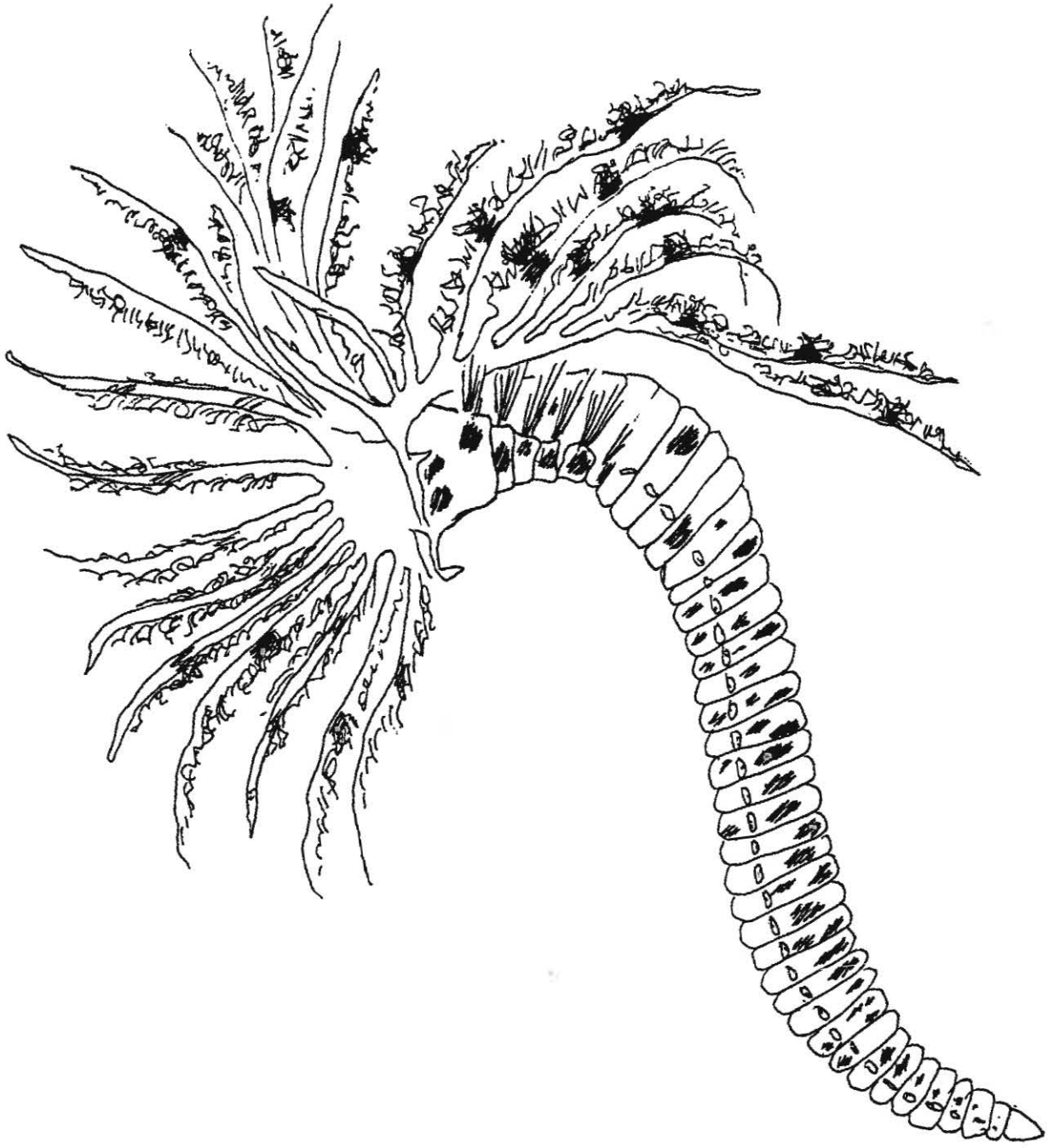


PLATE 8



P. Annelida
C. Polychaeta
F. Sabellidae

PLATE 9

P. Annelida
C. Polychaeta
F. Amphinomidae
Sea Mouse

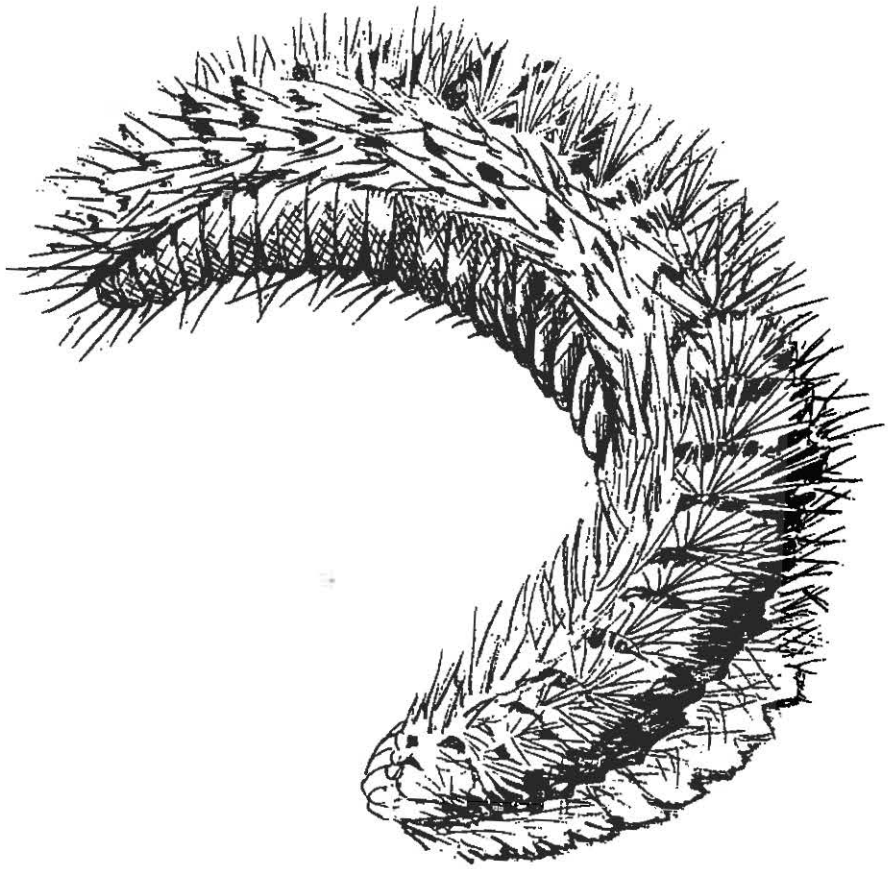


PLATE 10

P. Annelida
C. Polychaeta
F. Polynoidae

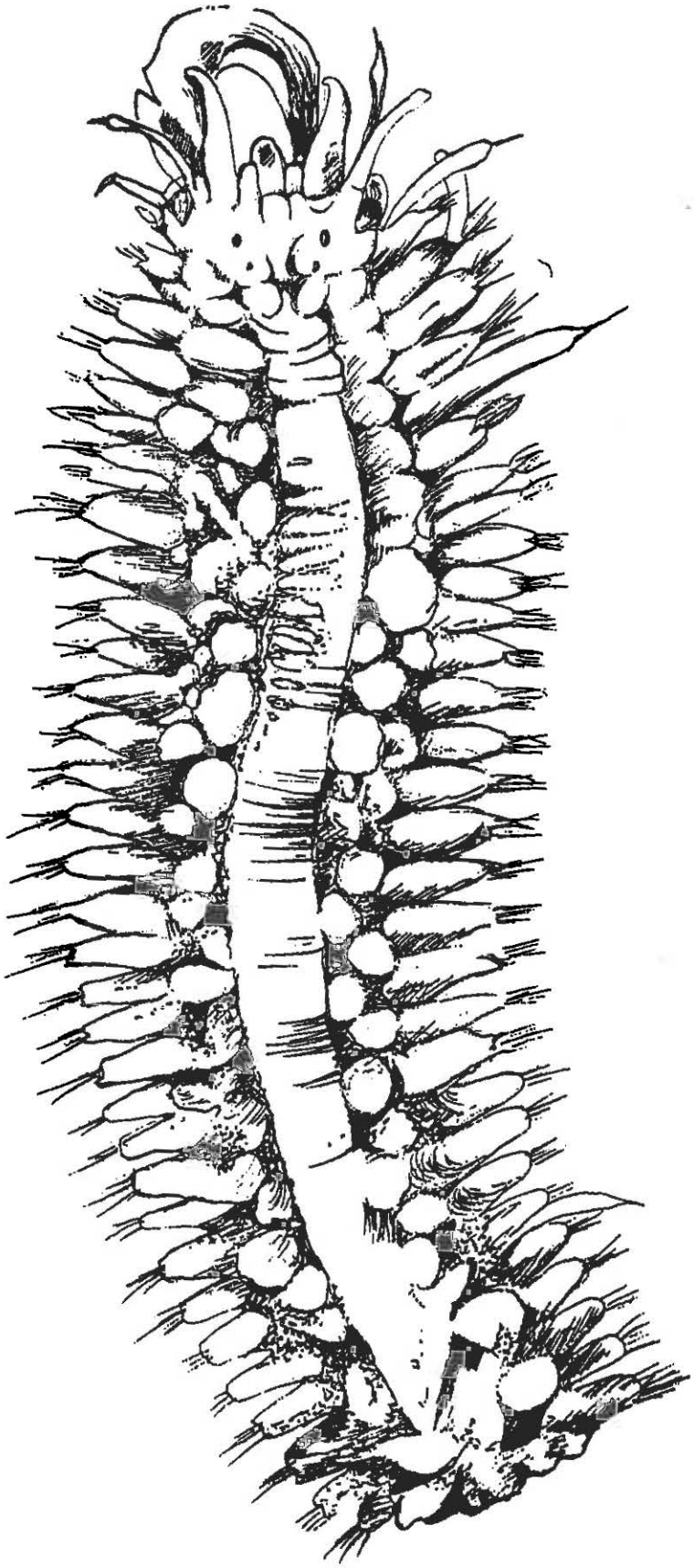


PLATE 11

P Annelida
C Polychaeta
