

Final report to the Fisheries Industry Research Committee

Colonisation of New South Wales by  
non-indigenous marine species.

Baseline studies at Twofold Bay, New South Wales.  
(FIRTA 84 - 49)

The Australian Museum

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## SUMMARY

The baseline survey of Twofold Bay has been completed.

Seven sites were chosen to represent various habitats of the Bay and were sampled at intervals from September 1984 to December 1985. The habitats at each of the sites are described. Species lists of the fauna present at each site together with some indication of the frequency of occurrence and abundance of the animals are given in a series of appendices. Many of the animals collected represent new records for the area, or new species, and the species lists will continue to be updated as taxonomic revisions are undertaken by specialists. To date we have recorded a total of 608 taxa in the Bay, consisting of: 179 molluscs, 251 crustaceans, 121 polychaetes, 28 echinoderms and 29 taxa belonging to other phyla. Reference collections have been deposited at the Australian Museum and a list of major publications used in the identification of the fauna is given.

The survey has revealed the following exotic species; the ascidian Stylea plicata, the molluscs Theba pisana, Crassostrea gigas and the crustaceans Notomegabalanus algicola, Carcinus maenas and Eurylana arcuata. We discuss how these species may have been introduced into the Bay.

The fauna of the Bay is briefly compared to other areas in South East Australia.

An article on the preliminary results of the survey appeared in Australian Fisheries and a concluding article will be prepared for this publication. A detailed scientific paper summarising the finding of this survey is being prepared for publication in the Proceedings of the Linnean Society of New South Wales.

## RATIONALE - FOR UNDERTAKING THE SURVEY

In the late 1970's the New South Wales Department of Fisheries (now Division of Fisheries, Department of Agriculture) was funded by FIRTA (project No. 76/18) to study the transport of marine organisms in ballast water. The Fisheries project identified 16 non-indigenous species of invertebrates alive in the ballast water tanks (Williams *et al.*, 1982). Other invertebrate larvae were present, but could not be identified to species. Thus, it is uncertain whether they represented indigenous or exotic fauna.

The Department of Agriculture needed to establish if these species survived the discharge into the Bay and could establish breeding populations. If this occurred, it was essential to determine if they would pose any threats to the fishing industry in this region.

Previous introductions of non-indigenous marine species to an area (either on purpose or accidentally) have proved in some cases beneficial, in other cases harmful, while in some no apparent impact on the local fauna has been recorded.

Commercially successful introductions include trout and Atlantic Salmon to some river systems. However, other successful commercial introductions have caused problems because of the pests or diseases which were brought in with the required animal (Hutchings *et al.*, 1986). When the oyster Crassostrea virginica which was introduced to the Pacific coast of North America in 1870, the oyster drill Urosalpinx cinerea was unknowingly and simultaneously introduced. On the Pacific coast, without a natural predator, the oyster drill became well established and caused widespread mortality of oysters. The oyster drill was also introduced into Europe in this way when oysters were shipped there in the 1920's and according to Galtsoff (1964) oyster drills became the most widespread predator of oysters in Europe.

By contrast, documentation of species being introduced accidentally by the discharging of ballast water are sparse. Hoese (1973) has suggested that two species of Japanese gobies in Sydney Harbour may have been introduced in this way. Paxton and Hoese (1985) also suggested that this was the means by which the Japanese Sea Bass (Lateolabrax japonicus) was introduced into eastern Australia.

With the growing percentage of Australian shipping being carried by specialised container ships, an increasing amount of ballast water collected from outside Australia (and potentially carrying the larvae of non-indigenous fauna) is being discharged into Australian ports.

Therefore, the purpose of this study was to carry out an inventory of the benthic fauna of Twofold Bay, where it is known that non-indigenous fauna from ballast water has been discharged since the early seventies. The source of this ballast water is

almost exclusively from Japanese ports.

Ballast water is taken on board the woodchip container ships as the chips are offloaded. Small or larval stages of animals inhabiting estuarine or shallow protected bays are sucked up with the water as it is being pumped into the ballast tanks of the ships. The adults of such animals tend to live as encrusting organisms, or benthic organisms in soft sediments or as a component of seagrass communities. Thus, introductions are most likely to occur amongst the marine benthic fauna. However, the composition of these communities in Australian ports is poorly known.

For these reasons, sampling was restricted to the following habitats in Twofold Bay:

- (a) fouling communities on wharfs and piles;
- (b) seagrass communities at the mouth of rivers, and creeks;
- (c) soft bottom communities and intertidal encrusting fauna in shallow estuarine areas;
- (d) intertidal rocks around the loading wharf at the woodchip plant;
- (e) saltmarsh areas.

No attempt was made to sample the pelagic communities within the Bay.

#### DESCRIPTIONS OF HABITATS

Twofold Bay is situated on the far south coast of New South Wales (Lat.  $37^{\circ}05'S$ , Long.  $149^{\circ}54'E$ ). It is a large open bay, consisting of 3 smaller bays; Calle Calle, Nullica and East Boyd Bay (see Figures 1, 2). The headlands (and corresponding rock platforms) are of Devonian sedimentary formation. The beaches between them are mini-barrier dune systems which form Curalo Lagoon and are also evident at the mouth of Fisheries Creek, Towamba and Nullica Rivers. After a preliminary inspection was made of the various aquatic habitats within the Bay, 7 sites were chosen. The choice was based on the need to qualitatively sample the entire fauna (larger than 5mm in length) from as many of the habitats outlined above as possible.

Sampling Sites (see Table 1)

##### 1. Curalo Lagoon (Figure 3, Plate 4)

A shallow brackish water lagoon, behind the most northern beach in Twofold Bay, which was closed to the sea in July 1984 for a short period. It had an average salinity of 26.5 parts per

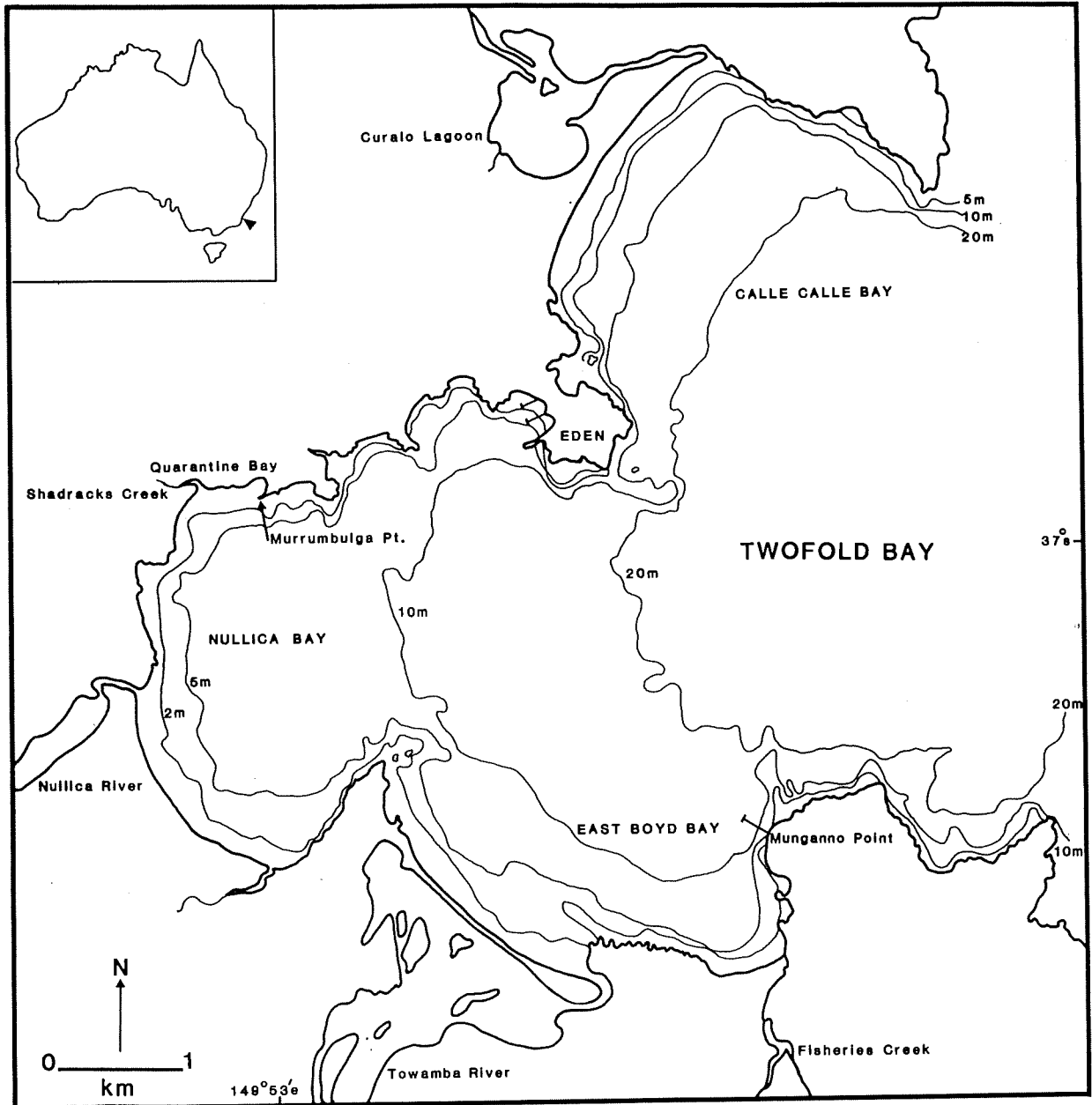


FIGURE 1. Map showing location of sampling sites within Twofold Bay

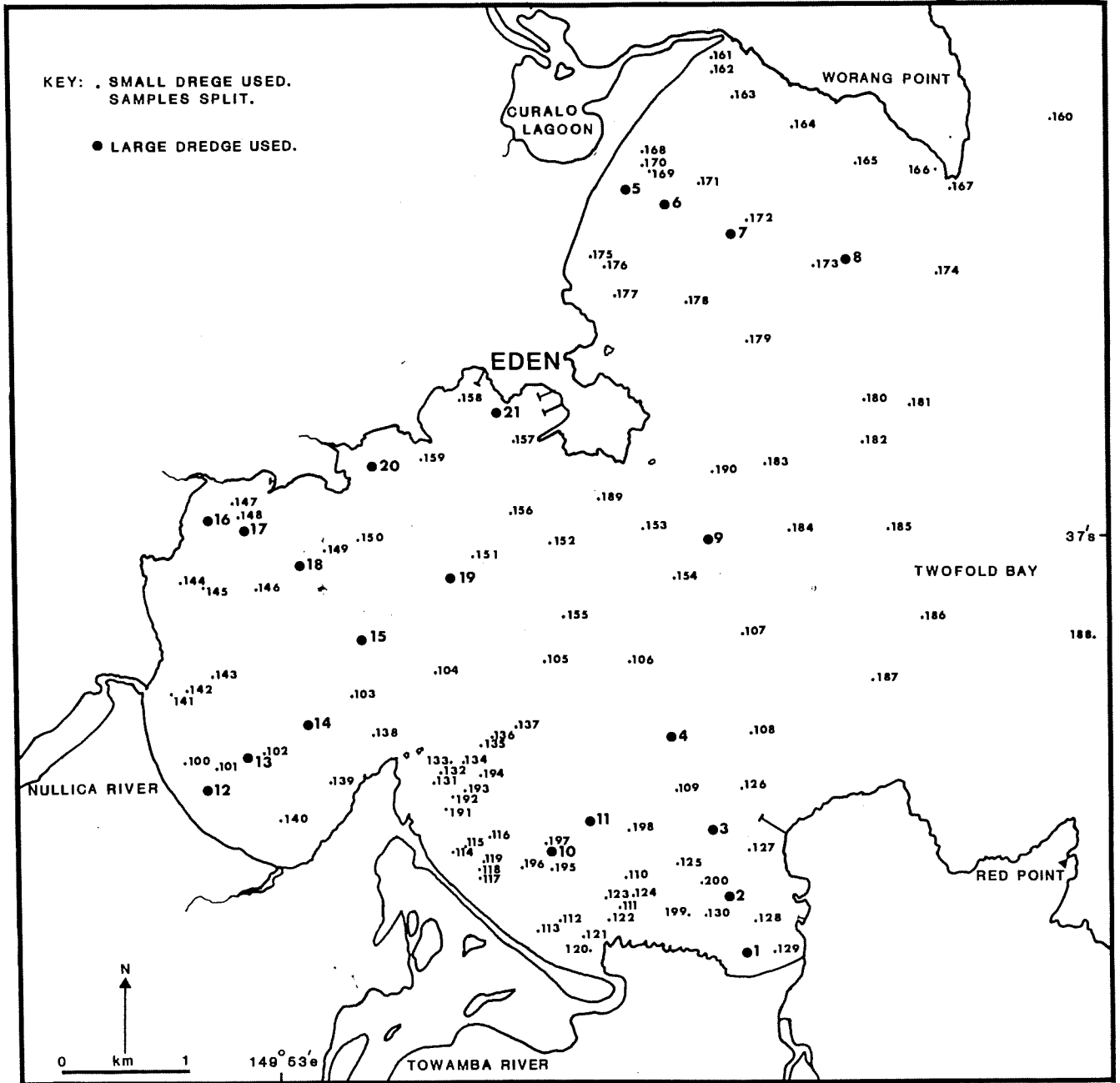


FIGURE 2. Location of 'deeper' water collection sites.  
(Map courtesy of the N.S.W. Geological Survey)



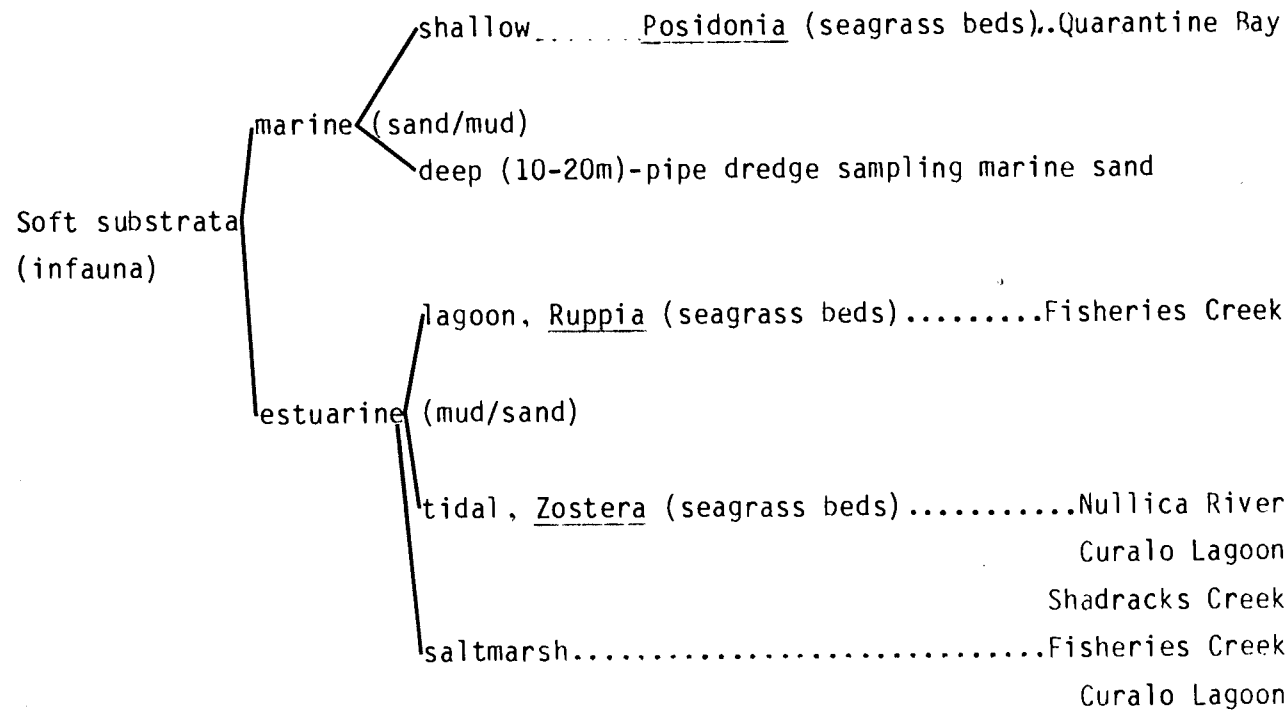
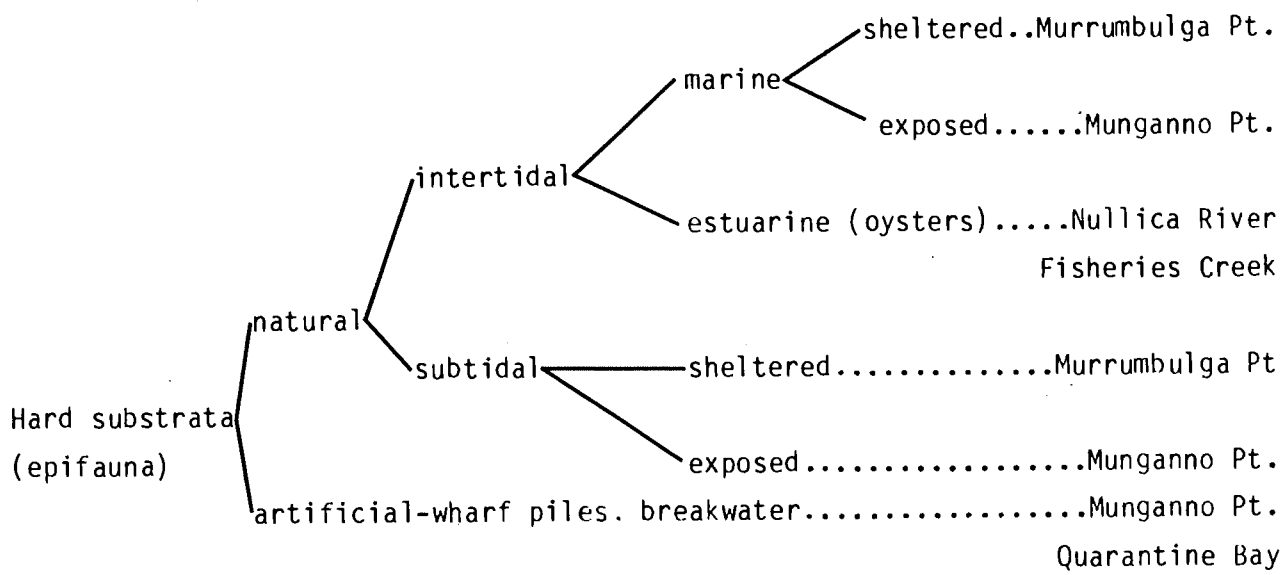


Table 1: A breakdown of the various types of habitats found at each site.

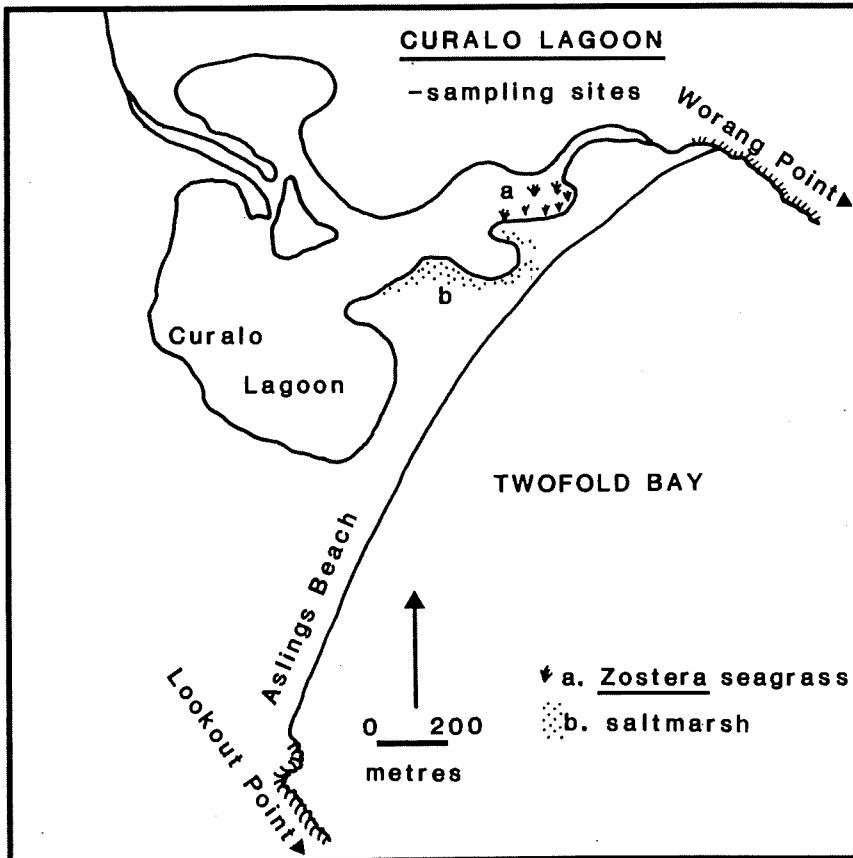


FIGURE 3. Location of collection sites at Curalo Lagoon.

thousand (range 20-32 parts per thousand).

The lake was near fresh in July 1984 with abundant Ruppia seagrass growing near the shores. The bar was breached between July and September 1984 and remained open to the sea at sampling for the rest of the survey. A patchy cover of Zostera seagrass replaced the Ruppia adjacent to the entrance. An extensive saltmarsh occurs on the eastern margin.

## 2. Murrumbulga Point (Figure 4, Plate 1).

A south-east facing 'sheltered' rocky shore with the intertidal rock platform approximately 15-20m wide. It has been eroded flat, with scattered rubble, boulders and sand at the north-eastern end. Zonation is not as apparent (as at Munganno Point) because of its more sheltered nature, gentle slope and numerous tidal pools.

The subtidal rock platform is a boulder strewn uneven 'platform' extending gradually to a depth of 9m. The boulders have a cover of kelp and other algae, while the crevices are dominated by sea urchins and encrusting red calcareous algae.

## 3. Quarantine Bay (Figure 4)

This bay is protected from heavy seas by a breakwater. Patchy Posidonia seagrass beds begin at approximately 2m depth between the rocks and sand. Encrusting and cryptic fauna were also collected from these rocks. The pylons of the recreational/public boating wharf were examined, as was the intertidal breakwater wall, but they lacked a rich fauna and were therefore not sampled.

## 4. Shadracks Creek (Figure 4)

A brackish tidal creek with sandy banks and Zostera seagrass growing on a rubble covered mud bottom forming a small lagoon behind Legges Beach.

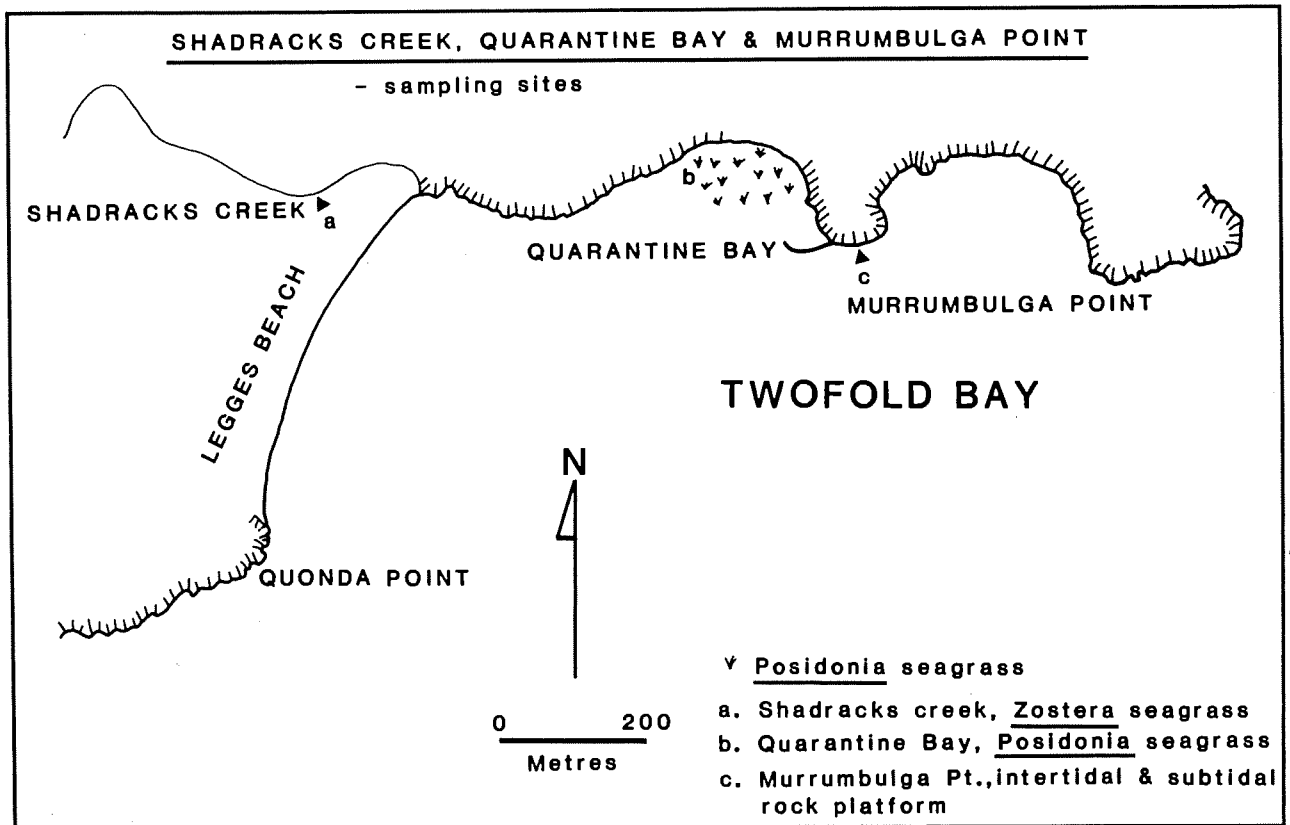
It had an average salinity of 14.5 parts per thousand (range 0-27 parts per thousand) and was closed in March, 1985.

## 5. Nullica River (Figure 5, Plates 2 & 3)

The estuary has extensive intertidal mud and sand flats. The seagrass Zostera grows in the channel and tide pools, and oysters cover the intertidal rocks. It was always open to the sea at times of sampling with an average salinity of 21.7 parts per thousand (range 11-30 parts per thousand).

## 6. Fisheries Creek (Figure 6, Plate 4)

A brackish tidal creek with intertidal mud and sand flats, oyster covered rocks, and the seagrasses Zostera and Ruppia growing in the deeper back waters. Saltmarshes are present along the bank.



**FIGURE 4.** Location of collection sites at Shadracks Creek, Quarantine Bay and Murrumbulga Point.

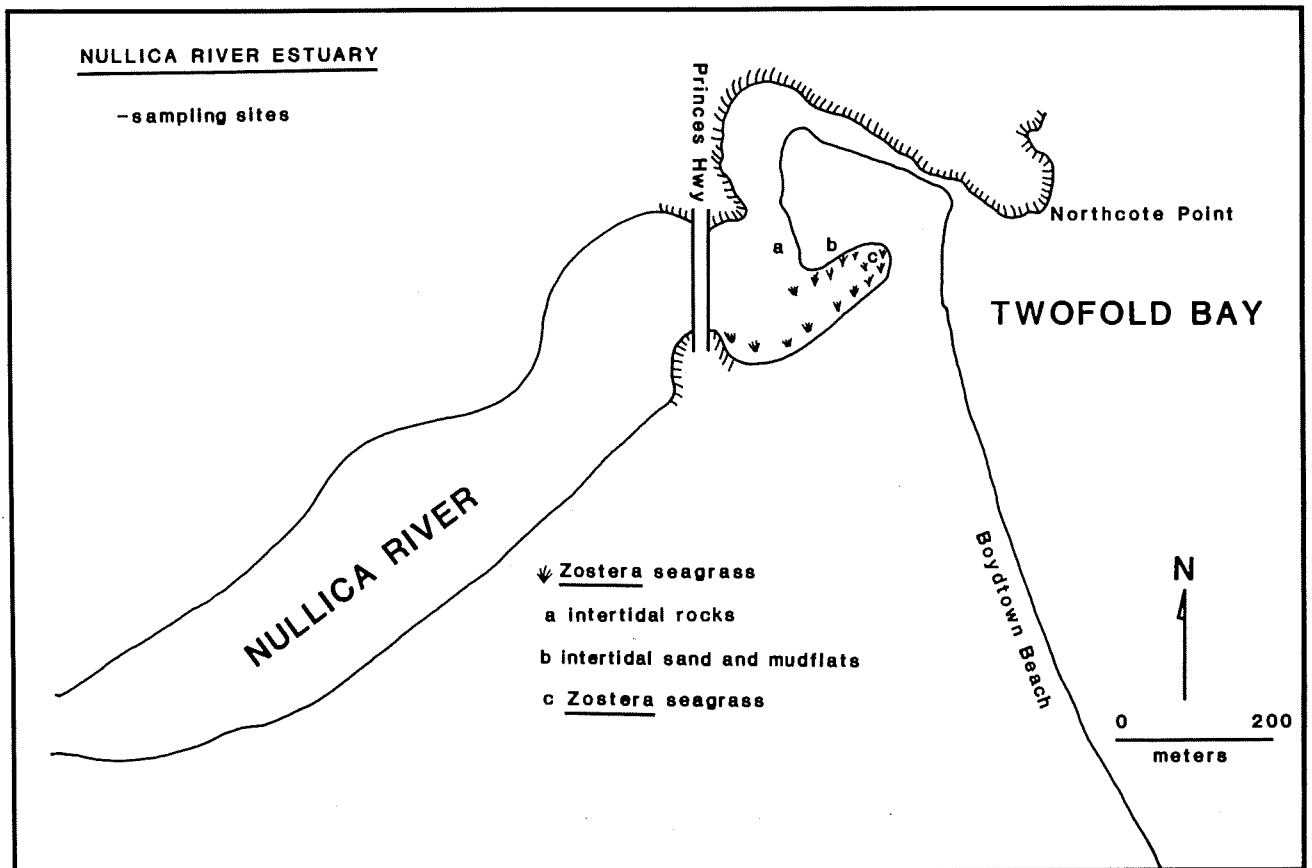


FIGURE 5. Showing location of sampling sites at the Nullica River estuary.