F Phyllodocidae
G *Phyllodoce malmgreni*

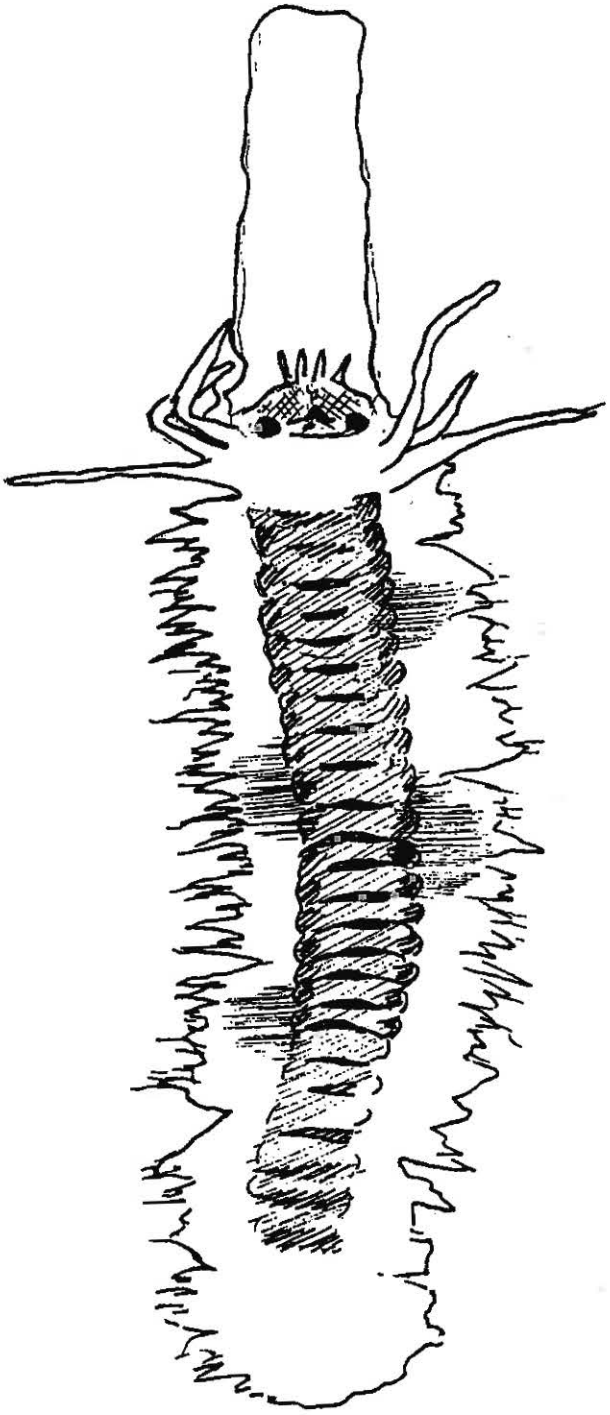


PLATE 12

P. Crustacea
C. Malacostraca
O. Isopoda

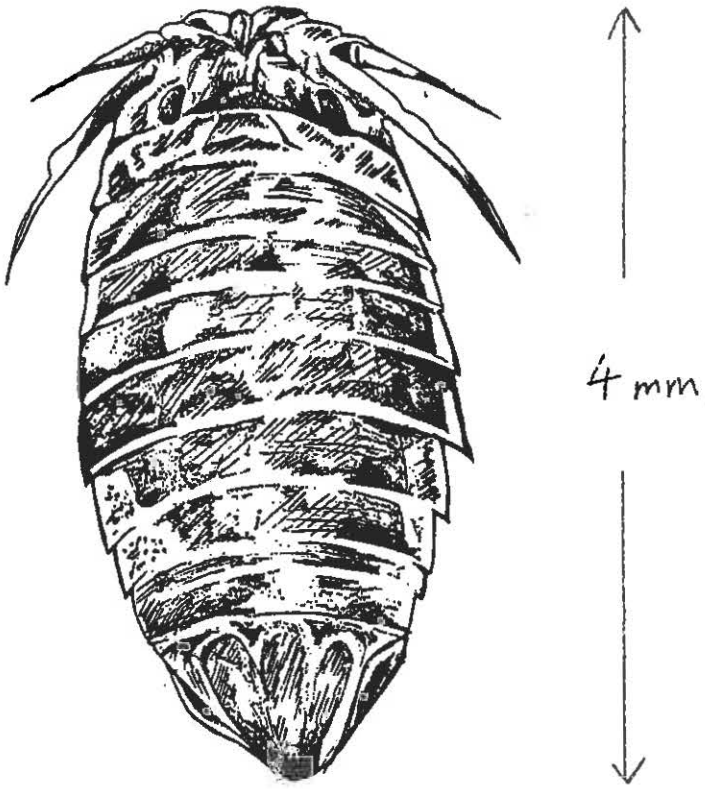


PLATE 13

P. Crustacea
C. Malacostraca
O. Brachyura
F. Majidae

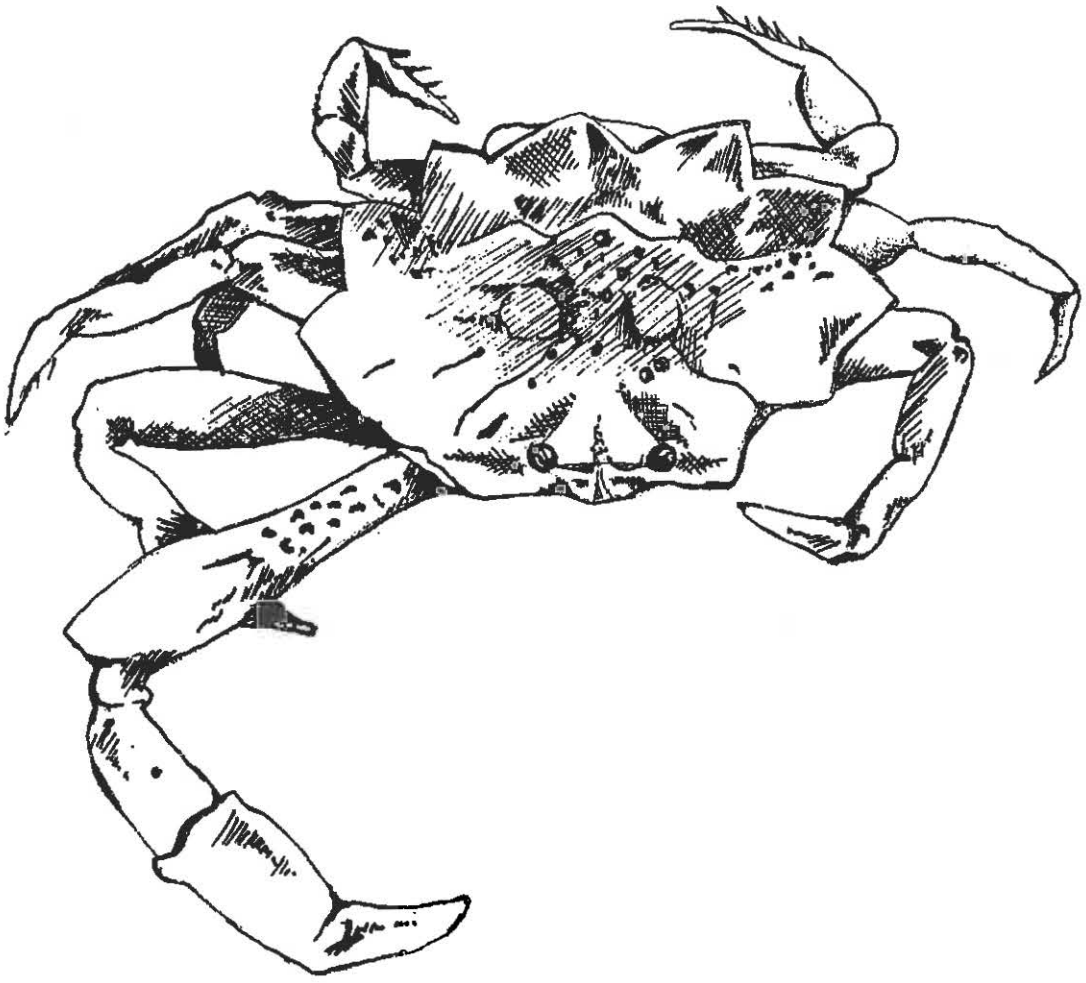
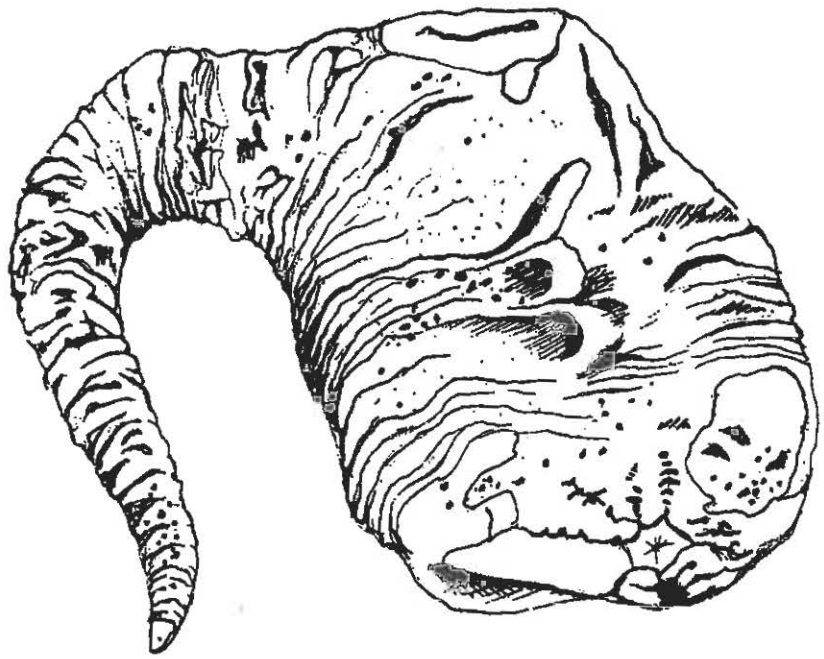