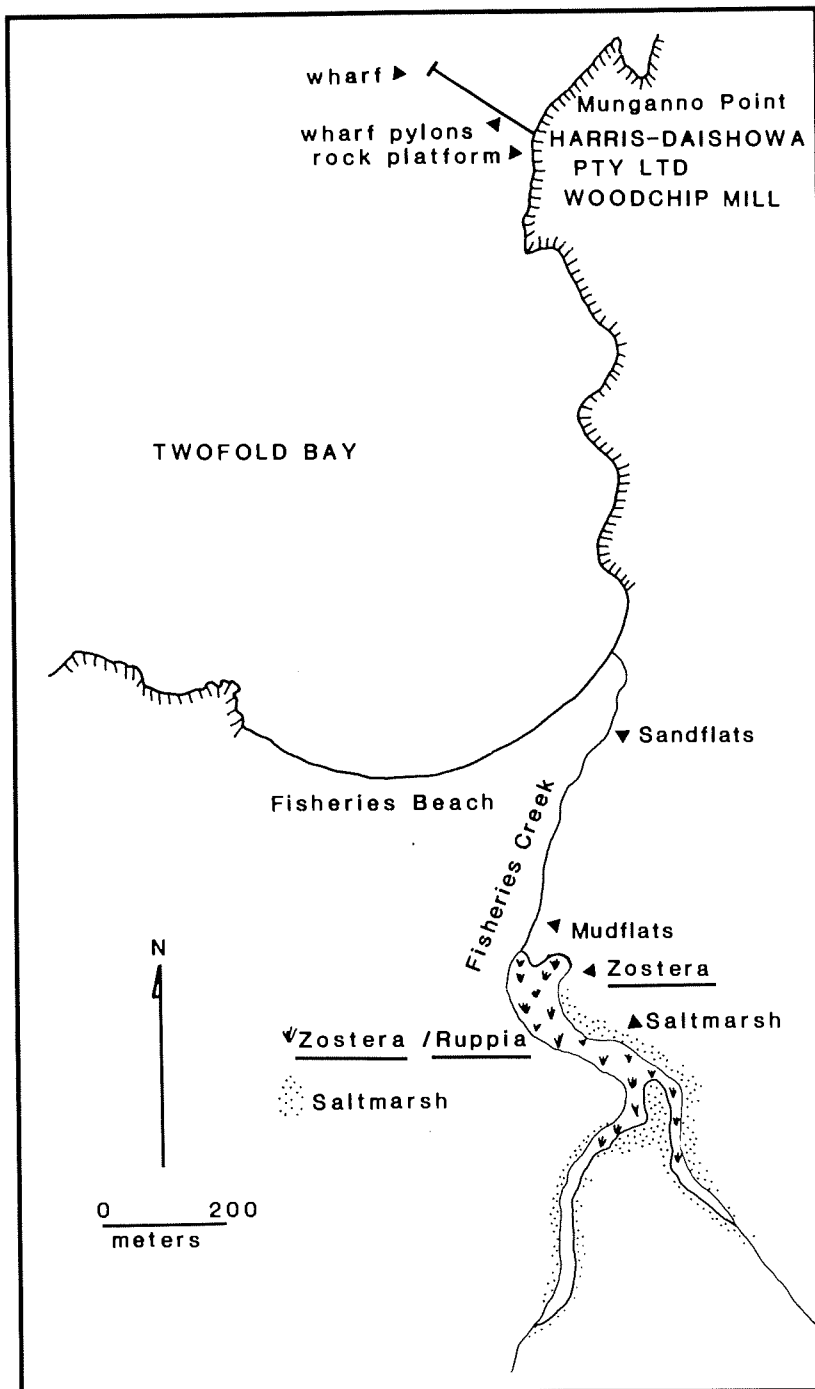


FIGURE 6. Location of collection sites at Munganno Point and Fisheries Creek.

The creek showed an average salinity of 29.8 parts per thousand (range of 20-36 parts per thousand), with salinity falling steeply from the mouth to the seagrass beds, a distance of approximately 500m. The creek was closed to the sea in March 1985 and in full flood in December later that year.

#### 7. Munganno Point (Figure 6, Plate 1)

A north-west facing 'exposed' rocky shore with the intertidal rock platform approximately 4m wide, backed by a small cliff. The 'platform' varies from a steeply sloping rock face to loose piled rubble with a few tide pools. There is some evidence of zonation. The lower zone is dominated by cungevoi (Pyura stolonifera) and mat forming weed. The upper zone was dominated by tube worms and barnacles. The subtidal rock platform is a tiered 'patchy' outcrop of rocks which extends down to sand at approximately 6m depth. The rocks support a healthy cover of kelp, Ecklonia radiata.

The wharf at Munganno Point extends perpendicularly from the shore for 244 metres, maximum water depth is 15 metres. The pylons are constructed of concrete encased steel. Pylons close to the shore were thickly encrusted with calcareous serpulid worm tubes intertidally, whilst supporting a heavy growth of tunicates, sponges and kelp for their entire length below the low water mark.

#### METHODS

The aim of this survey was to document the benthic marine fauna as completely as possible. Many species occurring in estuaries are not consistently present throughout the year, so sampling was done regularly in an effort to include these seasonally abundant species in our collection.

Sampling at the 7 sites began in September 1984 and continued at approximately 3 month intervals until December, 1985. Details of the times of sampling and the number of samples collected at each of the habitats at a particular site are given in Table 2.

A baited trap was used at Quarantine Bay, in an attempt to capture any specimens of the crustacean group which has been found in ballast water previously examined by Williams et al. (1982).

In addition, an opportunity arose to add to the findings of Williams et al. (1982). This involved the collection of five kilograms of ballast tank sediment (mud, sawdust and woodchips) on the 31 August 1984 from the 3rd ballast tank of the Malaysian carrier 'Bunga Tembusu' moored at Munganno Point.

Sampling in the Bay was qualitative, although the same techniques were used each time for a particular habitat allowing some estimates of abundances to be made. Sampling techniques were

TABLE 2. Details of times of sampling at each site and the number of samples collected in each habitat, during each collection period. Unit of collection = 36cm x 44 cm plastic bag. Variation between months in collection unit number caused by bad weather and time available for collection effort (e.g. daylight hours and tidal movements).

Sample Replicates SITES	Collection Units						
	Year Month	1984			1985		
		Sept	Dec	Mar	Jun	Sept	Dec
Munganno Pt.	Intertidal rock platform	3	2	2	3	3	4
	Subtidal rock platform	3	1	1	2	1	2
	Wharf piles	3	2	3	3	3	5
	Airlift sediment	1	1	1	-	-	-(a)
<hr/>							
Fisheries Creek	Intertidal rocks	-	1	1	1	1	1
	Sand sievings (intertidal)*	6	6	6	6	6	6
	Mud sievings (intertidal)*	6	6	6	6	6	6
	Mud sievings <u>Ruppia</u> *	6	6	6	6	6	6
	Saltmarsh	6	1	1	1	1	1
	<hr/>						
Nullica River	Sand sievings (intertidal)*	-	6	6	6	6	6
	Mud sievings (intertidal)*	6	6	6	6	6	6
	Mud sievings, <u>Zostera</u> *	6	6	6	6	6	6
	Intertidal rocks	2	1	2	1	1	2
<hr/>							
Shadracks Creek	Mud sievings, <u>Zostera</u> *	6	6	6	6	6	6
	Sand sievings (intertidal)*	6	-	-	-	-	-(a)
<hr/>							
Murrumbulga Point	Intertidal rock platform	2	2	3	3	3	3
	Subtidal rock platform	5	2	3	3	3	2
<hr/>							
Quarantine Bay	Airlift sediment ( <u>Posidonia</u> )	4	4	4	4	4	4
	Amphipod trap, wharf	1	-	1	1	1	1
<hr/>							
Curalo Lagoon	Sand sieving <u>Zostera</u> *	6	6	6	6	6	6
	Saltmarsh	1	1	1	1	1	1
<hr/>							
Total		79	66	71	71	70	74

\* hand corer used.

(a) Discontinued because returns did not justify effort.



varied according to the type of habitat being sampled:

a) Rocky substrata

On rocky intertidal shores, a transect was followed across the rocks to the waters edge at low tide. Cracks, crevices and the under surfaces of rocks were searched for animals while encrusting fauna, gravel and algae were washed and the animals extracted.

On subtidal rocky shores and wharf piles, the fauna was collected in a similar way using SCUBA gear.

b) Shallow water sediments

In creeks, lagoons and rivers, a hand operated corer was used (see Plate 2) to collect samples of sand, mud or seagrasses (i.e. Zostera and Ruppia). The core sample was 10cm in diameter and 30cm deep and was sieved through a 1mm mesh. Six replicates were taken in each habitat.

c) Subtidal sediments

The subtidal Posidonia seagrass beds were sampled under water using an airlift. This device, when attached to a SCUBA tank, draws the sediment through a 1mm mesh bag and the animals are retained in the bag.

d) Additional sediment collection

A separate collection of sediment from the 'deeper' waters of the Bay (0.6 - 40 metres) was made in late February, 1985 in conjunction with the NSW Geological Survey.

The Bay floor was sampled, at 121 localities with a pipe dredge (see Figure 2). At least 1 large sample was taken, solely to extract invertebrates while smaller samples were split for separate analysis (i.e. half for animals, half for sediment analysis).

Animals were extracted by sieving with a 1mm mesh. This material has been sorted into the major groups but identifications are not yet complete.

Unsieved material was kept for study by students at Sydney University. This will yield information on the sedimentary processes at work in Twofold Bay and enable a sediment map of the area to be produced. Such information would be valuable if any further survey of the invertebrates is undertaken.

All material from each of the habitats was fixed in an acid-neutralised 7% formalin/seawater solution and subsequently

transferred to 70% alcohol. The samples were then sorted to separate the animals from the mineral and vegetable matter. The animals were then identified under stereomicroscope in the laboratory.

## RESULTS

The Australian Museum has expertise in identifying the most commonly encountered organisms found, that is, the polychaetes, molluscs, echinoderms and certain small crustaceans. A representative collection has been deposited and registered, at the Australian Museum, to facilitate retrieval for comparative purposes. Some of the other common groups were sent away to other specialists in Australia for identification. However, for some groups such as the Nemertean, Platyhelminthes, Sipunculans and Copepods, no specialists are available in Australia. This material has also been registered and incorporated into the collections of this museum and is available for future workers upon request. Thus the species lists in the appendices will continue to be updated for the next few years as taxonomic revisions are undertaken.

Appendix 1a gives a complete list of the fauna (arranged in taxonomic order), with an indication of how often the species was recorded at a site and how abundant it was when collected.

The frequency refers to the rate of recurrence or number of collections in which it was found:

Occasionally	$0 < x \leq 2$
Usually	$2 < x \leq 4$
Regularly	$4 < x \leq 6$

where x represents the number of collections.

The abundance was a subjective measure of how plentiful the species was, based on the total numbers collected in that group. As the project was essentially a qualitative exercise, comparisons between groups proved difficult and a sliding scale was adopted. For example:

Few	= not many, small in number
	for polychaetes $x \leq 10$
	molluscs $x \leq 20$
peracarid (small) crustacea	$x \leq 50$
	other crustacea $x \leq 20$
Abundant	= plentiful
	polychaetes $20 < x \leq 50$
	molluscs $20 < x \leq 40$
peracarid crustacea	$50 < x \leq 100$
	other crustacea $20 < x \leq 40$

Numerous = consisting of a great number  
polychaetes x > 50  
molluscs x > 40  
peracarid crustacea x > 100  
other crustacea x > 40

where x represents the number of specimens.

Appendix 1b lists the opisthobranchs found by Dr. W. Rudman (Australian Museum) in Twofold Bay on separate collecting trips in 1983 and 1985. (Their collection and preservation requires specialist attention, and they are typically seasonal in occurrence).

Appendices 2-18 provide a list of the fauna collected at each site according to habitat. The fauna are listed alphabetically within the major taxonomic groupings.

Animals from the additional 'deep water' bay floor collection are included in Appendix 1a, but not Appendices 2-18.

The appendices do not include the one juvenile crab and sixty copepod crustaceans found in the ballast tank mud collection. As this was a supplement to the survey of the Bay, these results are reviewed in the discussion.

## DISCUSSION

The benthic macrofauna of Twofold Bay is a rich and diverse one, with over 608 taxa collected. This number includes 13 species of demersal fish which normally inhabit the seagrass beds which were sampled for their benthic invertebrates. This level of richness is fairly typical for southern New South Wales and exceeds the 246 invertebrate species identified at nearby Merimbula (Day and Hutchings, 1984). There is some overlap in species composition in the comparable habitats sampled in these two localities.

Some of the fauna collected at Twofold Bay is currently being taxonomically described: (Hutchings and Glasby (in press, a, b), Lowry and Stoddart (in prep.), Poore and Lew Ton (in press), Wilson (in prep.)). Most of these new species occur within the polychaete worms and smaller crustaceans. Thus, the comparison with Day and Hutchings (1984) will change with future identifications. This is why all the material from this survey has been lodged within the Australian Museum. Registration numbers are given to voucher specimens to facilitate the retrieval of material for such taxonomic revisions.

Some general comments on the fauna of Twofold Bay can be made. The fauna of seagrass beds and the saltmarshes are relatively sparse, because of their limited extent. In addition the seagrass habitats in Curralo Lagoon, Shadracks Creek, Nullica River and Fisheries Creek were subjected to considerable fluctuations in salinity during the sampling period. Such fluctuating environments have fewer species present than seagrass beds occurring in almost fully marine situations (Collett *et al.*, 1984). Also periodical closure of creeks or lagoons to the sea will restrict access of larvae from nearby coastal waters. We would suspect that the composition of these areas to vary considerably over time, with widespread mortality occurring when salinity falls, during floods, or exceeds that of seawater during drought conditions. There is a general tendency for species numbers in these habitats to decline as the latitude increases (Hutchings and Recher, 1982). However the rocky intertidal and subtidal communities are rich in terms of species and individuals.

The marine fauna of Twofold Bay is a composite one, consisting of a northern and southern component, indicating this area falls within the transition zone from a tropical to temperate fauna. This transition occurs at the boundary of 2 biogeographical zones, which are determined by current patterns and temperature regimes (Knox, 1963; Womersley, 1981).

The biogeography of the polychaete family Terebellidae has recently been investigated, Hutchings and Glasby (in press, c). Species with an Australian wide distribution are Nicolea amnis and Lanice n. sp. Other species are restricted to the eastern coast of Australia, and some are further restricted to SE Australia (e.g. the terebellid Streblosoma acymatum).

One new species of terebellid, Thelepus, is currently only known from Twofold Bay (Hutchings and Glasby, in press, b).

For a recent discussion on the biogeographical zones in this area, see King et al. (in press). However it must be stressed that we lack detailed knowledge of the distribution patterns of polychaetes and smaller crustaceans along the eastern coast of Australia, as much of the fauna remains to be described.

#### INTRODUCED SPECIES

The following species have been introduced in the Bay; Styela plicata (Ascidian); Theba pisana and Crassostrea gigas (Molluscs); Notomegabalanus algicola, Carcinus maenas and Eurylana arcuata (Crustaceans). Each of these is discussed in detail below.

#### Styela plicata (Lesueur)

This ascidean or sea squirt (Subphylum Urochordata) has long been known to occur on Australian shores. We recorded it from the subtidal rocks amongst the Posidonia seagrass in Quarantine Bay. It has a wide distribution within Australia and is found in many ports of the world.

Recent analysis of the biogeography of this species by Kott (1985) has indicated that it is non-indigenous to Australia. It is a recognised fouling organism and is likely to have been introduced to Australia attached to ships' hulls. The earliest Australian records date from 1878.

The origin of the Twofold Bay colony is unknown. It may have resulted from the spread of populations already established in Australia or a direct import from overseas shipping. This could have occurred at any time during the one hundred and fifty years that the Port of Twofold Bay has existed (Matthews, 1947).

#### Theba pisana (Müller)

This salt tolerant terrestrial snail was collected from the back of a saltmarsh at Curralo Lagoon. It is recognised as a pest of agricultural crops and gardens (Smith and Kershaw, 1979). They not only feed directly on the plants, but may contaminate the harvest and interfere with the machinery. Baker (1986) has reviewed the introduction and spread of T. pisana in Australia. Apparently it first began to appear in South Australia prior to 1928. It is now widely distributed over most of southern Australia but appears to favour a mediterranean-type climate. Its previous distribution includes Europe, the Mediterranean, North Africa, Atlantic Isles and British Isles. It has also been introduced to North America and South Africa. The mode of introduction into Australia is not known, but it may have been

brought to Australia as a food item by Italian migrants (P. Colman, pers.comm.). Saltmarshes could act as refuges for this species if a concerted spraying campaign was launched on agricultural land.

#### Crassostrea gigas (Thunberg)

The Pacific oyster was recorded, in small numbers, at Twofold Bay on the intertidal rocks at the mouth of the Nullica River (see Plate 3). This was the first record of occurrence in Twofold Bay (T. Mundy pers. comm.). Shipments of the Pacific oyster were made from Japan in 1947-8 to establish populations in southern Tasmania (Thomson, 1952). In 1955, adult Pacific oysters from Tasmania were transported to Mallacoota, Victoria. By 1958 a quarter of the population was still alive, but no spatfall was observed during this time (Thomson, 1959).

Wolf and Medcof (1974) documented the distribution of Crassostrea gigas in New South Wales. They provide an accurate documentation of all the Australian introductions and subsequent dispersal of stock. Although they did not record it from Twofold Bay, the oyster was recorded from Pambula (1967) and Merimbula (1973) just to the north. Subsequent papers by Medcof and Wolf (1975) and Holliday and Nell (1985) have further examined the expansion of the range of Crassostrea gigas and discuss the problems this oyster has caused in the NSW oyster industry. This organism is providing a case study of the effects of a 'pest' on an established fishery. A breeding population has established itself in Port Stephens, NSW (Holliday and Nell, 1985). The spatfall of the Pacific oyster is affecting the development of the Sydney Rock oyster after settlement. Costs will increase with the need to monitor and cull the Pacific oyster spat in order for the Sydney Rock oyster to be successively harvested. Research into selective cull techniques will be needed so that the range and biomass of the 'pest' will be contained and controlled.

#### Notomegabalanus algicola (Pilsbry)

This barnacle was originally described from South Africa and was first noted in Australia by Pope in 1943 (see Allen, 1953). It seems likely that the first introduction occurred in the Sydney region, although the barnacle may have been introduced into New South Wales on several occasions. Allen (1953) records this barnacle from Eden to Port Stephens and suggests that it was transported to Australia as a fouling species on the bottom of ships. Allen states that during the late 1940's to early 1950's it rapidly increased in numbers and became one of the most common sublittoral barnacles on the open coast. The record of this barnacle from Twofold Bay is therefore not surprising. It was found to be very common on the intertidal rocks and wharf piles of Munganno Point.

Carcinus maenas (Linnaeus)

This European swimming crab was first recorded from Australia by Fulton and Grant (1901) from Port Phillip Bay, Victoria. They suggest it was introduced in amongst the dense fouling growth on the bottoms of wooden ships. The young crabs could easily live amongst this growth during the long sea journey from Europe.

This crab has since been recorded from Western Port Bay to Mallacoota (Allen, 1953), and Healy and Yaldwyn (1970) recorded it as quite abundant on parts of the Victorian coastline. Day and Hutchings (1984) tentatively recorded it from Merimbula, New South Wales and specimens with collection localities in the vicinity of Narooma, New South Wales are held at the Australian Museum. We have found it commonly around Twofold Bay, amongst intertidal rocks as well as intertidal mud. Our survey thus confirms the continued extension of C. maenas populations to the north. Recent introductions of C. maenas have also been reported in South Australia and Western Australia (Zeidler, 1978; Rosenzweig, 1984).

To date, no information is available on the impact of this introduced species on our native populations. However, overseas experience indicates that such an "aggressive predator" constitutes a potential threat to native marine fauna (Joska and Branch, 1986).

Eurylana arcuata (Hale)

This cirrolanid isopod is well known only from New Zealand and Chile, South America. It is believed to have been a recently introduced species in San Francisco Bay, U.S.A. (Bowman et al., 1981). Bowman et al. suggest the isopod could have been introduced to San Francisco Bay in this case either in fouling, such as that found on propeller shaft housing, or via ballast water. They gave three localities in Australia where this isopod has been previously reported (Port Jackson and Broughton Island, New South Wales and Port Willunga, South Australia) and suggested that it may have been introduced at these points. To these Australian records and including ours from Twofold Bay, should be added a single specimen from Newcastle Harbour (Bruce, in press) and possibly a number of specimens from Pambula and Merimbula (Day and Hutchings, 1984). It occurred at the Murrumbulga intertidal rock platform and in the deep water sediments of Twofold Bay.

This disjunct distribution within Australia, associated with port facilities, and the fact that Eurylana arcuata is not recognised as an active swimmer (N. Bruce, pers. comm.), indicates that it may have been introduced on several different occasions at different localities.

In summary, of the six species recorded here as non-indigenous to Twofold Bay, two may have been introduced via ballast water: Eurylana arcuata and the larvae of Crassostrea gigas. The remaining species, with the exception of Theba pisana, were probably introduced as fouling organisms.

The influence of these six introduced species on the ecology of the indigenous marine life in the Bay is not known. To date only the Pacific oyster has been recognised as posing a possible commercial threat to fisheries, and this is a state wide problem, not one restricted to Twofold Bay. The spread of Carcinus maenas may warrant further investigation.

In the event of future surveys in the Bay, the findings of our ballast tank mud collection may prove significant. One juvenile crab and sixty copepod crustaceans were obtained.

The crab was identified as Charybdis cf. feriatus (Linnaeus), (Reg. No. P36717). C. feriatus has a recorded Indo-Pacific range from Japan and East Asia to the east coast of Africa, and south to Victoria, Australia. No specimens of it were obtained from Twofold Bay in our survey. We are not certain the crab was alive when collected, but its presence in the ballast tank, immediately after the tank was emptied, confirms the findings of Williams et al. (1982).

The sixty copepods (Order Harpacticoida) (Reg. No. P36715-6) remain unidentified to date because the Museum does not have the taxonomic expertise with this group.

## CONCLUSIONS

Twofold Bay has a rich and diverse benthic fauna typical of this region of SE Australia. However it must be stressed that detailed studies of many of the estuaries and coastal areas are sparse, and that this 'baseline' survey gives the species composition of Twofold Bay during 1984-1985. This will enable any subsequent introductions to be identified and the relative timing of introduction to be calculated.

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Note: These are only a starting point and specialised references are needed to identify the Australian fauna in many cases.

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APPENDIX 1a. INVENTORY OF MARINE FAUNA COLLECTED FROM TWOFOLD  
BAY (In alphabetical order within the major taxonomic  
groupings)

CLASSIFICATION & DESIGNATION	FREQUENCY/ ABUNDANCY		REGISTRATION NO'S
PHYLUM: COELENTERATA			
<u>Phlyctenactis tuberculosa</u> (Quoy & Gaimard)	occas	few	G15228
PHYLUM: PLATYHELMINTHES			
CLASS: TURBELLARIA:			
Acoela spp.	usually	abundant	W201435-6
PHYLUM: NEMERTINEA			
Nemertean ?sp.1	reg	num	W201433-4
Nemertean ?sp.2	usually	abundant	W201431-2
Nemertean ?sp.3	reg	abundant	W201429-30
Nemertean ?sp.4	reg	abundant	W201427-8
Nemertean ?sp.5	occas	few	W201426
Nemertean ?sp.6	occas	few	W201425
PHYLUM: ANNELIDA			
CLASS: POLYCHAETA			
FAMILY: AMPHARETIDAE			
<u>Isolda pulchella</u> Müller	usually	abundant	W199760-1
FAMILY AMPHINOMIDAE			
<u>Euphrosine</u> n.sp.	occas	few	W199762
FAMILY: ARABELLIDAE			
<u>Arabella iricolor iricolor</u> (Montagu)	occas	few	W201401
<u>Arabella</u> n.sp.	reg	num	W198896-976 W200167-68
FAMILY: CAPITELLIDAE			
<u>Barantolla lepte</u> Hutchings	occas	few	W201381
<u>Capitella "capitata"</u> (Fabricius)	occas	few	W20138
<u>Capitella</u> sp.			
<u>Leiocapitella</u> sp.	occas	few	W201378
<u>Notomastus torquatus</u> Hutchings & Rainer	occas	few	W201379
FAMILY: CHAETOPTERIDAE			
<u>Mesochaetopterus</u> sp.	occas	few	W199764
FAMILY: CHRYSOPETALIDAE			
<u>Chrysopetalum</u> sp.1	reg	abundant	W199721-31

## FAMILY: CIRRATULIDAE

<u>Cirriiformia capensis</u> (Schmarda)			
<u>Cirriiformia filigera</u> (delle Chiaje)			
<u>Cirriiformia</u> sp.			
<u>Dodecaceria</u> sp.	occas	few	W199748

## FAMILY: DORVILLEIDAE

<u>Dorvillea australiensis</u> (McIntosh)	occas	few	W199751-4
<u>Protodorvillea</u> sp.	occas	few	W199749-50
<u>Schistomeringos loveni</u> (Kinberg)	usually	few	W199755-9

## FAMILY: EUNICIDAE

<u>Eunice aphroditois</u> (Pallas)	reg	abundant	W201411
<u>Eunice cf. australis</u>	reg	abundant	W201410
<u>Eunice torresiensis</u> McIntosh	occas	few	W201409
<u>Eunice tridentata</u> Ehlers	occas	few	W201408
<u>Eunice tubifex</u> Crossland	occas	few	W201407
<u>Marphysa sanguinea</u> (Montagu)	occas	few	W201406
<u>Nematonereis unicornis</u> (Grube)	usually	few	W199804-5
<u>Palola</u> sp.	occas	few	W201405

## FAMILY: GLYCERIDAE

<u>Glycera tridactyla</u> Schmarda	occas	few	W199743-7
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## FAMILY: HESIONIDAE

<u>Podarke angustifrons</u> (Grube)	reg	num	W201374
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## FAMILY: LUMBRINEREIDAE

<u>Augeneria verdis</u> Hutchings & Murray	occas	few	W201403
<u>Lumbrineris latreilli</u> Audouin & Milne Edwards	occas	few	W201402

## FAMILY: LYSARETIDAE

<u>Lysidice cf. collaris</u>	reg	abundant	W19773-802 W199805-9
<u>Lysidice ninetta</u> Audouin & Milne Edwards	occas	few	W199803
? <u>Lysidice</u> sp.	occas	few	W201404

## FAMILY: MALDANIDAE

<u>Axiothella</u> sp.	usually	abundant	W199732-41
<u>Euclymene trinalis</u> Hutchings	occas	few	W199742

## FAMILY: MAGELONIDAE

	occas	few	W201382
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## FAMILY: NEPHTYIDAE

Nephtys australiensis Fauchald reg num W200238-337

## FAMILY: NEREIDIDAE

Australonereis ehlersi (Augener) reg abundant W201361  
Ceratonereis aequisetis Augener reg num W201362  
Nereis maxillodentata Hutchings & Turvey occas few  
Nereis cf. triangularis occas few  
Perinereis amblyodonta (Schmarda) reg num W201363  
Perinereis variodentata Augener occas few  
Platynereis dumerilii antipoda Hutchings & Rainer occas few

## FAMILY: OPHELIIDAE

usually few

## FAMILY: ONUPHIDAE

Diopatra dentata Kinberg reg abundant W200191-202

## FAMILY: ORBINIIDAE

Leitoscoloplos normalis Day usually abundant W201397  
Scoloplos (Scoloplos) cylindrifera Ehlers occas few W201400  
Scoloplos (Scoloplos) novaehollandiae  
(Kinberg) W201399  
Scoloplos (Scoloplos) simplex Hutchings usually few W201398

## FAMILY: OWENIIDAE

Owenia fusiformis delle Chiaje reg norm W200203-34

## FAMILY: PARAONIDAE

occas few

## FAMILY: PHYLLODOCIDAE

Anaitides longipes (Kinberg) reg abundant  
Eumida cf. sanguinea reg abundant  
Phyllodoce novaehollandiae Kinberg reg abundant  
Phyllodoce sp.1 usually few  
Phyllodocid sp.1 occas few  
Phyllodocid sp.2 occas few  
Phyllodocid sp.3 occas few

## FAMILY: POLYNOIDAE

Harmothoe sp.1 usually few W201418  
Harmothoe sp.2 reg abundant W201417  
Lepidasthenia sp. occas few W201422  
Lepidonotus carinulatus Grube occas few W201421

<u>Lepidonotus melanogrammus</u> Haswell	occas	few	W201420
<u>Lepidonotus</u> n.sp.1	reg	abundant	W201416
<u>Lepidonotus</u> n.sp.2	reg	abundant	W201415
<u>Lepidonotus</u> n.sp.3	reg	abundant	W201414
<u>Lepidonotus</u> n.sp.4	occas	few	W201419
FAMILY: SABELLARIIDAE			
<u>Idanthyrus pennatus</u> (Peters)	usually	abundant	W199879-95
FAMILY: SABELLIDAE			
<u>Amphiglena mediterranea</u> (Leydig)	usually	few	W199827-30
<u>Branchioma nigromaculata</u> (Baird)	reg	num	W199881-70
<u>Megalomma</u> sp.	reg	abundant	W199812-26
<u>Sabellastarte indica</u> (Savigny)	usually	few	W199765-72
FAMILY: SCALIBREGMATIDAE			
	occas	few	W201412
FAMILY: SERPULIDAE			
<u>Galeolaria caespitosa</u> Lamarck	reg	num	W201358
<u>Hydroides</u> cf. <u>brachyacantha</u>	reg	abundant	W201357
<u>Neovermilia globula</u> Dew	occas	few	W201355
<u>Pomatoceros</u> sp.1	reg	abundant	W201356
<u>Pomatoceros</u> sp.2	reg	num	W201360
<u>Protula</u> sp.1	occas	few	W201354
<u>Serpula jukesii</u> Baird	usually	few	W201359
<u>Serpula rubens</u> Straughan	usually	abundant	W201352
<u>Serpula</u> sp.1	usually	few	W201353
<u>Spirobranchus tetraceros</u> (Schmarda)	occas	few	W201351
FAMILY: SIGALIONIDAE			
<u>Psammolyce</u> cf. <u>antipoda</u>	usually	few	W201413
<u>Sigalion bandaeensis</u> Horst	occas	few	W199763
FAMILY: SPIONIDAE			
<u>Aonides oxycephela</u> (Sars)			W201392
<u>Australospio trifida</u> Blake & Kudenov			W201396
<u>Boccardia chilensis</u> Blake & Woodwick			W201391
<u>Boccardiella</u> sp.			W201388
<u>Carazziella victoriensis</u> Blake & Kudenov			W201390
? <u>Laonice</u> sp.			W201393
<u>Malacoceros</u> sp.			W201387
<u>Polydora socialis</u> Schmarda			W201389
<u>Polydora</u> cf. <u>woodwicksi</u>			W201394
<u>Polydora</u> sp.			W201385
<u>Prionospio cirrifera</u> Wlrén			W201395
<u>Prionospio</u> cf. <u>cirrifera</u>			W201386
<u>Prionospio multipinnulata</u> Blake & Kudenov			W201384
<u>Spio pacifica</u> Blake & Kudenov			W201383

## FAMILY: SPIROBIDAE

occas      few

## FAMILY: SYLLIDAE

<u>Autolytus</u> sp.1	usually	few	W201364
<u>Autolytus</u> sp.2	occas	few	W201365
<u>Autolytus</u> sp.3	occas	few	W201366
<u>Autolytus</u> sp.4	occas	few	W201367
<u>Syllid</u> ?sp.1	reg	num	W201368
<u>Syllid</u> ?sp.2	reg	num	W201369
<u>Syllid</u> ?sp.3	reg	abundant	W201370
<u>Syllid</u> ?sp.4	occas	few	W201371
<u>Syllid</u> ?sp.5	occas	few	W201372
<u>Syllid</u> ?sp.6	usually	few	W201373