PLATE 14

P. Sipuncula



APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	ONE		TWO		THREE		FOUR	
GASTROPODA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Acrilla acumunala	1							
Atys cylindricus	102	26	21	31	1			4
Bedeva (padaei)				1	2	5	1	2
Bedeva hanleyi								1
C. Gastropoda 3			2	1				
C. Gastropoda 8	1	1						
C. Gastropoda 10			14					1
C. Gastropoda 14	54	12	37	35	1			3
C. Gastropoda 15							1	
C. Gastropoda 20	33	2	10	10			5	11
C. Gastropoda 23			1					
C. Gastropoda 37	13	1	6					
C. Gastropoda 38			2					
C. Gastropoda 42			4					
C. Gastropoda 43			6	1	30	1	14	40
C. Gastropoda 46			5		7	1	6	4
C. Gastropoda 48	1		1	3			2	
C. Gastropoda 51			2		1		1	
C. Gastropoda 54	35		4	1		1	1	
C. Gastropoda 55			3		5	1	1	2
C. Gastropoda 61		1						
C. Gastropoda 63					57		8	28
C. Gastropoda 65				1				
C. Gastropoda 69	1							
C. Gastropoda 71							1	1
C. Gastropoda 83								1
C. Gastropoda 84	1				4			
C. Gastropoda 85	1							
C. Gastropoda 86		1						3
C. Gastropoda 87		2						
C. Gastopoda 88			1					1
C. Gastropoda 91			1	1	2			3
C. Gastropoda 92					1		2	3
C. Gastropoda 94								1
Chicoreus teretus					1		1	1
Cyclichna sp.			2	6		1	2	1
Cyclsostremiscus sp. 1	65	15	30	10	2		1	1
Cyclostremiscus sp. 2			10	2	1			
Cylcostremiscus sp. 3			1					
Epitonium sp. 1			6					
Epitonium sp. 2	4		1		11	1	9	26
Epitonium sp. 4	41	4	19	9	3			
Ergalatax sp.	1							
Euchelus atratus			1	1	3		3	3
F. Aceonidae			1					
F. Archeogastropoda								2
F. Cypraeidae					1			
F. Muricidae							1	
F. Muricidae 2						2	1	2
F. Naticidae							1	
F. Neritidae			3	1				
F. Neritidae 2			1					
F. Pyramidellidae 1			1			1		

APPENDIX 1 : cont.

F. Pyramidellidae 2	1							
F. Pyramidellidae 3								3
F. Pyramidellidae 4			6		37		10	35
F. Trochidae 10					12			
F. Turbinidae 1								2
F. Turbinidae 2					3	1		2
F. Turbinidae 3								8
F. Turridae 1	2							
F. Turridae 2								1
F. Turritellidae 1			1					1
F. Vermetidae				2	5	3	1	
Fusinus sp.							2	1
Gyrineum jacundum					1		1	1
Lochyrma sulcifera	3		12	3	5		2	8
Nassarius sp.	211	29	93	94	4		1	6
Natica euzona	2							
Phenacovolva angusi					1			
Plicarcularia burchardi			1					
Polinices sp.			1		1			
Pupa solidula/fumata			1					
Pyrene sp.			4		88	9	38	96
Ringicula sp.	22	63	39	27				1
Syrnola sp.	32	11	19	20	4		1	3
Thalotia sp. 1			1					2
Turritella sp.			3		20		3	5
TOTAL GASTROPODA	627	168	377	260	314	25	121	320

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	ONE		TWO		THREE		FOUR	
BIVALVES	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Aloidis hyropica	1		2		1			
Antigona materna					3	1		
Arca tortuosa					1	1		2
Azorinus sp.	2							
C. Bivalvia 18			1					
C. Bivalvia 19	1							
C. Bivalvia 20	1							
C. Bivalvia 21	1						1	1
C. Bivalvia 23		1						
C. Bivalvia 24							1	
C. Bivalvia 25							3	6
C. Bivalvia 26						1	2	
Cardita incrassala	2				1			1
Cardita sp.	5		4	2	10		2	1
Corbula sp.					25	21	10	20
Corbula sulcata	2							
F. Arcidae							1	2
F. Cuspidaridae	13	5	4	8				
F. Myochamidae	21	3	9	6				
F. Nuculanidae	2							
F. Pectinidae					8	31	33	47
F. Solecurtidae	1				1			
Gari anomala	3	10						
Limaria sp.						1		
Mactra abbreviata	10	2	12	2				
Modiolus sp.								2
Paphies (cunata)	2	1	2					
Pectin sp.					1			3
Pharelli wardi	1							
Pitar trevori		2						
Placamen tiara	2			3		4	4	2
Semele petalina	3							
Semele sp. 1	75	16	55	15	1		4	
Soletellina sp.	1							
Strigilla euronia			1					
Tellina sp. 2	2							
Tellina sp. 3	5		3	4				
Tellina sp. 4	1							
Tellina sp. 5	2	1						
Tellina sp. 6				2				
Volachlamys singaporinus						1		
TOTAL BIVALVIA	159	41	93	42	52	61	61	87

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	ONE		TWO		THREE		FOUR	
POLYCHAETES	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Branchiomma nigromaculata							1	
Diopatra (dentata)				1				
Eumida (sanguinea)							1	
Eunice (vittata)					6	3	13	2
Eunice sp. 1	3		2	1				1
Eunice sp. 4							3	1
Eunice sp. 5								2
Eupanthalis sp.	1	1						
F. Acrocirridae	1							
F. Ampharetidae								2
F. Arabellidae					1			
F. Capitellidae 3	3							
F. Capitellidae 4	1							
F. Dorvillidae	2							
F. Flabelligeridae						1		
F. Goniadidae							2	3
F. Hesionidae 1								
F. Maldanidae 1	17		1	1			5	
F. Maldanidae 2	1						5	3
F. Maldanidae 3			1			2		
F. Maldanidae 4			1					
F. Maldanidae 5				1				
F. Nereidae 4							1	
F. Phyllodocidae							1	
F. Pilargidae	2	1				1		
F. Sabellidae 2			2	2				
F. Sabellidae 5					4	1	8	
F. Sabellidae 7							1	
F. Sabellidae 8							1	
F. Sabellidae 9							1	
F. Sigalionidae	1	2	5	6		2		
F. Spionidae 1	1	2	1	1		1		
F. Spionidae 2	1	1				1		
F. Spionidae 3	1							
F. Spionidae 4	20	3	2	1		2		
F. Syllidae 1							1	
F. Syllidae 2							2	
F. Trichobranchidae			9	2				
Glycera sp.			1					
Lumbrineris sp. 1	1	1						
Lumbrineris sp. 2				1		1		1
Lumbrineris sp. 3			1			1	2	1
Nematonereis unicornis					1		1	1
Nephtys sp.			1	1				
Nothria sp.							3	2
Notomastus sp. 1	1							
Notomastus sp. 2	1							
Notomastus sp. 3			1				1	
Ophelina sp.							5	
Sternaspis scutata	14	3	11	8				
TOTAL POLYCHAETA	72	14	39	26	12	16	58	19