## FAMILY: TERESELLIDAE

<u>Lanassa</u> n.sp. Hutchings & Glasby, in press	occas	few	
<u>Lanice</u> n.sp. Hutchings & Glasby, in press	occas	few	W201375
<u>Longicarpus modesta</u> Hutchings & Murray	usually	abundant	W200388-97
<u>Nicolea amnis</u> Hutchings & Murray	reg	abundant	W200375-80
			W200383-7
<u>Pista</u> n.sp. Hutchings & Glasby, in press	usually	few	W200635-7
			W2006460
			W2006465
<u>Pista violacea</u> Hartmann-Schröder			
<u>Reterebella</u> n.sp. Hutchings & Glasby, in press	usually	few	W200398
			W200137-8
<u>Streblosoma acymatum</u> Hutchings & Rainer	occas	few	W201377
<u>Terebella pappus</u> Hutchings & Murray	usually	abundant	200404-10
<u>Thelepus</u> n.sp.1 Hutchings & Glasby, in press	occas	few	W198918
<u>Thelepus</u> n.sp.2 Hutchings & Glasby, in press	occas	few	W201376
<u>Thelepus</u> n.sp.3 Hutchings & Glasby, in press	usually	abundant	W198916-7

## PHYLUM: MOLLUSCA

## CLASS: POLYPLACOPHORA

<u>Acanthochitona pilsbryi</u> (Sykes)	reg	num	C148809-10
<u>Acanthochitona retrojecta</u> (Pilsbry)	reg	num	C148811
<u>Acanthochitona</u> sp.1	usually	few	C148812
<u>Callistochiton antiquus</u> (Reeve)	occas	few	C150544
<u>Chiton jugosus</u> (Gould)	reg	few	C148797
<u>Chiton pelliserpentis maugeanus</u> (Iredale & May)	reg	num	C148798-800
<u>Ischnochiton australis</u> Sowerby	reg	num	C148821-3
<u>Ischnochiton cariosus</u> (Dall)	reg	few	C148813
<u>Ischnochiton elongatus crispus</u> Reeve	reg	num	C148824-5
<u>Ischnochiton lentiginosus</u> (Sowerby)	usually	few	C148820
<u>Ischnochiton smaragdinus</u> (Angas)	usually	abundant	C148814-6
<u>Ischnochiton versicolor</u> Iredale & Hull	reg	abundant	C148817-9
<u>Ischnochiton</u> sp.1	occas	few	C148826
<u>Ischnochiton</u> sp.2	occas	few	C148827
<u>Kopionella matthewsi</u> (Iredale)	usually	few	C148807-8

<u>Lorica volvox</u> (Reeve)	occas	few	C150545
<u>Notoplax cf. rubrostrata</u>	usually	few	C148805-6
<u>Parachiton</u> sp.	occas	few	C148803-4
<u>Plaxiphora albida</u> (Blainville)	reg	abundant	C148802

## CLASS: BIVALVIA

<u>Acar botanica</u> (Hedley)	occas	few	C148541
<u>Acrosterigma cygnorum</u> (Deshayes)	occas	few	C150546
<u>Ambuscintilla praemium</u> Iredale	reg	abundant	C150547
<u>Anomia descripta</u> Iredale	occas	few	C150548
<u>Anomia ione</u> (Gray)	usually	few	C148530
<u>Austromytilus rostratus</u> Dunker	occas	few	C150549
<u>Bankia</u> sp.	occas	few	C150550
<u>Barbatia pistachia</u> (Lamarck)	usually	few	C148542
<u>Bassina pachyphylla</u> (Jonas)	occas	few	C150551
<u>Bivalve ? sp.1</u>	occas	few	C150552
<u>Cardita excavata</u> Deshayes	occas	few	C150553
<u>Corbula smithiana</u> Brazier	occas	few	C150554-5
<u>Crassostrea gigas</u> (Thunberg)	occas	few	C150556
<u>Donax</u> sp. (juv.)	occas	few	C150557
<u>Electroma georgiana</u> (Quoy & Gaimard)	occas	few	C150558
<u>Eumarcia fumigata</u> Sowerby	reg	abundant	C148525
<u>Fulvia tenuicostata</u> (Lamarck)	occas	few	C148521
<u>Gari</u> sp.	occas	few	C150559
<u>Glycymeris flammeus</u> (Reeve)	occas	abundant	C148794-5
<u>Hiatella australis</u> (Lamarck)	reg	num	C148531
<u>Lasaea australis</u> (Lamarck)	reg	num	C148545-6
<u>Laternula creccina</u> Reeve	occas	few	C150560-1
<u>Laternula cf. creccina</u>	occas	few	C148544
<u>Lima nimbifer</u> (Iredale)	occas	few	C148536
<u>Mesodesma elongata</u> (Reeve)	occas	few	C148516
<u>Mimachlamys asperrimus</u> (Lamarck)	usually	few	C150563
<u>Modiolus areolatus</u> (Gould)	usually	few	C148532
<u>Monia zealandica</u> (Gray)	occas	few	C150564
<u>Musculus nanus</u> (Dunker)	reg	num	C148533
<u>Musculus</u> sp. (juv.)	usually	num	C148534
<u>Myadora pandoriformis</u> (Stutchbury)	occas	few	C150565
<u>Mytilus edulis</u> (Linnaeus)	reg	num	C148548-9
			C150566
? <u>Notocallista</u> sp.	occas	few	C150567
<u>Nuculana spathula</u> (Hedley)	occas	few	C150568
<u>Ostrea angasi</u> Sowerby	usually	few	C148793
<u>Placamen placidum</u> (Philippi)	occas	few	C150569
<u>Saccostrea commercialis</u> (Iredale & Roughley)	reg	num	C148796
			C148547
<u>Sanguinolaria donacioides</u> (Reeve)	occas	few	C148543
<u>Scaeolea hanleyi</u> (Angas)	reg	num	C150570
<u>Solemya australis</u> (Lamarck)	usually	abundant	C148522
<u>Solen vaginoides</u> (Lamarck)	occas	few	C150571
<u>Spisula trigonella</u> (Lamarck)	occas	few	C150572
<u>Tellina deltoidalis</u> (Lamarck)	reg	num	C148517
<u>Tellina tenuilirata</u> Sowerby	usually	few	C150573

<u>Tellina</u> sp.	reg	abundant	C150574-5
<u>Teredo</u> sp.	occas	few	C150576
<u>Timoclea cardiodes</u> (Lamarck)	occas	few	C148524
<u>Trichomusculus barbatus</u> Reeve	reg	num	C148537
<u>Trichomya hirsuta</u> (Lamarck)	reg	num	C148538-40
<u>Venerupis crenata</u> (Lamarck)	reg	num	C148518
<u>Venerupis fabagella</u> (Deshayes)	usually	abundant	C148519-20
<u>Vulsella vulsella</u> (Linnaeus)	occas	few	C148535
<u>Wallucina assimilis</u> (Angas)	usually	few	C148523
<u>Xenostrobus securis</u> (Lamarck)	occas	few	C150577

## CLASS: GASTROPODA

## SUBCLASS: PROSOBRANCHIA

## ORDER: ARCHAEOGASTROPODA

<u>Amblychilepas javanicensis</u> (Lamarck)	occas	few	C150578
<u>Astraea tenforiformis sirius</u> (Gould)	reg	abundant	C148499
<u>Astralium</u> sp.	occas	few	C148500
<u>Austrocochlea concamerata</u> (Wood)	reg	num	C148493
<u>Austrocochlea constricta</u> (Lamarck)	reg	num	C148496-7
<u>Austrocochlea</u> sp.(juv.)	occas	few	C148498
<u>Bankivia fasciata</u> Menke	usually	num	C148390
<u>Cantharidella picturata</u> (A.Adams & Angas)	usually	abundant	C148374-5
<u>Cellana tramoserica</u> (Holten)	reg	num	C148828-9
? <u>Cellana tramoserica</u>	occas	few	C150579
<u>Diodora lineata</u> (Sowerby)	occas	few	C150580
<u>Emarginula</u> sp.	occas	few	C148850
<u>Euriclanculus floridus</u> (Philippi)	reg	few	C148372-3
<u>Eurytrochus strangei</u> (A. Adams)	reg	num	C150581
<u>Gena impertusa</u> (Burrow)	reg	abundant	C148369
<u>Granata imbricata</u> (Lamarck)	reg	few	C148370-1
<u>Haliotis ruber</u> (Leach)	usually	few	C148851
<u>Herpetopoma aspersa</u> (Philippi)	reg	num	C148367-8
<u>Kerguelenella stoweai</u> (Virco)	occas	few	C150582
<u>Leiopyrga lineolanis</u> (Gould)	usually	num	C148389
<u>Mesoclanculus plebejus</u> (Philippi)	usually	abundant	C150583
<u>Montfortula rugosa</u> (Quoy & Gaimard)	reg	num	C148852
<u>Nerita atramentosa</u> (Reeve)	reg	num	C148494
<u>Notoacmea flammea</u> (Quoy & Gaimard)	usually	few	C148844
			C150584
<u>Notoacmea petterdi</u> (Tenison-Woods)	reg	num	C148841
<u>Patella chapmani</u> (Tenison-Woods)	usually	few	C148845-7
<u>Patella peroni</u> (Blainville)	reg	abundant	C148842-3
<u>Patelloida alticostata</u> (Angas)	reg	num	C148830-1
<u>Patelloida latistrigata</u> (Angas)	reg	abundant	C148832-4
<u>Patelloida mimula</u> (Iredale)	reg	num	C148835-7
<u>Patelloida mufria</u> (Hedley)	reg	num	C148838-40
<u>Phasianotrochus eximus</u> (Perry)	occas	few	C148350
<u>Phasianotrochus</u> sp.	usually	abundant	C150585
<u>Scutus antipodes</u> Montfort	reg	abundant	C148848

<u>Scutus</u> sp. (juv.)	usually	few	C148849
<u>Thaliota</u> sp.	usually	few	C148357
<u>Tugali</u> sp.	usually	few	C148861
<u>Turbo torquatus</u> (Gmelin)	occas	few	C148502
<u>Turbo undulatus</u> (Solander)	reg	abundant	C148364-5

## ORDER: MESOGASTROPODA

<u>Assiminea tasmanica</u> Tenison-Woods	occas	few	C150586
<u>Bembicium auratum</u> (Quoy & Gaimard)	reg	num	C148510-1
<u>Bembicium nanum</u> (Lamarck)	reg	num	C148508-9
<u>Bittium</u> sp.	reg	num	C148405-7
<u>Cabestana spengleri</u> (Perry)	occas	few	C148503
<u>Charonia lampax rubicunda</u> (Perry)	occas	few	C148506
<u>Crepidula aculeata</u> Gmelin	occas	few	C150587
<u>Hinea braziliiana</u> Lamarck	occas	abundant	C15088-9
<u>Nodilittorina pyramidalis</u> (Quoy & Gaimard)	usually	abundant	C148346
<u>Nodilittorina unifasciata</u> (Gray)	reg	num	C148345
<u>Philippia lutea</u> (Lamarck)	occas	few	C148366
<u>Polinices melastomum</u> (Swainson)	occas	few	C148354
<u>Pyrasus ebeninus</u> (Bruguiere)	reg	few	C150590
<u>Ranella australasia</u> (Perry)	usually	few	C148504-5
<u>Septa parthenopea</u> (von Salis)	occas	few	C150591
<u>Serpulorbis siphon</u> (Lamarck)	occas	few	C148507
<u>Velacumantus australis</u> (Quoy & Gaimard)	reg	num	C148391-2

## ORDER: NEOGASTROPODA

<u>Agnewia tritoniformis</u> (Blainville)	reg	abundant	C148358
<u>Bedevea hanleyi</u> (Angas)	reg	abundant	C1548361
<u>Bedevea</u> sp.(juv.)	occas	few	C148362
<u>Chicoreus denudatus</u> (Perry)	occas	few	C148359
<u>Cominella lineolata</u> (Lamarck)	reg	abundant	C148352-3
<u>Conus anemone</u> Lamarck	occas	few	C148351
<u>Guraleus pictus</u> (Adams & Angas)	usually	few	C148363
<u>Haustrum vinosum</u> (Quoy & Gaimard)	reg	abundant	C148355
" <u>Lepsiella</u> " <u>reticulata</u> (Blainville)	usually	few	C148356
<u>Mesoginella cf.translucida</u>	occas	few	C148387
<u>Mesoginella turbinata</u> (Sowerby)	usually	abundant	C148388
<u>Mitrella leucostoma</u> (Gaskoin)	occas	few	C148377-8
<u>Mitrella lincolniensis</u> (Reeve)	occas	few	C148379-80
<u>Mitrella pulla</u> (Gaskoin)	usually	few	C148381-3
<u>Mitrella</u> sp.	usually	few	C148384-6
<u>Morula marginalba</u> (Blainville)	reg	num	C148495
<u>Nassarius burchardi</u> (Dunker)	reg	abundant	C148402
<u>Nassarius cf. burchardi</u>	occas	few	C148401
<u>Nassarius glans particeps</u> (Hedley)	occas	few	C148403
<u>Nassarius pauperatus</u> (Lamarck)	reg	num	C148400
<u>Nassarius pauperus</u> (Gould)	occas	few	C148404
<u>Nassarius</u> sp.(juv.)	usually	abundant	C148399
<u>Olivella leucozona</u> Adams & Angas	occas	few	C148376
<u>Thais orbita</u> (Gmelin)	reg	num	C148501
			C150592



## SUBCLASS: OPISTHOBRANCHIA

(\* NOTE: See Appendix 1b for other species occurring in the Bay as recorded by Rudman).

<u>Aphelodoris varia</u> (Abraham)	occas	few	C150593
<u>Aplysia sydneyensis</u> Sowerby	occas	few	C148512
<u>Austraeolis cacaotica</u> (Stimpson)	occas	few	C150594
<u>Bulla quoyii</u> (Gray)	occas	few	C148360
<u>Caldukia affinis</u> (Burn)	occas	few	C150595
<u>Ceratosoma amoena</u> (Cheeseman)	occas	few	C150596
<u>Dorid Nudibranch sp.1</u>	occas	few	C148862
<u>Dorid Nudibranch sp.2</u>	occas	few	C148863
<u>Philine cf. angasi</u>	occas	few	C148866
<u>Pleurobranch sp.1</u>	occas	few	C148865
<u>Polycera capensis</u> Quoy & Gaimard	occas	few	C150597
<u>Pteraeolidia ianthina</u> (Angas)	occas	few	C150598

## SUBCLASS: PULMONATA

<u>Onchidella patelloides</u> (Quoy & Gaimard)	reg	abundant	C148859-60
<u>Onchidina australis</u> Semper	reg	few	C148864
<u>Ophicardelus ornatus</u> (Ferussac)	reg	num	C148393-4
<u>Ophicardelus quoyi</u> (H. & A. Adams)	reg	abundant	C148396-7
<u>Ophicardelus cf. quoyi</u>	occas	few	C148395
<u>Ophicardelus sulcatus</u> (H. & A. Adams)	usually	few	C148398
<u>Salinator fragilis</u> (Lamarck)	reg	num	C148347-8
<u>Salinator solida</u> (von Martens)	reg	num	C148349
<u>Siphonaria denticulata</u> Quoy & Gaimard	reg	abundant	C148853
<u>Siphonaria diemenensis</u> Quoy & Gaimard	reg	num	C148854-5
<u>Siphonaria funiculata</u> Reeve	reg	abundant	C148856
			C150599
<u>Siphonaria sp. (juv.)</u>	occas	few	C148857-8
<u>Theba pisana</u> (Müller)	occas	few	C150600

## CLASS: SCAPHOPODA

<u>Cadulus acuminatus</u> Tate	usually	num	C150969
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## PHYLUM: ARTHROPODA

## CLASS: CRUSTACEA

## SUBCLASS: OSTRACODA

## ORDER: MYODOCOPA

<u>Myodocopa spp.</u>	reg	numerous	P36562-83
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## SUBCLASS: CIRRIPIEDIA

## ORDER: THORACICA

<u>Austrobalanus imperator</u> (Darwin)	few		P36114
<u>Austromegabalanus nigrescens</u> (Lamarck)	abundant		P36119
<u>Balanus trigonus</u> Darwin	numerous		P36112
<u>Balanus variegatus</u> Darwin	few		P36614
<u>Catomerus polymerus</u> (Darwin)	abundant		P36122
<u>Chamaesipho columna</u> (Spengler)	numerous		P36120
<u>Chthamalus antennatus</u> Darwin	numerous		P36124
<u>Elminius covertus</u> Foster	numerous		P36125
<u>Ibla quadrivalvis</u> Cuvier	few		P36113
<u>Notomegabalanus algicola</u> (Pilsbry)	numerous		P36116-8
<u>Tesseropora rosea</u> Krauss	abundant		P36121
<u>Tetraclitella purpurascens</u> (Wood)	numerous		P36123

## SUBCLASS: MALACOSTRACA

## ORDER: LEPTOSTRACA

Neballiacean sp.	occas	few	p36584-7
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## SUPERORDER: PERACARIDA

## ORDER: MYSIDACEA

<u>Heteromysis</u> sp.	usually	few	P36617-9
<u>Siriella australis</u> W.M. Tattersall	occas	few	P36615-6

## ORDER: CUMACEA

Cumacean spp.	reg	numerous	P36594-613
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## ORDER: TANAIDACEA

Tanaidacean spp.	reg	numerous	P36525-48
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## ORDER: ISOPODA

## SUBORDER: GNATHIIDEA

<u>Gnathia ferox</u> (Haswell)	usually	few	P36588-91
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## SUBORDER: ANTHURIDEA

<u>Apanthura drosera</u> Poore & Lew Ton	occas	few	P36050
<u>Apanthura isotoma</u> Poore & Lew Ton	usually	few	P36046-8
<u>Apanthura xanthorrhoea</u> Poore & Lew Ton	reg	abundant	P35640-2 P36154-6
<u>Apanthuretta olearia</u> Poore & Lew Ton	occas	few	P36049 P36059
<u>Bullowanthura pambula</u> Poore	occas	few	P36052

<u>Cyathura hakea</u> Poore & Lew Ton	occas	few	P36593
<u>Haliophasma canale</u> Poore	occas	few	P36058
<u>Haliophasma</u> sp.1	occas	few	P36061-2 P36592
<u>Haliophasma</u> sp. 2	occas	few	P36056-7 P36133-5
<u>Leptanthura diemenensis</u> (Haswell)	reg	abundant	P35648-9 P36053-5 P36170-2
<u>Mesanthura dianella</u> Poore & Lew Ton	usually	few	P35643-5 P36149
<u>Paranthura acacia</u> Poore	occas	few	P36060
<u>Paranthura senecio</u> Poore	reg	few	P35646-7 P36167-9
<u>Ulakanthura marlee</u> Poore	occas	few	P36051
SUBORDER: FLABELLIFERA			
<u>Amphoroidea angustata</u> Baker	occas	few	P35957
<u>Cerceis ?obtusa</u>	occas	few	P36625
<u>Cirolana australiense</u> Hale	reg	numerous	P35961 P36146-8
<u>Cirolana victoriae</u> Bruce	occas	few	P35972
<u>Cilicaea tenuicauda</u> Haswell	occas	few	P36626
<u>Cilicaeopsis</u> cf. <u>whiteleggei</u>	occas	few	P36627
<u>Cilicaeopsis</u> sp.	occas	few	P35970
<u>Cymodoce</u> cf. <u>bidentata</u>	occas	few	P35969 P36178
<u>Cymodoce haswelli</u> Harrison & Holdich	usually	few	P36628
<u>Cymodoce</u> spp. (females)	reg	num	P35948 P35960 P36173 P35949 P36145 P35954 P36174 P36623 P36624 P35955
? <u>Cymodopsis</u> sp.	occas	few	P35955
<u>Cymothoid</u> sp.	occas	few	P36631
<u>Eurydice ?binda</u>	occas	few	P36629
<u>Eurydice</u> sp.	occas	few	P35971
<u>Eurylana arcuata</u> (Hale)	reg	few	P35958 P36175-7
<u>Exosphaeroma</u> sp.	occas	abundant	P35959
<u>Haswellia carnea</u> (Haswell)	occas	few	P35950 P36144
<u>Haswellia</u> cf. <u>juxtacarnea</u>	occas	few	P35951 P36159-60
<u>Ischromene ?polytyla</u>	reg	num	P35953
<u>Limnoria</u> sp.	reg	abundant	P36165-6 P35952 P36157-8

? <u>Paracilicaea</u> sp.	usually	few	P36622
<u>Paracassidina pectinata</u> Baker	occas	few	P35963 P36179
<u>Pseudolana towrae</u> Bruce	occas	few	P35966-7
<u>Serolis minuta</u> Beddard	occas	few	P35964-5
<u>Sphaeromatid</u> sp.1	occas	few	P35956
<u>Sphaeromatid</u> sp.2	occas	few	P35962
<u>Sphaeromatid</u> sp.3	usually	few	P36620
<u>Sphaeromatid</u> sp.4	occas	few	P36621
<u>Sphaeromatid</u> sp.5	occas	few	P36630
<u>Syncassidina aesturia</u> Baker	usually	few	P35968 P36143
SUBORDER: ONISCOIDEA			
<u>Oniscoidean</u> sp.1	occas	few	P36633-6
<u>Oniscoidean</u> sp.2	occas	few	P36632
SUBORDER: VALVIFERA			
<u>Euidotea</u> cf. <u>peronii</u>	occas	few	P36068
<u>Microarcturus</u> sp.	occas	few	P36071
<u>Neoarcturus</u> sp.	occas	few	P36070
<u>Pseudarcturella</u> sp.	occas	few	P36072
<u>Synidotea</u> sp.	occas	few	P36069
SUBORDER: ASELLOTA			
<u>Iathrippa</u> sp.	reg	num	P35653-5 P36150-1
<u>Ianiropsis</u> sp.	reg	num	P35658-9 P36152-3
<u>Jaeropsis</u> sp.1	reg	num	P35660-2 P36163-4
<u>Jaeropsis</u> sp.2	occas	few	P36064-5
<u>Janirid</u> sp.1	occas	few	P36066
<u>Janirid</u> sp.2	occas	few	P36067
<u>Stenetrium armatum</u> Haswell	usually	num	P35650-2 P36161-2
<u>Stenetrium</u> cf. <u>armatum</u>	occas	few	P36063
ORDER: AMPHIPODA			
SUBORDER: GAMMARIDEA			
FAMILY: AMPELISCIDAE			
<u>Ampelisca dimboola</u> Lowry & Poore	occas	few	P36660
<u>Ampelisca euroa</u> Lowry & Poore	reg	few	P36638
<u>Byblis bega</u> Lowry & Poore	occas	few	P36659

## FAMILY: AMPHILOCHIDAE

<u>Cyproidea ornata</u> Haswell	reg	num	P36709
<u>Narapheonoides mullaya</u> J.L. Barnard	occas	few	P36708

## FAMILY: AMPITHOIDAE

<u>Ampithoe</u> sp.1	occas	abundant	P36005
<u>Ampithoe</u> sp.2	usually	few	P36712
<u>Ampithoe</u> sp.3	usually	few	P36706
<u>Ampithoe</u> sp.4	occas	few	P36713
<u>Ampithoe</u> sp.5	occas	few	P36707
<u>Cymadusa</u> sp.1	usually	few	P35993
<u>Cymadusa</u> sp.2	occas	few	P36710
? <u>Pseudopleonexes</u> sp.	occas	few	P36705

## FAMILY: ANAMIXIDAE

<u>Anamixis</u> sp.	occas	few	P36651 P36714
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## FAMILY: AORIDAE

<u>Aora hebes</u> Myers & Moore	reg	num	P35992 P36187-8
<u>Aora maculata</u> (Thomson)	usually	num	P36014-5
<u>Aora mortoni</u> (Haswell)	reg	num	P36032 P36181
<u>Lemboides australis</u> (Haswell)	reg	abundant	P36031 P36189
<u>Lembos aequimanus</u> Schellenberg	reg	few	P36033 P36180
<u>Xenocheira fasciata</u> Haswell	occas	few	P36007

## FAMILY: COROPHIIDAE

<u>Corophium</u> sp.	reg	num	P36641
<u>Paracorophium</u> ? <u>excavatum</u>	reg	num	P36042
<u>Siphonoecetes</u> spp.	occas	few	P36295-306

## FAMILY DEXAMINIDAE

<u>Atylus homochir</u> Haswell	reg	abundant	P36029
<u>Haustoriopsis</u> sp.1	reg	abundant	P36028
<u>Haustoriopsis</u> sp.2	occas	few	P36027
<u>Paradexamine churinga</u> J.L. Barnard	occas	few	P36005
<u>Paradexamine dandaloo</u> J.L. Barnard	occas	few	P36043
<u>Paradexamine frinsdorfi</u> Sheard	usually	few	P35991
<u>Paradexamine lanacoura</u> J.L. Barnard	reg	abundant	P36026
<u>Paradexamine</u> ? <u>quarallia</u>	occas	few	P36711
<u>Paradexamine</u> ? <u>thadalee</u>	reg	num	P36025 P36203

<u>Polycheira tenuipes</u> Haswell	occas	few	P36703
<u>Syndexamine cf. runde</u>	occas	few	P36009
<u>Syndexamine sp.1</u>	usually	few	P36024

## FAMILY: EUSIRIDAE

<u>Gondogeneia microdeuteropa</u> (Haswell)	reg	abundant	P35973
<u>Meteusiroides sp.</u>	reg	abundant	P36004
? <u>Paramoera sp.</u>	occas	few	P36012
<u>Tethygeneia nalgo</u> J.L. Barnard	reg	num	P36010
<u>Tethygeneia waminda</u> J.L. Barnard	occas	num	P36040

## FAMILY: EXOEDICEROTIDAE

<u>Exoediceroides maculosus</u> (Sheard)	occas	few	P35639
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## FAMILY: HYALIDAE

<u>Hyale crassicornis</u> (Haswell)	reg	few	P35977
			P36185-86
<u>Hyale cf. loorea</u>	usually	abundant	P36645
<u>Hyale maroubrae</u> Stebbing	usually	few	P36013
			P36184
<u>Hyale rubra</u> (Thomson)	usually	few	P36182-3
			P35976
<u>Hyale sp.</u>	reg	few	P36646

## FAMILY: ISAEIDAE

<u>Ampelisciphotis sp.</u>	reg	num	P36030
<u>Cheiriphotis sp.</u>	occas	few	P35994-5
<u>Gammaropsis sp.</u>	reg	abundant	P36003
? <u>Gammaropsis sp.1</u>	reg	num	P35985
? <u>Gammaropsis sp.2</u>	usually	few	P36002
? <u>Gammaropsis sp.3</u>	reg	abundant	P35984
<u>Photis sp.1</u>	reg	num	P36034-5
			P36190-1
<u>Photis sp.2</u>	occas	few	P36018
			P36102-4

## FAMILY: ISCHYROCERIIDAE

<u>Cerapus sp.</u>	occas	few	P36195-202
			P36006
<u>Erichthonius sp.</u>	reg	num	P36023
<u>Parajassa sp.</u>	usually	num	P36704

## FAMILY: LEUCOTHOIDAE

<u>Leucothoe assimilis</u> J.L. Barnard	occas	few	P36642
<u>Leucothoe boolpooli</u> J.L. Barnard	ref	num	P35990
			P36213
<u>Leucothoe commensalis</u> Haswell	reg	abundant	P35983
			P36214
<u>Paraleucothoe novaehollandiae</u> (Haswell)	reg	abundant	P35989
			P36215

## FAMILY LILJEBORGIIDAE

<u>Liljeborgia aequabilis</u> Stebbing	reg	abundant	P36001
			P36216
<u>Liljeborgia</u> sp.1	occas	few	P36022
<u>Liljeborgia</u> sp.2	occas	few	P36038

## FAMILY: LYSIANASSIDAE

<u>Amaryllis</u> sp.1	occas	few	P36700
<u>Amaryllis</u> sp.2	occas	few	P36701
<u>Amaryllis</u> sp.3	reg	abundant	P35982
			P36702
<u>Lysianassid</u> sp.1	usually	few	P35981
			P36212
<u>Parawaldeckia dilkera</u> J.L. Barnard	reg	few	P36021
			P36211
<u>Parawaldeckia</u> sp.	reg	few	P36207-9
			P36044-5
<u>Tryphosella camelus</u> (Stebbing)	usually	few	P36016-7
			P36210
<u>Uristidid</u> sp.1	occas	few	P36204-6
			P36036
<u>Waldeckia</u> sp.	reg	num	P35988

## FAMILY: MELITIDAE

<u>Ceradocus ramsayi</u> (Haswell)	reg	num	P35987
			P36229
<u>Ceradocus serratus</u> (Bate)	usually	few	P36000
			P36218-9
<u>Ceradocus rubromaculatus</u> (Stimpson)	reg	few	P36637
<u>Ceradocus</u> sp.	occas	few	P36650
? <u>Ceradocus</u> sp.	reg	few	P36644
<u>Dulichella australis</u> (Haswell)	reg	num	P35980
			P36221
<u>Elasmopus bollonsi</u> Chilton	usually	num	P35979
			P36230
<u>Elasmopus ?yunde</u>	occas	few	P36644
<u>Gammarella berringar</u> (J.L. Barnard)	occas	few	P35999
<u>Gammarella mokari</u> (J.L. Barnard)	usually	few	P35998
			P36224-6

<u>Maera viridis</u> Haswell	reg	num	P35978 P36222-3
<u>Maera</u> sp.	occas	few	P36649
? <u>Maera</u> sp.	reg	num	P36643
<u>Mallacoota subcarinata</u> Haswell	occas	few	P35988
<u>Melita matilda</u> J.L. Barnard	reg	abundant	P36041 P36227-8
<u>Melita</u> sp.	usually	few	P36647-8
<u>Victoriopisa australiensis</u> (Chilton)	reg	abundant	P36699
FAMILY: PARACALLIOPIIDAE			
<u>Paracalliope</u> sp.	reg	num	P35637-8
FAMILY: PHLIANTIDAE			
<u>Gabophlias olono</u> J.L. Barnard	usually	few	P36011 P36220
<u>Iphiplateia whiteleggei</u> Stebbing	occas	few	P36020
FAMILY: PHOXOCEPHALIDAE			
<u>Birubius mayamayi</u> Barnard & Drummond	occas	few	P36691
<u>Birubius muldarpus</u> Barnard & Drummond	occas	few	P36698
<u>Birubius</u> cf. <u>nammuldus</u>	occas	few	P36690
<u>Birubius quearus</u> Barnard & Drummond	reg	few	P36694-5
? <u>Birubius</u> sp.	occas	few	P36697
<u>Brolgus tattersalli</u> (J.L. Barnard)	occas	few	P36692
<u>Tipimegus dinjerrus</u> Barnard & Drummond	occas	few	P36696
<u>Wildus</u> sp.	reg	abundant	P36693
FAMILY: PODOCERIDAE			
<u>Podocerus</u> sp.1	occas	abundant	P35997
<u>Podocerus</u> sp.2	reg	num	P35996 P36232-3
<u>Podocerus</u> sp.3	reg	abundant	P36019 P36231
FAMILY: SYNOPIIDAE			
<u>Tiron</u> sp.	occas	few	P36039
FAMILY: TALITRIDAE			
<u>Orchestia</u> ? <u>australis</u>	reg	few	P36037 P36217
<u>Orchestia</u> sp.	usually	few	P35974 P35975