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	ONE		TWO		THREE		FOUR	
CRUSTACEANS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Alpheus nr pacificus								3
Atylus falcatus						2		1
C. Malacostraca			1					
C. Ostracoda			1					
F. Dexaminidae							11	1
F. Pandalidae	1							
F. Xanthidae 1						1		
I. O. Caridea		1				1	1	
Macrobranchium intermedium				1				
Metapenaes sp.								
O. Amphipoda 1			1				2	
O. Amphipoda 2	2						1	
O. Amphipoda 3	1							
O. Anomura						1		2
O. Brachyura			1					
O. Cumacea							1	
O. Isopoda 1					3	3	1	
O. Tanaidacea 1			2		1	1	2	1
Ogyrides delli	2	4						
Panaeus merguiensis								1
Pontophilus sp.								1
Processa dimorpha								
S. O. Flabellifera					1			
TOTAL CRUSTACEA	6	5	6	1	5	9	19	10

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	ONE		TWO		THREE		FOUR	
MISCELLANEOUS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
C. Anthozoa 1	3	1	1					
C. Asteroidea		1				1	1	
C. Holothuroidea 2							1	
C. Holothuroidea 3					1			
C. Oligochaeta	2							
C. Ophiuroidea 1	1	1			3		6	4
C. Ophiuroidea 10							2	
C. Ophiuroidea 11							1	
C. Ophiuroidea 12						1		
C. Ophiuroidea 2		1						
C. Ophiuroidea 5		1	2	3			1	
C. Polyplacophora 2							2	
Caberea sp.					1	1		1
Cellanthus sp.	1		23	1	2	1		
Dentalium javaunum	2			1				
Dentalium sp.	41	6	17	18				
Extruded molluscs	4			1				
F. Gobiidae	1							
Halophila spinulosa								
Lytocarpus phillipinnus						1	1	
O. Archaeogastropoda							1	
O. Ascidiacea 1					4	40	8	5
O. Ascidiacea 2					1		3	
O. Cylcostomata							1	
O. Foraminifera	237	22	93	101	1			
O. Polycladida			2			1		
O. Polyplacophora 1					1		1	
P. Nematoda								1
P. Nemertea	4					1		
P. Porifera 1						6	2	
P. Sipuncula								
S. O. Anasca					1			
Trypauchen microcephalus	1			2				
Unknown specimens	1	2	1	1	4		8	
TOTAL MISCELLANEOUS	298	35	139	128	19	53	39	11
TOTAL NO. ORGANISMS	1162	263	654	457	402	164	298	447

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FIVE		SIX		SEVEN		EIGHT	
GASTROPODS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Atys cylindricus	17	11	14	37	2	4		3
Austrocochlea obtusa				1				
Bedeva (padaei)	3	17	22	16	1			1
Bedeva hanleyi			10	9	1	1	2	1
C. Gastropoda 10		3	1					
C. Gastropoda 100			3	2				
C. Gastropoda 101			1					
C. Gastropoda 102					1			
C. Gastropoda 103				8				
C. Gastropoda 104				2				
C. Gastropoda 105				1				
C. Gastropoda 106				3				
C. Gastropoda 14	26	25	31	13	3	5	5	8
C. Gastropoda 15		29	28	25				1
C. Gastropoda 20	2	242	455	272	44	29	46	69
C. Gastropoda 23	1	2	1					
C. Gastropoda 25		3	9	2				1
C. Gastropoda 3	1	8	1	1				
C. Gastropoda 33		22	11	3				
C. Gastropoda 38		3	6	7			1	1
C. Gastropoda 42	2	7	33	20		1		5
C. Gastropoda 43	3	160	246	190	33	20	35	53
C. Gastropoda 46	9	60	98	89	2	22	7	24
C. Gastropoda 48	2	3	3	9	8		10	
C. Gastropoda 51	3	29	26	12		1	8	9
C. Gastropoda 54	2	1						
C. Gastropoda 55	3	34	52	53	12	6		13
C. Gastropoda 58		4	10	19		2	1	1
C. Gastropoda 61	1							
C. Gastropoda 63	4	30	36	34	43	15	17	12
C. Gastropoda 65		1						
C. Gastropoda 66			2					
C. Gastropoda 67		2	1					
C. Gastropoda 68			5					
C. Gastropoda 69	6	23	23	12			2	
C. Gastropoda 71	1	9	24	17	1	1	2	
C. Gastropoda 72		3	2	4				
C. Gastropoda 76		8	4	3			1	
C. Gastropoda 77		1	3		1			1
C. Gastropoda 78		1	7	3	1	1	2	1
C. Gastropoda 8		1	4	3				1
C. Gastropoda 80			5	1				
C. Gastropoda 83	2	10				1	1	
C. Gastropoda 88		14	24	20	1	1	1	2
C. Gastropoda 91	1	7	3					
C. Gastropoda 92		32	50	24	4	1	4	5
C. Gastropoda 94	1	4	7	13	2	2	2	1
C. Gastropoda 95	2	26	30	32	1	3		
C. Gastropoda 96		8	5	10				
C. Gastropoda 97		6	9	3		1	1	1
C. Gastropoda 98		2	1	1				
C. Gastropoda 98			3	6	1			2
C.Gastropoda 107						1		
Chicoreus teretus		3	21	4	1			1

Cyclichna sp.		5						
Cyclostremiscus sp. 2	3	11	9	7				2
Cyclostremiscus sp. 3		3	1	2	1			
Cylcostremiscus sp. 1	27	22	34	22		1	2	2
Epitonium sp. 1		14	61	6	2			
Epitonium sp. 2	3	12	12	23	13	7	8	4
Epitonium sp. 3		8	1	18		2	3	10
Epitonium sp. 4	39	37	58	60	2	2	5	15
Ergalatax sp.		5	4	6			1	5
Euchelus atratus	19	20	21	16	3	4	1	5
F. Buccinidae 1		1						
F. Cypraeidae						2	1	
F. Fissurellidae						1		
F. Muricidae 1		5	10	2		1		3
F. Muricidae 2			2	5	2	1		6
F. Neritidae 1							1	
F. Pyramidellidae 1		3	8	1	7			11
F. Pyramidellidae 2								
F. Pyramidellidae 3		3	6	4	3		3	3
F. Pyramidellidae 4	7	66	67	83	21	9	25	26
F. Trochidae 1			3	3				
F. Trochidae 10		4						
F. Trochidae 2		1					1	
F. Turbinidae 1		1				2	2	3
F. Turbinidae 2	2	5	2	4		1	2	1
F. Turbinidae 3				1				
F. Turbinidae 4	1							
F. Turridae 1		3	2					
F. Turridae 2		1	3			2		
F. Turridae 3		3	9	4		1		
F. Vermetidae 1				3	2	1	3	
Fusinus sp.				1				1
Gyrineum jacundum		11	7	10				
Lochryma sulcifera	13	107	84	86	4	1	1	8
Nassarius dorsatus						1		1
Nassarius sp.	139	213	225	88	6	9	7	11
Natica euzona	8		5	1				
Phenacovolva angusi		1	3					1
Plicarcularia burchardi	1	1						
Polinices sp.	12	8	7	9			3	1
Pupa solidula/fumata		1						
Pyrene (propinqua)						1		
Pyrene sp.	6	224	284	191	79	42	50	33
Ringicula sp.	7	7	8	5				
Syrnola sp.	43	171	230	147	5	4	6	20
Thalotia chlorostoma		7				1		
Thalotia marginata		1						
Thalotia sp. 1	3	2	15	4	3	4	2	5
Trigonostoma obliquata		2						
Turritella sp. 1	41	23	9	2	2	1	1	
Turritella sp. 3			31	31	9	6	9	8
TOTAL GASTROPODA	761	2147	2828	2113	615	520	578	685

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FIVE		SIX		SEVEN		EIGHT	
BIVALVIA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Aloidis hydropica	4	2	1	1		7		2
Anodontia omissa								1
Antigona materna				2	1	2		1
Arca tortuosa	1	1				1		2
C. Bivalvia 18		1						
C. Bivalvia 25	6	1						1
C. Bivalvia 26	3			1				
C. Bivalvia 27			2	1	1			
C. Bivalvia 28							1	2
Cardita incrassala				4				1
Cardita sp.	9	38	50	22	3	2	1	12
Corbula sp.	5	9	2	13	14	12	12	1
Corbula sulcata	2	1		4	3	2	9	1
F. Arcidae						1	4	
F. Cuspidaridae 1	7		1					
F. Myochamidae	8	1	1	3				
F. Pectinidae	12	5	6	25	12	1	4	1
F. Semelidae					4	3	3	2
F. Solecurtidae	3			1				
F. Tellinidae 3	3							
Gari anomala		1						
Limaria sp.						2		
Mactra abbreviata	1						2	
Modiolus sp.								1
Paphia undulata	1			1		1		
Paphies cunata	1							
Paphies heterodon				6				1
Pectin sp. 1		6						
Pharella wardi				1				
Placamen tiara	5	1	1	11	3		1	
Semele sp.	66	3	3		1			
Soletellina sp.	3							
Tellina sp. 1	1		2					
Tellina sp. 2			2					
Tellina sp. 3	2		1		1			
Tellina sp. 4								
Tellina sp. 5	4							
Volachlamys singaporinus		2						
TOTAL BIVALVIA	147	72	72	94	42	32	37	28