## FAMILY: UROHAUSTORIIDAE

<u>Gheegerus</u> cf. <u>garbaius</u>	occas	few	P36661
<u>Tottungus</u> ? <u>tungus</u>	occas	few	P36652
<u>Urohaustorius</u> <u>gunni</u> Barnard & Drummond	occas	few	P36658
<u>Urohaustorius</u> <u>merkanus</u> Barnard & Drummond	occas	few	P36656
<u>Urohaustorius</u> <u>metungi</u> Fearn-Wannan	usually	few	P36653-4
<u>Urohaustorius</u> <u>parnggius</u> Barnard & Drummond	occas	few	P36657
<u>Urohaustorius</u> ? <u>urungari</u>	occas	few	P36655

## SUBORDER: CAPRELLIDEA

<u>Caprella</u> <u>danilevskii</u> Czerniavski	occas	few	P36684-5
<u>Caprella</u> <u>equilibra</u> Say	occas	few	P36688-9
<u>Caprella</u> <u>scaura</u> Templeton	occas	few	P36676-7
? <u>Hircella</u> <u>cornigera</u>	occas	few	P36687
<u>Orthoprotella</u> cf. <u>mayeri</u>	usually	few	P36681-3
<u>Paraprotos</u> <u>spinosa</u> (Haswell)	occas	abundant	P36686
? <u>Paraprotos</u> sp.	usually	few	P36678-90

## SUPERORDER: EUCARIDA

## ORDER: DECAPODA

## SUBORDER: NATANTIA

## SECTION: PENAEIDEA

<u>Penaeus</u> <u>plebejus</u> Hess	usually	few	P36102-3 P36668
? <u>Penaeus</u> sp. (juv.)	occas	few	P36106

## SECTION: CARIDEA

<u>Alpheus</u> <u>euphrosyne</u> <u>richardsoni</u> Yaldwyn	usually	few	P36100 P36666
<u>Alpheus</u> <u>socialis</u> Heller	usually	few	P36115
<u>Alpheus</u> sp.	usually	few	P36664-5
<u>Alope</u> ? <u>orientalis</u>	occas	few	P36663
<u>Hippolyte</u> <u>caradina</u> Holthuis	usually	abundant	P36108
<u>Hippolyte</u> <u>ventricosa</u> Milne-Edwards	occas	few	P36110
<u>Palaemon</u> <u>affinis</u> Milne-Edwards	reg	abundant	P36101
<u>Palaemon</u> <u>serenus</u> Heller	occas	few	P36667
<u>Rhynchocinetes</u> ? <u>rugulosus</u>	occas	abundant	P36662
<u>Synalpheus</u> <u>tumidomanus</u> (Paulson)	usually	few	P36105

## SUBORDER: REPTANTIA

## SECTION: MACRURA

## SUPERFAMILY: THALASSINIDEA

<u>Axiopsis australiensis</u> De Man	occas	few	P36104
<u>Callianassa arenosa</u> Poore	usually	few	P36099

## SECTION: ANOMURA

<u>Diogenes custos affinis</u> Henderson	occas	few	P36111
<u>Diogenes senex</u> Heller	occas	few	P36098
<u>Paguristes squamosus</u> McCulloch	occas	few	P36107
<u>Pagurus ?lacertosus nana</u>	occas	few	P36109
<u>Pagurus sinuatus</u> (Stimpson)	occas	few	P36669
<u>Pagurus</u> sp.	occas	few	P36670

## SECTION: BRACHYURA

<u>Actaea peronii</u> (Milne-Edwards)	occas	few	P36083
<u>Amarinus paralacustris</u> (Lucas)	usually	few	P36090
<u>Carcinus maenas</u> (Linnaeus)	reg	abundant	P36248-9
			P36089
<u>Cyclograpsus audouinii</u> Milne-Edwards	reg	num	P36076
			P36239
<u>Cyclograpsus cf. audouinii</u>	occas	few	P36080
<u>Halicarcinus ovatus</u> Stimpson	reg	num	P36095
			P36234-6
<u>Heloecius cordiformis</u> Milne-Edwards	occas	few	P36086
			P36247
<u>Helograpsus haswellianus</u> (Whitelegge)	reg	num	P36091
			P36242-3
<u>Hymenosoma hodgkini</u> Lucas	occas	few	P36087
<u>Leptograpsus variegatus</u> (Fabricius)	reg	abundant	P36079
<u>Macrophthalmus latifrons</u> Haswell	usually	abundant	P36085
			P36245-6
<u>Mictyris longicarpus</u> Latrielle	reg	num	P36084
<u>Naxia deflexifrons</u> Haswell	occas	few	P36673
<u>Notomithrax minor</u> (Filhol)	usually	abundant	P36094
<u>Notomithrax ursus</u> (Herbst)	occas	few	P36675
<u>Ovalipes australiensis</u> Stephenson & Rees	occas	few	P36088
			P36126
<u>Ovalipes</u> sp. (juv.)	occas	few	P36097
<u>Ozius truncatus</u> (Milne-Edwards)	reg	abundant	P36081
			P36238
<u>Pachygrapsus laevimanus</u> Stimpson	usually	abundant	P36075
<u>Paragrapsus laevis</u> (Dana)	reg	num	P36092
			P36240-1
<u>Petalomera lateralis</u> (Gray)	occas	few	P36073

<u>Pilumnus rufopunctatus</u> Stimpson	reg	abundant	P36082 P36237
<u>Pilumnus serratifrons</u> (Kinahan)	reg	few	P36077
<u>Pilumnus</u> sp.	occas	few	P36671
<u>Pinnotheres hickmani</u> (Guiler)	occas	few	P36672
<u>Plagusia chabrus</u> (Linnaeus)	reg	few	P36074
<u>Plagusia glabra</u> Dana	usually	few	P36078
<u>Portunus pelagicus</u> (Linnaeus)	occas	few	P36096
<u>Sesarma erythroductyla</u> Hess	reg	few	P36244
<u>Xanthias elegans</u> (Stimpson)	occas	few	P36674
?Xanthid (juv.)	occas	few	
Decapod Larvae	occas	few	

## CLASS: PYCNOGONIDA

Pycnogonid spp.	usually	few	P36549-61
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## PHYLUM: SIPUNCULIDA

Sipunculan spp.	reg	abundant	W201423
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## PHYLUM: BRACHIOPODA

<u>Magellania flavescens</u> (Lamarck)	occas	few	C150562
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## PHYLUM: ECHINODERMATA

## CLASS: ASTEROIDEA

<u>Coscinasterias calamaria</u> (Gray)	reg	num	J19884-5 J19834-48
<u>Nectria ocellata</u> E. Perrier	occas	few	J19855
<u>Patiriella calcar</u> (Lamarck)	usually	abundant	J19849-52 J19887
<u>Patiriella exigua</u> (Lamarck)	reg	num	J19865-73 J19875-76 J198788-92
<u>Patiriella gunni</u> (Gray)	usually	abundant	J19853-54 J19874
<u>Petricia vernicina</u> (Lamarck)	usually	abundant	J19856-8
<u>Plectaster decanus</u> (Müller & Troschel)	occas	few	
<u>Uniophora granifera</u> (Lamarck)	occas	abundant	J19859-63

## CLASS: OPHIUROIDEA

<u>Amphipholis squamata</u> (Delle Chiaje)	occas	few	J20001 J19899-901
<u>Amphiura constricta</u> Lyman	usually	few	J19881-3 J19906
<u>Amphiura micra</u> H.L. Clark	occas	few	J19877-79 J19907

<u>Clarkcoma pulchra</u> (H.L. Clark)	occas	few	J19832
? <u>Ophiacantha</u> sp.	occas	few	J19895
<u>Ophiactis resiliens</u> Lyman	occas	abundant	J19902-5 J10008-9 J20002
<u>Ophionereis schayeri</u> (Miller & Toschel)	usually	num	J19826-9
<u>Ophiothrix</u> ( <u>Ophiothrix</u> ) <u>caespitosa</u> Lyman	occas	few	J19893-4
<u>Ophiothrix</u> ( <u>Ophiothrix</u> ) <u>ciliaris</u> (Lamarck)	occas	few	J19995-7
<u>Ophiothrix</u> ( <u>Placophiothrix</u> ) <u>spongicola</u> Stimpson	occas	few	J19831

## CLASS: ECHINOIDEA

<u>Centrostephanus rodgersii</u> (A. Agassiz)	reg	abundant	J19815
<u>Heliocidaris erythrogramma</u> (Valenciennes)	reg	abundant	J19816-21
<u>Heliocidaris tuberculata</u> (Lamarck)	reg	num	J19822
<u>Holopneustes inflatus</u> A. Agassiz	occas	few	J19910
<u>Phyllacanthus parvispinus</u> Tenison-Woods	reg	few	J19823-5

## CLASS: HOLOTHUROIDEA

<u>Paracaudina chilensis</u> var. <u>ransonnetti</u> (von Marenzeller)	occas	few	J19908
<u>Pentacta ignava</u> (Ludwig)	occas	abundant	J19896-8
<u>Plectaster decanus</u> (Miller & Troschel)	occas	few	J198604
<u>Pseudocnus</u> sp.	usually	abundant	J19909

## CLASS: CRINOIDEA

<u>Cenolia tasmaniae</u> (A.H. Clark)	occas	few	J19833
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## PHYLUM: CHORDATA

## SUBPHYLUM: UROCHORDATA

## CLASS: ASCIDIACEA

<u>Herdmania momus</u> (Savigny)	reg	num	Y2061-65
<u>Pyura gibbosa</u> (Heller)	reg	num	Y2057-59
<u>Pyura spinifera</u> (Quoy & Gaimard)	occas	few	Y2049
<u>Pyura stolonifera</u> (Heller)	reg	num	Y2050-56
<u>Styela plicata</u> (Lesueur)	occas	few	Y2060

## PHYLUM: CHORDATA

## GRADE: PISCES

<u>Amphioxus</u> sp.	occas	few	
<u>Anguilla australis</u> Richardson	occas	few	I26017-001 I26018-001
<u>Arenigobius bifrenatus</u> (Kner)	occas	few	I26020-001

<u>Centropogon australis</u> (White)	occas	few	I26015-002
<u>Epinephelus</u> sp.	occas	few	I26012-001
<u>Favonigobius tamarensis</u> (Johnson)	occas	few	I26014-002
<u>Heteroclinus heptaeolus</u> (Ogilby)	occas	few	I26008-001
			I26010-001
<u>Muraenichthys</u> sp.	occas	few	I26019-001
<u>Philypnodon grandiceps</u> (Kreft)	occas	few	I26016-001
<u>Pseudogobius olorum</u> (Sauvage)	occas	few	I26013-001
			I26014-001
			I26015-001
<u>Pseudogobius</u> sp.	occas	few	I26011-001
<u>Rubralga ergastulorum</u> (Richardson)	occas	few	I26007-001
<u>Scorpaenidae</u> sp.	occas	few	I26015-003
			I26009-001

## APPENDIX 1b.

Opisthobranchs found in Twofold Bay on field trips of Feb 1983 and March 1986. (Courtesy of Dr. W. Rudman).

Species	Year found
Order Aplysiomorpha	
<u>Aplysia parvula</u> Guilding	83/86
<u>Dolabrifera dolabrifera</u> (Cuvier)	86
<u>Stylocheilus longicauda</u> (Quoy & Gaimard)	83
Order Pleurobranchomorpha	
<u>Berthellina citrina</u> (Ruppell & Leuckart)	83
<u>Pleurobranchaea maculata</u> (Quoy & Gaimard)	83
Order Bullomorpha	
<u>Chelidonura fulvipunctata</u> Baba	83
<u>Chelidonura inornata</u> Baba	83
<u>Ilbia ilbi</u> Burn	83
<u>Philine</u> sp.	83
Order Sacoglossa	
<u>Elysia maoriae</u> Powell	86
<u>Hermaea cremoniana</u> Trinchese	83
' <u>Hermaea cf. dendritica</u> '	86
Order Nudibranchia	
Suborder Dendronotacea	
<u>Bornella stellifer</u> (Adams & Reeve)	83
<u>Tritonia</u> sp.1	86
<u>Tritonia</u> sp.2	86
Suborder Doridacea	
<u>Aphelodoris varia</u> (Abraham)	83/86
<u>Ceratosoma amoena</u> (Cheeseman)	83
<u>Chromodoris hunteri</u> Rudman	86
<u>Chromodoris tasmaniensis</u> Bergh	83
<u>Chromodoris thompsoni</u> Rudman	83/86
<u>Dendrodoris 'nigra'</u>	86
<u>Dendrodoris</u> sp.	83/86
<u>Discodoris</u> sp.	83
<u>Glossodoris angasi</u> Rudman	83/86
' <u>Hoplodoris nodulosa</u> '	83/86
<u>Hypselodoris bennetti</u> (Angas)	83/86
<u>Jorunna pantherina</u> (Angas)	86
<u>Noumea haliclona</u> Burn	83
<u>Plocamopherus imperialis</u> Angas	86
<u>Polycera capensis</u> (Quoy & Gaimard)	86
<u>Polycera</u> sp.	83
<u>Trippa albata</u> Burn	83

Suborder	<u>Aeolidacea</u>	
	<u>Aeolidiella foulisi</u> Angas	83
	<u>Austraeolis cacaotica</u> (Stimpson)	83/86
	<u>Cratena lineata</u> Eliot	83
	<u>Eubranchus</u> sp.1	86
	<u>Eubranchus</u> sp.2	86
	<u>Facelina newcombi</u> (Angas)	86
	<u>Favorinus japonicus</u> Baba	86
	<u>Fiona pinnata</u> (Eschscholtz)	83
	<u>Flabellina peonicia</u> (Burn)	86
	<u>Flabellina</u> sp.	86
	<u>Pteraeolidia ianthina</u> Angas	83/86
Suborder	<u>Arminacea</u>	
	<u>Caldukia affinis</u> (Burn)	83/86
	<u>Madrella sanguinea</u> (Angas)	86

APPENDICES 2 - 18. INVENTORY OF MARINE FAUNA FOUND AT EACH SITE  
ACCORDING TO HABITAT.