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FIVE		SIX		SEVEN		EIGHT	
POLYCHAETA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Armandia sp.	1		1					
Branchiomma nigromaculata			1					
Dasybranchus sp.			1					
Diopatra dentata		1						
Eunice (vittata)	3	1	17	2	1			
Eunice sp. 1	13		1					
Eunice sp. 2			3					
Eunice sp. 4					6			4
Eunice sp. 5		2			6			
Eupanthalis sp.	1							
F. Aphroditae							1	
F. Arabellidae 1					8			
F. Capitellidae 1			1		2			
F. Capitellidae 2			3		1			
F. Goniadidae 1	1			2				
F. Hesionidae 2					2			
F. Maldanidae 1		1	9	7				
F. Maldanidae 2	6		3	11				
F. Maldanidae 3					1			
F. Maldanidae 5			1					
F. Maldanidae 6			6		1			
F. Nereidae 1	1							
F. Nereidae 4					2			
F. Nereididae 5					2			
F. Orbiinidae 1			3		2			
F. Paraonidae			1					
F. Polynoidae 2					2			
F. Sabellaridae 1					1			
F. Sabellidae 1		1						
F. Sabellidae 2		1						
F. Sabellidae 3		2						
F. Sabellidae 4		1			1			
F. Sabellidae 5	6		3		7			
F. Sabellidae 7					2			
F. Sabellidae 9					1			
F. Serpulidae			1		4			
F. Spionidae 1			2					
F. Spionidae 2	1		11	1				
F. Spionidae 3								
F. Spionidae 4	1	1	3					
F. Syllidae 1	1		1		1			
F. Syllidae 2			1		1			
F. Trichobranchidae	1	2	5					
Glycera sp. 1	1	1	6					
Haploscoloplos sp. 1			2					
Lumbrineris sp. 1		1	6					
Lumbrineris sp. 2			10					
Lumbrineris sp. 3	4		2		2			
Marphysa sp. 1			1					
Marphysa sp. 3	1							
Nematonereis unicornis					1			
Nephtys sp.1	7		5					
Nothria sp.	1				1			
Notomastus sp. 2		1	1					

Notomastus sp. 3			2					
Orseis sp.					1			
Pseudoscalibregma sp.			1					
S. F. Ampheretinae 1	1				1			
Sternaspis scutata		1						
TOTAL POLYCHAETA	51	17	114	23	58	0	1	4

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FIVE		SIX		SEVEN		EIGHT	
CRUSTACEANS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Alpheus nr pacificus		1	1	8		8	2	
Atylus falcatus	1			8	2		6	2
C. Remipedia				1				
F. Dexaminidae	3		1		13	2	1	4
F. Majidae 1					1	2		
F. Majidae 3				1				
I.O. Caridea			4	16	4	6	54	2
Macrobranchium intermedium				1				
Metapenaenus sp.				1				
O. Amphipoda 1	1							
O. Amphipoda 3			1		3	1	1	
O. Amphipoda 4				6		7	5	2
O. Cumacea			5				1	
O. Isopoda 1	1		1		4			
O. Isopoda 2					5		1	
O. Tanaidacea 1			2	14	3	5	19	2
O. Tanaidacea 2				9	1	8	3	1
O. Xanthidae 1				1				
O. Xanthidae 2						1		
O.Amphipoda 2			4	1	7	2		
Penaeus meguiensis								1
S. O. Caprellidae							1	
S. O. Flabellifera			1	12		1	1	
TOTAL CRUSTACEA	6	1	20	79	43	43	95	14
TOTAL NO. ORGANISMS	1182	2251	3054	2372	810	663	788	776

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FIVE		SIX		SEVEN		EIGHT	
MISCELLANEOUS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
C. Anthozoa 1	5					1		
C. Anthozoa 2							2	
C. Ascidiacea 1	6	1	2	2	23	14	5	25
C. Ascidiacea 2			2	1	2	2	1	2
C. Holothuroidea 3	3			1				
C. Ophiuroidea 1	2	2		6	3	12	5	
C. Ophiuroidea 10		1		2	5		5	
C. Ophiuroidea 11			1	3		2		
C. Ophiuroidea 12		1		1		4	4	
C. Ophiuroidea 13				1				
C. Ophiuroidea 14	2	1	1		4		1	
C. Ophiuroidea 14							1	
C. Ophiuroidea 15				16		3	3	
C. Ophiuroidea 2				1				
C. Ophiuroidea 3				1				
C. Ophiuroidea 4						1	8	2
C. Ophiuroidea 5				9		16	22	3
C. Ophiuroidea 6	5		1	2			2	
C. Ophiuroidea 8				1				
C. Ophiuroidea 9	2							
C. Polyplacophora 1					1			1
C. Polyplacophora 2				2				
Caberea sp.	1							
Cellanthus sp.	1			8		3	7	5
Dentalium javanum	1		3					
Dentalium sp.	12	2	4	1				
Endeis straughani						2	3	
Lytocarpus phillipinnus					1	1	1	
O. Cyclostomata	1		1	1				
O. Foraminifera	177							
O. Gobiidae		1	2	2		1	1	
O. Gorgonacea 1						1	1	
P. Bryozoa 2	1	1	1	1	1		1	1
P. Bryozoa 3		1		1	1	1	1	1
P. Bryozoa 4						1	1	
P. Porifera 1		1	1		4			4
P. Porifera 2	1				7	1	1	
P. Porifera 3						1		
S. O. Anasca			1	1		1	1	1
Trypauchen microcephalus		2						
TOTAL MISCELLANEOUS	217	14	20	63	52	68	77	45

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	NINE		TEN		ELEVEN	
GASTROPODA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Euchelus atratus	6	5	1	15	11	
Acrilla acumunala	1					
Atys cylindricus	15	6	18	15	10	
Austrocochlea obtusa		4		1	2	
Bedeva hanleyi		1				
Bedeva padaei			1	3		
C. Gastropoda 10		501		48	3	
C. Gastropoda 100			4			
C. Gastropoda 101					3	
C. Gastropoda 102					1	
C. Gastropoda 103	2				1	
C. Gastropoda 104	1	3				
C. Gastropoda 106	1				34	
C. Gastropoda 108	1					
C. Gastropoda 110		4				
C. Gastropoda 111					1	
C. Gastropoda 112					6	
C. Gastropoda 113					5	
C. Gastropoda 113					1	
C. Gastropoda 114					1	
C. Gastropoda 115					11	
C. Gastropoda 117					1	
C. Gastropoda 14		97	5	33	13	
C. Gastropoda 15	8		2	48		
C. Gastropoda 16					6	
C. Gastropoda 20	88	178	49	200	32	
C. Gastropoda 23		6		5	4	
C. Gastropoda 25	1			16	3	
C. Gastropoda 29	1					
C. Gastropoda 33				18	2	
C. Gastropoda 34					2	
C. Gastropoda 37					6	
C. Gastropoda 38	12	10		1	11	
C. Gastropoda 4		3				
C. Gastropoda 41		1			2	
C. Gastropoda 42	4		2	45	1	
C. Gastropoda 43	75	222	34	183	20	
C. Gastropoda 46	21	15	28	71	5	
C. Gastropoda 48	3	1	15	2	6	
C. Gastropoda 51	5	3	8	14	6	
C. Gastropoda 54				2		
C. Gastropoda 55	6	20	9		2	
C. Gastropoda 58				9	18	
C. Gastropoda 63	15	99	29	244	1	
C. Gastropoda 65						
C. Gastropoda 69	22		7	75	12	
C. Gastropoda 71	4		2	10	1	
C. Gastropoda 72	1					
C. Gastropoda 76				3		
C. Gastropoda 77	2		1	6	1	
C. Gastropoda 78			1	1		
C. Gastropoda 8	2	1		2	3	
C. Gastropoda 80	1		1	5	6	
C. Gastropoda 81					1	

C. Gastropoda 83	3		1	6		
C. Gastropoda 86		1			2	
C. Gastropoda 88	3	2	3	13	2	
C. Gastropoda 90		1				
C. Gastropoda 91		8	3	4		
C. Gastropoda 92	10	105	8	34		
C. Gastropoda 94	3	16	3	38		
C. Gastropoda 95	10	38	2	11	4	
C. Gastropoda 96		1		1		
C. Gastropoda 97	5	2	2			
C. Gastropoda 98	1		2			
Chicoreus teretus	3		5	2		
Cyclichna sp.		2		3	11	
Cyclostremiscus sp. 1	8	34	23	38	44	
Cyclostremiscus sp. 2		52	3	9	12	
Cyclostremiscus sp. 3		33		11	2	
Epitonium sp. 2	10	17	7	5	3	
Epitonium sp. 3	13	2	8	60	20	
Epitonium sp. 4	22	8	21	100	92	
Ergalatax sp.	8		1			
F. Architectonidae		3				
F. Muricidae 2	2	4				
F. Naticidae 1					1	
F. Neritidae		4			3	
F. Neritidae 1				2		
F. Neritidae 2					3	
F. Pyramidellidae 1		1		1		
F. Pyramidellidae 3		1	2	15	1	
F. Pyramidellidae 4	39	23	44	44	3	
F. Trochidae 1					1	
F. Turbinidae 2		1	2	5	4	
F. Turbinidae 4	1	10	2			
F. Turridae 1				4		
F. Turridae 2				2		
F. Turridae 3	1			7	2	
F. Vermetidae	1	3	2			
Fusinus sp.	1		3			
Gyrineum jacundum	1					
Lochryma sulcifera	25	17	4	60	8	
Nassarius dorsatus			2	14	3	
Nassarius sp.	17	17	12	679	59	
Natica euzona	1			5	1	
O. Archeogastropoda	1					
Plicarcularia burchardi		2	2	5	1	
Polinices sp.	3	2		3	5	
Pupa solidula/ fumata					3	
Pyrene sp.	57	17	105	108	4	
Ringicula sp.			2	30	38	
S. F. Patellacea		1				
Syrnola sp.	42	65	24	183	47	
Thalotia sp. 1	2	4	6	5	7	
Trigonostoma obliquata	1		2		3	
Turritella sp. 3	10	1	6	22	1	
TOTAL GASTROPODA	602	1678	529	2604	639	0

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS: DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	NINE		TEN		ELEVEN	
BIVALVIA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Aloidis hydropica	1	6		6	3	
Anodontia ornissa		1		1		
Antigona materna	1	1				
Arca tortuosa			4	2		
C. Bivalvia 21		3				
C. Bivalvia 23					3	
C. Bivalvia 25	2					
C. Bivalvia 26		1	1			
C. Bivalvia 29	2					
C. Bivalvia 30		2				
Cardita incrassala	2	2		16	1	
Cardita sp.	33	4	14	12	7	
Corbula sp.	15	7	3	1	3	
Corbula sulcata	2	4	4	1		
F. Arcidae		2		1		
F. Cuspidaridae				1		
F. Myochamidae		1		7	8	
F. Mytilidae		1		1		
F. Pectinidae	45		39			
F. Solecurtidae	9		3			
Limaria sp.		2	1			
Mactra abbreviata					36	
Modiolus sp.	1					
Paphia undulata		2		2		
Paphies heterodon	6	4	1			
Pharella wardi				1		
Placamen tiara	7		3	11		
Semele sp.		1		9		
Soletellina sp.					4	
Tellina sp. 1	1					
Tellina sp. 2				1		
Tellina sp. 4					3	
Tellina sp. 5	1		2			
Tellina sp.3				3		
TOTAL BIVALVIA	128	44	75	76	68	0

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS: DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	NINE		TEN		ELEVEN	
POLYCHAETES	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Armandia sp.	10	1	3			
Branchiomma nigromasculata	1		1			
Diopatra dentata	1					
Eunice (vittata)	7	2	9	8		
Eunice sp. 1	1			10	2	
Eunice sp. 2			2			
Eunice sp. 4		5				
Eunice sp. 5	2		1			
F. Amphinomidae	1		1			
F. Aphroditidae		1				
F. Arabellidae 1			1			
F. Dorvillidae 1					1	
F. Flabelligeridae	1					
F. Maldanidae 2	6		1			
F. Maldanidae 3			3	1	3	
F. Maldanidae 6			2	6		
F. Nereididae 1	3					
F. Nereididae 2			1			
F. Nereididae 4	3					
F. Nereididae 5	2	2	2			
F. Orbiniidae 1			2	2		
F. Paraonidae			1	1		
F. Polynoidae			1			
F. Sabellaridae 1				1	1	
F. Sabellidae 2	1					
F. Sabellidae 4			2			
F. Sabellidae 5	2		1		2	
F. Sabellidae 8			1			
F. Sabellidae 9	5					
F. Serpulidae 1	3	1				
F. Spionidae 2			2			
F. Syllidae 1	1					
F. Syllidae 2	7					
F. Trichobrachidae	1		2	49	1	
Glycera sp.	9		6	1	2	
Lumbrineris sp. 3			14	2	6	
Nephtys sp.					1	
Nothria sp.	1	2				
Notomastus sp. 2			1			
Notomastus sp. 3			1			
Ophelina sp.				1	3	
Phyllodoce malmgreni				1		
TOTAL POLYCHAETA	68	14	61	83	22	0

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS: DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	NINE		TEN		ELEVEN	
CRUSTACEA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Alpheus nr pacificus			1		1	
Alpheus richardsoni				1		
Atylus falcatus	8	1	14		1	
C. Cirripedia			1			
F. Dexaminidae	11	1	20			
F. Majidae 3	1					
I. O. Caridea	3	8	3	9	3	
O. Amphipoda 1	4					
O. Amphipoda 2	4		3			
O. Amphipoda 3	1					
O. Amphipoda 4	24	3	3			
O. Amphipoda 5		1				
O. Cumacea	9					
O. Isopoda 1	1					
O. Isopoda 2	1		2			
O. Isopoda 3			1	1		
O. Tanaidacea 1	4	15		2		
O. Tanaidacea 2	21		2	1		
S.O. Flabellifera	3	4	3			
TOTAL CRUSTACEA	95	33	53	14	5	0
TOTAL NO. ORGANISMS	962	1833	791	2806	881	149

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS: DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	NINE		TEN		ELEVEN	
MISCELLANEOUS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
C. Anthozoa 1				2		2
C. Anthozoa 3		1				
C. Ascidacea 1	7	4	34			
C. Ascidiacea 2	1	1	6			
C. Asteroidea 1	2		1			
C. Holothuroidea 2	1					
C. Ophiuroidea 1		12	6	4	5	
C. Ophiuroidea 10	2					
C. Ophiuroidea 11						1
C. Ophiuroidea 12	1					
C. Ophiuroidea 12	1	1				
C. Ophiuroidea 14		1				
C. Ophiuroidea 15	3		3			
C. Ophiuroidea 16		2				
C. Ophiuroidea 17		1				
C. Ophiuroidea 18				1		
C. Ophiuroidea 2		2				
C. Ophiuroidea 4	8					
C. Ophiuroidea 5	7	19	7		4	
C. Ophiuroidea 6		4				
C. Ophiuroidea 8						5
C. Ophiuroidea 9	14			5	5	
C. Polyplacophora 1	2		1			
C. Pycnogonida 1	1					
C. Pycnogonida 2	1	1				
C. Pycnogonida 3	1	1			1	
C. Pycnogonida 4		2				
Caberea sp.	1	1	1	1		
Cellanthus sp.	6	1	5		6	
Dentalium javaunum				1	3	1
Dentalium sp.		1		9	94	
Endeis straughani	2					
F. Gobiidae	1			1		
Lytocarpus phillipinnus	1	1		1		
O. Cyclostomata	1		1		1	
O. Foraminifera					26	135
O. Gorgonacea		1				
O. Gorgonacea 2		1				
P. Bryozoa 2		1	1			
P. Bryozoa 3	1	1	1			
P. Bryozoa 4		1				
P. Bryozoa 5		1	1	1		
P. Chordata					1	
P. Nematoda						1
P. Nemertea					1	1
P. Porifera 1	2		5	2		
P. Sipuncula 2						1
P. Sipuncula 3						1
P. Sipuncula 4						1
S. F. Phidoloporidae	1	1				
S. O. Anasca	1	1		1		
TOTAL MISCELLANEOUS	69	64	73	29	147	149

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FOURTEEN	
GASTROPODA	Nov-95	Apr-96
Atys cylindricus	20	
Bedeva padaei	2	
C. Gastropoda 10	3	
C. Gastropoda 14	142	
C. Gastropoda 15	1	
C. Gastropoda 20	4	
C. Gastropoda 23	1	
C. Gastropoda 24	1	
C. Gastropoda 25	1	
C. Gastropoda 3	3	
C. Gastropoda 8	15	
Cyclostremiscus sp. 3	1	
Epitonium sp. 1	1	
Epitonium sp. 2	1	
Epitonium sp. 3	5	
Epitonium sp. 4	23	
F. Pyramidellidae 1	1	
F. Pyramidellidae 3	9	
F. Trochidae 1	2	
F. Turridae 1	1	
Lochryma sulcifera	1	
Nassarius dorsatus	1	
Nassarius sp	153	
Pupa solidula/fumata	3	
Pyrene sp.	1	
Ringicula sp	32	
Syrnola sp.	11	
Trigonostoma obliquata	18	
Trigonostoma obliquata	1	
Turritella sp. 1	3	
TOTAL GASTROPODA	461	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FOURTEEN	
BIVALVIA	Nov-95	Apr-96
Gari anomala	42	
Laterna constricta	1	
Paphia undulata	5	
Pharella wardi	2	
Placamen tiara	4	
Tellina sp. 1	36	
Volachlamys singaporinus	5	
TOTAL BIVALVIA	95	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FOURTEEN	
MISCELLANEOUS	Nov-95	Apr-96
C. Holothuroidea 1	1	
C. Holothuroidea 2	5	
C. Oligochaeta 2	1	
C. Ophiuroidea 2	2	
C. Ophiuroidea 5	2	
C. Ophiuroidea 6	1	
O. Cheilostomata	1	
O. Cyclostomata	1	
P. Bryozoa	1	
P. Nemertea	1	
Trypauchen microcephalus	10	
TOTAL MISCELLANEOUS	26	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FOURTEEN	
CRUSTACEANS	Nov-95	Apr-96
F. Majidae	1	
Macrobranchium intermedium	8	
O. Isopoda	2	
O. Tanaidacea	2	
O. Xanthidae 1	1	
Ogyrides delli	2	
TOTAL CRUSTACEA	16	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	FOURTEEN	
POLYCHAETA	Nov-95	Apr-96
Antiobactrum sp.	1	
Diopatra dentata	10	
Eunice sp. 1	2	
Eupanthalis sp.	44	
F. Ampharetidae 2	1	
F. Nereididae 2	2	
F. Sabellidae 1	1	
F. Sabellidae 2	8	
F. Sigalionidae 1	1	
F. Spionidae 4	1	
F. Trichobranchidae	10	
Leiochrides sp. 2	1	
Lumbrineris sp.1	3	
Nephtys sp.	38	
TOTAL POLYCHAETA	115	
TOTAL NO. ORGANISMS	713	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	SEVENTEEN		EIGHTEEN		NINETEEN		TWENTY	
GASTROPODA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Acrilla acuminata	1				1			
Atys cylindricus	42		173		15		12	
Austrocochlea constricta	1							
Austrocochlea obtusa	1				7			
Bedeva hanleyi					3			
Bedeva sp.	1				24			
C. Gastropoda 10	304		335		96		12	
C. Gastropoda 14	580		1286		452		48	
C. Gastropoda 15			6		14			
C. Gastropoda 20	23		125		43		8	
C. Gastropoda 23	18		50		2			
C. Gastropoda 24	169		664					
C. Gastropoda 25	25		32		54		4	
C. Gastropoda 3	5		1		2		7	
C. Gastropoda 33			2		21		1	
C. Gastropoda 37	28		199		4		4	
C. Gastropoda 38	25		141		2			
C. Gastropoda 41	49						1	
C. Gastropoda 42	6		5		48		5	
C. Gastropoda 43	11				25			
C. Gastropoda 46					31		17	
C. Gastropoda 47			1		1			
C. Gastropoda 48			3		1		2	
C. Gastropoda 51			2		1		10	
C. Gastropoda 53					1			
C. Gastropoda 54			27				2	
C. Gastropoda 55					3			
C. Gastropoda 58					2		8	
C. Gastropoda 60					1			
C. Gastropoda 61					1			
C. Gastropoda 63			5		16		8	
C. Gastropoda 65					1			
C. Gastropoda 66					1			
C. Gastropoda 67					2			
C. Gastropoda 68					2			
C. Gastropoda 69					4			
C. Gastropoda 71					5			
C. Gastropoda 72					2			
C. Gastropoda 75			9					
C. Gastropoda 77			4		9			
C. Gastropoda 8	1							
Chicoreus teretus					2			
Cyclichna sp.					4		4	
Cyclostremiscus sp. 1	236		484		20		4	
Cyclostremiscus sp. 2	36		40		3		1	
Cyclostremiscus sp. 3	11		51		5			
Epitonium sp. 2	16		40		84		51	
Epitonium sp. 4	178		508		185		92	
Ergalatax sp.					1		1	
Euchelus atratus	1				18		10	
F. Muricidae 1					9			

F. Neritidae 1	177		344					
F. Pyramidellidae 1	10		12		3		2	
F. Pyramidellidae 3					1			
F. Pyramidellidae 4					30			
F. Trochidae 1	22		9		4			
F. Trochidae 10			4		25			
F. Trochidae 11			1		1			
F. Trochidae 3			3					
F. Trochidae 7	2							
F. Turridae 1			1		34		12	
F. Turridae 2	1				11			
F. Turridae 3	3				4			
Gyrineum jacundum					1			
Haminoea wallasi					1		1	
Lochryma sulcifera			3		24		3	
Nassarius dorsatus	4		8		24		17	
Nassarius sp.	182		283		268		316	
Plicarcularia burchardi	57		39		5			
Polinices sp.					19			
Pupa solidula / fumata			4		5		1	
Pyrene sp.	5		8		71		6	
Ringicula sp.	1184		1319		58		168	
Scaliformis trigonostoma					1			
Syrnola sp.	105		242		294		156	
Thalotia chlorostoma	11		7					
Thalotia marginata					1			
Thalotia sp. 1	2		1		22			
Trigonostoma obliquata					18		5	
Turritella sp. 1	1		63		36		18	
Turritella sp. 2					1			
TOTAL GASTROPODA	3534		6544		2189		1017	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	SEVENTEEN		EIGHTEEN		NINETEEN		TWENTY	
BIVALVIA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Aloidis hydropica	1		4		2		2	
Anodontia omissa	4		4					
Antigona materna					2		2	
Arca tortuosa					8		3	
C. Bivalvia 13			4					
C. Bivalvia 17					1			
Cardita incrassala							1	
Cardita sp.					83		26	
F. Arcidae							1	
F. Cuspidaridae			17		2		4	
F. Myochamidae	1		18		22		22	
F. Mytilidae					3			
F. Nuculanidae					6			
F. Tellinidae 1			3				3	
F. Tellinidae 2			3					
Gari anomala			1		1			
Limaria sp.					1		1	
Mactra abbreviata	3		11		4			
Modiolus sp.					2			
Paphia gallus					2			
Paphia undulata	2		2					
Paphies cunata	5		1					
Paphies heterdon							1	
Pectin sp.					1			
Pharella wardi							2	
Pitar trevori	3		2		2			
Placamen tiara			2		3		3	
Semele sp.	9		8		2		6	
Soletetellina petalina			1					
Strigilla euronia	6		1				1	
Tellina sp. 1	17		14					
Tellina sp. 2							5	
Tellina sp. 3							9	
Tellina sp. 4	3							
Tellina sp. 5					7			
TOTAL BIVALVIA	54		96		154		92	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	SEVENTEEN		EIGHTEEN		NINETEEN		TWENTY	
POLYCHAETA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Armandia sp.					7		3	
Dasybranchus sp. 1	1				1			
Diopatra (dentata)	2				5		16	
Eumida sanguinea							1	
Eunice sp. 1	5		7		1		3	
Eupanthalus sp.	6		2				1	
F. Ampharetidae					3			
F. Bogueidae	1							
F. Capitellidae 1					1			
F. Capitellidae 2	1							
F. Eunicidae					28			
F. Goniadidae 1	1						4	
F. Goniadidae 2			9		2			
F. Maldanidae 1	17		11					
F. Maldanidae 2			2					
F. Maldanidae 3			4					
F. Maldanidae 4			2					
F. Maldanidae 5	1				1		1	
F. Maldanidae 7	1							
F. Maldinidae 6					29		15	
F. Nereididae 4	1		1					
F. Orbiinidae					1		2	
F. Paraonidae	1							
F. Phyllodocidae					1			
F. Polynoidae					1			
F. Sabellidae 1					1		1	
F. Sabellidae 4	1				1			
F. Sabellidae 5	1				1			
F. Sacalibregmidae	4							
F. Sigalionidae			2					
F. Spionidae 4			2					
F. Trichobranchidae	1				2			
Glycera sp.	2		11		5		4	
Haploscloplos sp.	1							
Leiochrides sp.	2							
Leocratides filamentosa	1							
Lumbrineris sp. 1	1							
Lumbrineris sp. 2			1					
Lumbrineris sp. 3	2		10		7		6	
Marphysa sp. 2					1		2	
Nematoneris unicornis			2		2		2	
Nepthys sp.	3		9		9		7	
Nothria sp.					1			
Notomastus sp.	1							
Notomastus sp. 2					3		1	
Ophelina sp.	2				3		3	
Orseis sp.	1							
Phyllodoce malmgreni	2							
Pseudoscalibregma sp.					1			
S. F. Ampharetidae					5		1	
Scoloplos madagascariensis	1							
Sternaspis sp.			2					
TOTAL POLYCHAETA	64		77		123		73	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	SEVENTEEN		EIGHTEEN		NINETEEN		TWENTY	
CRUSTACEA	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
Alpheus nr pacificus					1			
Alpheus richardsoni					1			
Atylus falcatus			5		6		2	
F. Dexaminidae					9			
F. Majidae					1			
F. Panaeidae 2					1			
F. Pandalidae					1			
I.O. Caridea	2		2				4	
Latreutes pygmaeus			1					
Macrobranchium intermedium	1		2		1			
Metapenaeus sp.	1				1			
O. Amphipoda 1	1							
O. Amphipoda 2	15		1		8		10	
O. Amphipoda 4							1	
O. Decapoda 1					10			
O. Decapoda 2			1					
O. Isopoda	1		4		1		3	
O. Isopoda 3					2			
O. Tanaidacea 1			1		7		5	
Ogyrides delli			1					
Processa dimorpha	1				1			
S. O. Caprellidae					1		1	
S. O. Flabellifera							3	
TOTAL CRUSTACEA	22		18		52		29	

APPENDIX 1 : GLADSTONE PORT AUTHORITY BENTHIC SURVEY RESULTS:
DISTRIBUTION AND ABUNDANCE OF MACROFAUNAL SPECIES

	SEVENTEEN		EIGHTEEN		NINETEEN		TWENTY	
MISCELLANEOUS	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96	Nov-95	Apr-96
C. Holothuroidea 1	2		5					
C. Holothuroidea 2	1							
C. Holothuroidea 3					2			
C. Ophiuroidea 1					4			
C. Ophiuroidea 2							1	
Caberea sp.							1	
Cellanthus sp.	154		168		13			
Dentalium javanum							1	
Dentalium sp.					9		25	
F. Gobiidae			1				1	
Halophila spinulosa	1							
Lytocarpus phillipinnus					1			
O. Ascidiacea 1					41		5	
O. Ascidiacea 2					6		2	
O. Ceriantharia					16		3	
O. Cheilostomata					1			
O. Cyclostomata					1		1	
O. Foraminifera	6		2153		1			
P. Nemertea 1					2			
P. Porifera 1					8			
P. Sipuncula 1	1		2				2	
Trypauchen microcephalus	1							
TOTAL MISCELLANEOUS	166		2329		105		42	
TOTAL NO. ORGANISMS	3840		9064		2623		1253	

APPENDIX 2.1: Distribution of macrobenthic fauna - Gastropoda by survey station, Pitch Bay, South Trees 13.11.96

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS
C. GASTROPODA																					
F. Aceonidae 1			1																	1	2
F. Aceonidae 2			5		1							1	1	3		1	1	4	4		21
F.Aceonidae 3															1		5				6
Pupa solidula/fumala		2	6									1		1					3		13
Atys cylindricus					4		3		8	1	1		2	7	1				3		30
Cyclichna sp.	3	3																			6
Vexillum sp.																1					1
Pyrene sp.	17	4	1			1															23
Pyrene propinqua	1	1																			2
F. Cypraeidae	1																				1
Epitonium sp.1	5	7	13		2	2						1				2			1		33
Epitonium sp.2	1	4	3	5		1			1							1					16
Epitonium sp.3	1	1	5				3							3		2			3		18
Fusinus sp.		1																			1
F. Littorinidae	2	1	8	2		1			57	16	4	10	5	127	7	20	2	5	30		297
Lochryma sulcifera	3	6	3	1																	13
Marginella sp.			2																		2
Ergalatax sp.	1		1													1					3
Nassarius sp. 1	7	8	19		2	3									1	1	1			1	43
Nassarius sp. 2																1					1
Natica euzona							1				2	1	1	2	1	9	2	4	8	6	37
F. Neritidae 1			1		3		1		11	2	10	5	5	31	3	11		1	23		107
F. Neritidae 2																1					1
F. Pyramidellidae	6	5	1									1									13
Syrnola sp.	7	6	14			1	1					2				1			1		33
F. Potamididae															4	2	7	3	1		17
Ringicula sp.	4		10	2	1	2			2		4	2		1							28
F. Scaphandridae																1					1
F. Trochidae 1	1																				1
F. Trochidae 2			3								1					1			1		6
F. Trochidae 3			1															2			3
F. Trochidae 4			1																		1
F. Trochidae 5			1																		1
F. Trochidae 6																1					1
F. Trochidae 7																1					1
F. Trochidae 8																1					1
F. Trochidae 9																4					4
Turritella sp. 1	5	2	4													1					12
Turritella sp. 2		3	3											1		1					8
Cyclostremiscus sp. 1		2	6	1	2	3			2		3										19
Cyclostremiscus sp. 2														8	2	23	3	8		3	47
C. Gastropoda 1	6	2	4			1	1												1		15
C. Gastropoda 2	6	4										2									12
C. Gastropoda 3	4																				4
C. Gastropoda 4	1		1																		2
C. Gastropoda 5	2	2	2		2		1									1					10
C. Gastropoda 6	1		1																		2
C. Gastropoda 7	3	1	1			3															8
C. Gastropoda 8	2	1	2																		5

APPENDIX 2.1 Cont. Distribution of macrobenthic fauna - Gastropoda - by survey station, Pitch Bay, South Trees 13.11.96

C. Gastropoda 9	1				1														2
C. Gastropoda 10	2																		2
C. Gastropoda 11	1																		1
C. Gastropoda 12		1													1				2
C. Gastropoda 13		1																	1
C. Gastropoda 14		1	6															3	10
C. Gastopoda 15		3	2		2	3	5	1											16
C. Gastropoda 16		1	2																3
C. Gastropoda 17		2																	2
C. Gastropoda 18		1																	1
C. Gastropoda 19		1																	1
C. Gastropoda 20		1	4															1	6
C. Gastropoda 21			2		3				2				1		1			1	10
C. Gastropoda 22			2								2			2					6
C. Gastropoda 23			1			1													2
C. Gastropoda 24			5	1	1	1									3			1	12
C. Gastropoda 25			3		3		3		5		4	2	1	6	1	23	2	8	3	64
C. Gastropoda 26			1																1
C. Gastropoda 27			1	4															5
C. Gastropoda 28			1																1
C. Gastropoda 29			1	2	1								1						5
C. Gastropoda 30			1																1
C. Gastropoda 31			1																1
C. Gastropoda 32			7		1						3	1	5				1	20	38
C. Gastropoda 33			1							8									9
C. Gastropoda 34				1															1
C. Gastropoda 35							1		2										3
C. Gastropoda 36										2	1		2		5			4	14
C. Gastropoda 37														5	2	2		2	11
C. Gastropoda 38																		4	2	6
TOTAL GASTROPODA																				**1135**

APPENDIX 2.2: Distribution of macrobenthic fauna - Bivalvia, by survey station, Pitch Bay, South Trees 13.11.96

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS
C. BIVALVIA																					
Aloidis hydropica						2		1				1					3				7
F.Arcidae															1						1
Cardita sp.													1								1
Corbula sp.		2												1							3
Corbula sulcata	1																2				3
F.Pectinidae		1																			1
Semele sp.				2	2	4															8
Azorinus sp.							1	5	1						34	6	2		1		50
Tellina sp. 1									4			1	1	1	1						8
Tellina sp. 2												3	2					3			8
Pitar sp.															3						3
Placamen tiara		3																			3
C. Bivalvia 1	3																				3
C. Bivalvia 2	1	1	2		1			5								1					11
C. Bivalvia 3			1			1															2
C Bivalvia 4						3															3
C. Bivalvia 5											1										1
C. Bivalvia 6									7							5	5				17
C. Bivalvia 7																2	2				4
TOTAL BIVALVIA																					**129**

APPENDIX 2.3 : Distribution of macrobenthic fauna - Crustacea by survey satation, Pitch Bay South Trees 13.11.96

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS
P. CRUSTACEA																					
O. Amphipoda 1		1																			1
O. Amphipoda 2		1																			1
O.Amphipoda 3			1																		1
I.O. Anomura											2										2
Atylus falcatus	3																				3
I.O. Brachyura 1							2														2
I.O. Brachyura 2							1														1
I.O. Brachyura 3										1											1
I.O. Brachyura 4																2	1			1	4
O. Conchostraca	1			1																	2
O. Decapoda						1			7									7			15
F. Dexaminidae	5																				5
F.Majidae 1		1																			1
F.Majidae 2																	2				2
F. Mictrydae																				1	1
F. Penaeidae	1																				1
F.Portunidae										1											1
O.Tanaidacea			1			1												1			3
F.Xanthidae	2																				2
TOTAL CRUSTACEA																					**47**

APPENDIX 2.4 : Distribution of macrobenthic fauna - Polychaeta by survey station, Pitch Bay, South Trees 13.11.96

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS
C. POLYCHAETA																					
F. Capitellidae	5																				5
F. Cirratulidae					1																1
Eunice (vittata)?		2																			2
Marphysa sp.										1											1
Nematonereis unicornis	1																				1
Glycera sp.	2	1				1	1			1		1	3	1	4	1	2	2		1	21
F. Goniadidae			1	2	2						2		1								8
Lumbrineris sp. 1	3	1	1	1																	6
Lumbrineris sp. 2	1																				1
F. Maldanidae	2																				2
F. Nereididae													1	1		1					3
Diopatra (dentata)?	1			9																	10
F. Orbiniidae 1	1																				1
F. Orbiniidae 2			1	1		3															5
Ophelina sp.		1	1	1																	3
F. Phyllodocidae				1																	1
F. Polynoidae	1	1																			2
F. Sabellidae			1																		1
F. Spionidae 1		3	1	2		1															7
F. Spionidae 2						1															1
Sternaspis scutata						2		1	7					1							11
F. Terebellidae 1	2	1																			3
F. Terebellidae 2			1																		1
F. Trichobrachidae					1																1
C. Polychaeta	1																				1
TOTAL POLYCHAETA																					**49**

APPENDIX 2.5 : Distribution of macrobenthic fauna - Miscellaneous by survey station, Pitch Bay, South Trees 13.11.96

STATION NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTALS
MISCELLANOUS																					
C. Ascidiacea 1		1																			1
C. Ascidiacea 2		1																			1
C. Asteroidea		1																			1
Dentalium sp.	1		4	2	14	14					1	1							1		38
Dentalium javuanum		2	1			1															4
C. Echinoidea		1	1																		2
Cellanthus sp.	6	6	4									2							2		20
O. Foraminifera						1															1
F. Gobiidae																			1		1
C. Ophiuroidea 1	1	3																			4
C. Ophiuroidea 2	1																				1
C. Ophiuroidea 3	3		1																		4
C. Ophiuroidea 4					1																1
C. Pycnogonida 1		2	1																		3
C. Pycnogonida 2			1																		1
P. Sipuncula								1							5		5				11
Zostera sp.										P						P	P				
TOTAL MISC.																					**93**
TOTAL NO. ORGANISMS																					**1453**