APPENDIX: 2

SITE: MUNGANNO POINT

HABITAT: INTERTIDAL ROCK PLATFORM

POLYCHAETA

CRUSTACEA

MOLLUSCA

Arabella n.sp.1  
Autolytus sp.1  
Branchiomma  
nigromaculata  
Ceratonereis aquisetis  
Chrysopetalum sp.1  
Eumida cf. sanguinea  
Eunice aphroditois  
Galeolaria caespitosa  
Harmothoe sp.1  
Harmothoe sp.2  
Idanthyrus pennatus  
Lepidonotus sp.1  
Lepidonotus sp.2  
Lepidonotus sp.3  
Longicarpus modesta  
Lysidice cf. collaris  
Perinereis amblyodonta  
Phyllodoce n.sp.1,  
Pomatoceros sp.1  
Pomatoceros sp.2  
Serpula rubens  
Syllid ?sp.1  
Syllid ?sp.2  
Syllid ?sp.3  
Terebella pappus

Alope ?orientalis  
Aora maculata  
Austrobalanus imperator  
Austromegabalanus  
nigrescens  
Catomerus polymerus  
Chamaesipho columna  
Chthamalus antennatus  
Cyclograpsus audouinii  
Cyclograpsus cf.  
audouinii  
Elasmopus bollonsi  
Elasmopus ?yunde  
Eurylana arcuata  
Exosphaeroma sp.  
?Gammaropsis sp.1  
?Gammaropsis sp.3  
Gondogeneia  
microdeuteropa  
Halicarcinus ovatus  
Hyale crassicornis  
Hyale cf. loorea  
Hyale maroubrae  
Hyale rubra  
Hyale sp.  
Ianiropsis sp.  
Iathrippa sp.  
Ischromene ?polytyla  
Jaeropsis sp.1  
Leptograpsus variegatus  
Notomegabalanus  
algicola  
Notomithrax minor  
Notomithrax ursus  
  
Orchestia sp.  
Ozium truncatus  
Pachygrapsus laevimanus  
Pagurus sp.  
?Paramoera sp.  
Plagusia chabrus  
Tanaidacean spp.  
Tesseropora rosea  
Tetraclitella  
purpurascens

Acanthochitona pilsbryi  
Acanthochitona retrojecta  
Acanthochitona sp.1  
Amblychilepas  
javanicensis  
Anomia descripta  
Astraea tenforiformis  
sirius  
Austrocochlea concamerata  
Austrocochlea constricta  
Austrocochlea sp.(juv.)  
Austromytilus rostratus  
Bembicium nanum  
Cantharidella picturata  
Cellana tramoserica  
Chiton pelliserpentis  
maugeanus  
Euriclianculus floridus  
Haliotis ruber  
Herpetopoma aspersa  
Hinea braziliiana  
Ischnochiton australis  
Ischnochiton elongatus  
crispus  
Kopionella matthewsi  
Lasaea australis  
Mimachlamys asperimus  
Mitrella sp.  
Montfortula rugosa  
Morula marginalba  
Mytilus edulis  
Nerita atramentosa  
Nodilittorina pyramidalis  
Nodilittorina unifasciata  
Notoacmea flammea  
Notoacmea petterdi  
Patella peroni  
Patelloida alticostata  
Patelloida latistrigata  
Patelloida mufria  
Plaxiphora albida  
Ranella australasia  
Saccostrea commercialis  
Scutus antipodes  
Siphonaria denticulata  
Siphonaria diemenensis



## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Siphonaria funiculata  
Siphonaria sp.(juv.)  
Thais orbita  
Thaliota sp.  
Trichomusculus barbatus  
Trichomya hirsuta  
Turbo undulatus

## ECHINODERMATA

## OTHERS

Coscinasterias calmaria  
Ophionereis schayeri  
Patiriella calcar  
Patiriella exigua  
Petricia vernicina  
Uniophora granifera

Acoela spp. (PLATYHELMINTHES)  
Heteroclinus heptaeolus (PISCES)  
Nemertean ?sp.1 (NEMERTINEA)  
Nemertean ?sp.3 (NEMERTINEA)  
Nemertean ?sp.5 (NEMERTINEA)  
Phlyctenactis tuberculosa (COELENTERATA)  
Pycnogonid spp. (PYCNOGONIDA)  
Pyura gibbosa (UROCHORDATA)  
Sipunculan spp. (SIPUNCULA)

APPENDIX: 3  
 SITE: MUNGANNO POINT  
 HABITAT: SUBTIDAL ROCK PLATFORM

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

<u>Amphiglena mediterranea</u>	<u>Actaea peronii</u>	<u>Acanthochitona</u> sp.1
<u>Arabella iricolor</u>	<u>Alpheus socialis</u>	<u>Aphelodoris varia</u>
<u>iricolor</u>	<u>Amaryllis</u> sp.1	Bivalve ? sp.1
<u>Arabella n.sp.1</u>	<u>Amaryllis</u> sp.3	<u>Cantharidella picturata</u>
<u>Augeneria verdis</u>	<u>Ampelisca euroa</u>	<u>Cardita excavata</u>
<u>Autolytus</u> sp.3	<u>Ampelisciphotis</u> sp.	<u>Ceratosoma amoena</u>
<u>Axiothella</u> sp.	<u>Ampithoe</u> sp.2	<u>Chicoreus denudatus</u>
<u>Branchiomma</u>	<u>Ampithoe</u> sp.3	<u>Herpetopoma aspersa</u>
<u>nigromaculata</u>	<u>Ampithoe</u> sp.5	<u>Hiatella australis</u>
<u>Diopatra dentata</u>	<u>Aora hebes</u>	<u>Ischnochiton australis</u>
<u>Dorvillea australiensis</u>	<u>Aora maculata</u>	<u>Ischnochiton cariosus</u>
<u>Eunice aphroditois</u>	<u>Apanthura xanthorrhoea</u>	<u>Ischnochiton versicolor</u>
<u>Eunice torresiensis</u>	<u>Balanus trigonus</u>	<u>Ischnochiton</u> sp.2
<u>Euphrosine</u> sp.	<u>Ceradocus ramsayi</u>	<u>Lorica volvox</u>
<u>Galeolaria caespitosa</u>	<u>Ceradocus rubromaculatus</u>	<u>Mimachlamys asperrimus</u>
<u>Harmothoe</u> sp.1	? <u>Ceradocus</u> sp.	<u>Mitrella pulla</u>
<u>Harmothoe</u> sp.2	<u>Cheiriphotis</u> sp.	<u>Mitrella</u> sp.
<u>Hydroides</u> cf.	<u>Cirolana australiense</u>	<u>Musculus nanus</u>
<u>brachyacantha</u>	<u>Corophium</u> sp.	<u>Musculus</u> sp. (juv.)
? <u>Laonice</u> sp.	<u>Cymadusa</u> sp.1	<u>Mytilus edulis</u>
<u>Lepidasthenia</u> sp.	<u>Cymodoce</u> spp.	<u>Notoplax</u> cf. <u>rubrostrata</u>
<u>Lepidonotus</u>	<u>Elasmopus bollonsi</u>	<u>Parachiton</u> sp.
<u>melanogrammus</u>	<u>Erichthonius</u> sp.	<u>Patella chapmani</u>
<u>Lepidonotus</u> sp.3	<u>Gammaropsis</u> sp.	<u>Polycera capensis</u>
<u>Longicarpus modesta</u>	? <u>Gammaropsis</u> sp.1	<u>Pteraeolidia ianthina</u>
<u>Lysidice</u> cf. <u>collaris</u>	? <u>Gammaropsis</u> sp.2	<u>Ranella australasia</u>
<u>Megalomma</u> sp.	? <u>Gammaropsis</u> sp.3	<u>Trichomusculus barbatus</u>
<u>Nematonereis unicornis</u>	<u>Gnathia ferox</u>	<u>Tugali</u> sp.
<u>Neovermilia globula</u>	<u>Halicarcinus ovatus</u>	<u>Turbo torquatus</u>
<u>Nicolea amnis</u>	<u>Haliophasma</u> sp.1	<u>Venerupis fabagella</u>
<u>Palola</u> sp.1	<u>Haswellia</u> cf. <u>juxtacarnea</u>	<u>Vulsella vulsella</u>
<u>Perinereis amblyodonta</u>	<u>Heteromysis</u> sp.	
<u>Phyllodoce</u> n.sp.1	<u>Hippolyte ventricosa</u>	
<u>Pista</u> n.sp.	<u>Iathrippa</u> sp.	
<u>Podarke angustifrons</u>	<u>Jaeropsis</u> sp.1	
<u>Pomatoceros</u> sp.1	<u>Janirid</u> sp.1	
<u>Pomatoceros</u> sp.2	<u>Janirid</u> sp.2	
<u>Sabellastarte indica</u>	<u>Lemboides australis</u>	
<u>Serpula rubens</u>	<u>Leucothoe boolpooli</u>	
<u>Serpula</u> sp.1	<u>Leucothoe commensalis</u>	
<u>Spirobranchus tetroceros</u>	<u>Liljeborgia aequabilis</u>	
<u>Syllid</u> ?sp.1	<u>Limnoria</u> sp.	
<u>Syllid</u> ?sp.2	<u>Lysianassid</u> sp.1	
<u>Syllid</u> ?sp.3	<u>Maera viridis</u>	
<u>Syllid</u> ?sp.5	? <u>Maera</u> sp.	
<u>Syllid</u> ?sp.6	<u>Mallacoota subcarinata</u>	
<u>Thelepus</u> n.sp.2	<u>Melita</u> sp.	

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Mesanthura dianella  
Meteusiroides sp.  
Myodocopa spp.  
Naxia deflexifrons  
Notomegabalanus algicola  
Notomithrax minor  
Paguristes squamosus  
Pagurus sinuatus  
?Paracilicaea sp.  
Paradexamine frinsdorfi  
Paradexamine ?thadalee  
Paraleucothoe novaehollandiae  
Paranthura senecio  
Parawaldekia dilkera  
Photis sp.1  
Pilumnus rufopunctatus  
Pilumnus sp.  
Plagusia chabrus  
Podocerus sp.2  
Podocerus sp.3  
?Pseudopleonexes sp.  
Siriella australis  
Sphaeromatid sp.5  
Stenetrium armatum  
Tanaidacean spp.  
Tethygeneia nalgo  
Tethygeneia waminda  
Waldeckia sp.

## ECHINODERMATA

## OTHERS

<u>Amphiura constricta</u>	Acoela spp. (PLATYHELMINTHES)
<u>Amphiura micra</u>	Nemertean ?sp.1 (NEMERTINEA)
<u>Cenolia tasmaniae</u>	Nemertean ?sp.2 (NEMERTINEA)
<u>Centrostephanus</u>	Nemertean ?sp.3 (NEMERTINEA)
<u>rodgersii</u>	Pycnogonid spp. (PYCNOGONIDA)
<u>Coscinasterias</u>	<u>Pyura gibbosa</u> (UROCHORDATA)
<u>calamaria</u>	<u>Pyura spinifera</u> (UROCHORDATA)
<u>Heliodaridaris</u>	
<u>erythrogramma</u>	
<u>Nectria ocellata</u>	
<u>Ophiactis resiliens</u>	
<u>Ophionereis schayeri</u>	
<u>Ophiothrix (Ophiothrix)</u>	
<u>cularis</u>	
<u>Ophiothrix (Placophiothrix)</u>	
<u>spongicola</u>	
<u>Patiriella exigua</u>	
<u>Patiriella gunni</u>	
<u>Pentacta ignava</u>	
<u>Petricia vernicina</u>	

ECHINODERMATA

OTHERS

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Phyllacanthus  
parvispinus  
Plecaster decanus  
Uniophora granifera

APPENDIX: 4  
 SITE: MUNGANNO POINT  
 HABITAT: WHARF PILE, INTERTIDAL AND SUBTIDAL

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

<u>Amphiglena mediterranea</u>	<u>Actaea peronii</u>	<u>Acanthochitona pilsbryi</u>
<u>Arabella iricolor</u>	<u>Alpheus socialis</u>	<u>Acanthochitona retrojecta</u>
<u>iricolor</u>	<u>Alpheus sp.</u>	<u>Acanthochitona sp.1</u>
<u>Arabella n.sp.1</u>	<u>Amaryllis sp.3</u>	<u>Agnewia tritoniformis</u>
<u>Autolytus sp.1</u>	<u>Ampelisca euroa</u>	<u>Anomia ione</u>
<u>Autolytus sp.2</u>	<u>Aora hebes</u>	<u>Austreaolis cacaotica</u>
<u>Axiothella sp.</u>	<u>Apanthura xanthorrhoea</u>	<u>Bivalve ? sp.1</u>
<u>Branchiomma</u>	<u>Austrobalanus imperator</u>	<u>Callistochiton antiquus</u>
<u>nigromaculata</u>	<u>Austromegabalanus</u>	<u>Chiton pelliserpentis</u>
<u>Chrysopetalum sp.1</u>	<u>nigrescens</u>	<u>maugeanus</u>
<u>Eumida cf. sanguinea</u>	<u>Balanus trigonus</u>	<u>Dorid Nudibranch sp.1</u>
<u>Eunice aphroditois</u>	<u>Caprella equilibra</u>	<u>Dorid Nudibranch sp.2</u>
<u>Eunice cf. australis</u>	<u>Ceradocus ramsayi</u>	<u>Emarginula sp.</u>
<u>Eunice tubifex</u>	<u>Cirolana australiense</u>	<u>Herpetopoma aspersa</u>
<u>Euprosine sp.</u>	<u>Corophium sp.</u>	<u>Hiatella australis</u>
<u>Galeolaria caespitosa</u>	<u>Cymodoce haswelli</u>	<u>Lasaea australis</u>
<u>Harmothoe sp.1</u>	<u>Cymodoce spp.</u>	<u>Lima nimbifer</u>
<u>Harmothoe sp.2</u>	<u>Decapod larvae</u>	<u>Mimachlamys asperrimus</u>
<u>Hydroides cf.</u>	<u>Dulichchiella australis</u>	<u>Mitrella pulla</u>
<u>branchyacantha</u>	<u>Elasmopus bollonsi</u>	<u>Modiolus areolatus</u>
<u>Idanthyrus pennatus</u>	<u>Gammaropsis sp.</u>	<u>Montfortula rugosa</u>
<u>Isolda pulchella</u>	<u>?Gammaropsis sp.1</u>	<u>Musculus nanus</u>
<u>Lepidonotus sp.1</u>	<u>?Gammaropsis sp.2</u>	<u>Musculus sp. (juv.)</u>
<u>Lepidonotus sp.2</u>	<u>?Gammaropsis sp.3</u>	<u>Mytilus edulis</u>
<u>Lepidonotus sp.3</u>	<u>Gnathia ferox</u>	<u>Nassarius pauperus</u>
<u>Longicarpus modesta</u>	<u>Gonodogeneia</u>	<u>Notoplax cf. rubostrata</u>
<u>Lysidice cf. collaris</u>	<u>microdeuteropa</u>	<u>Ostrea angasi</u>
<u>Megalomma sp.</u>	<u>Halicarcinus ovatus</u>	<u>Philippia lutea</u>

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Mesochaetopterus sp.  
Nematonereis unicornis  
Nicolea amnis  
Palola sp.1  
Perinereis amblyodonta  
Phyllodoce n.sp.1  
Phyllodocid n.sp.2  
Phyllodocid n.sp.3  
Pista n.sp.  
Podarke angustifrons  
Polydora socialis  
Pomatoceros sp.2  
Protula sp.  
Sabellastarte indica  
Serpula rubens  
Spirobranchus tetraceros  
Syllid ?sp.1  
Syllid ?sp.2  
Syllid ?sp.3  
Syllid ?sp.4  
Syllid ?sp.6  
Thelepus n.sp.1  
Thelepus n.sp.2  
Thelepus n.sp.3

Haswellia carnea  
Haswellia cf.  
juxtacarnea  
Heteromysis sp.  
?Hircella cornigera  
Ianiropsis sp.  
Iathrippa sp.  
Ibla quadrivalvis  
Ischromene ?polytyla  
Jaeropsis sp.1  
Janirid sp.1  
Janirid sp.2  
Leucothoe assimilis  
Leucothoe boolpooli  
Leucothoe commensalis  
Liljeborgia aequabilis  
Lysianassid sp.1  
Maera viridis  
?Maera sp.  
Meteusiroides sp.  
Myodocopa spp.  
Notomegabalanus algicola  
Notomithrax minor  
Pachygrapsus laevimanus  
Pagurus ?lacertosus nana  
Paradexamine ?thadalee  
Parajassa sp.  
Paraleucothoe novaehollandiae  
Paranthura senecio  
Photis sp.1  
Pilumnus rufopunctatus  
Pilumnus sp.  
Pinnotheres hickmani  
Plagusia chabrus  
Plagusia glabra  
Podocerus sp.2  
Podocerus sp.3  
Polycheira tenuipes  
Rhynchocinetes ?rugulosus  
Sphaeromatid sp.3  
Stenetrium armatum  
Synalpheus tumidomanus  
Tanaidacean spp.  
Tesseropora rosea  
Tethygeneia nalgo  
Tetraclitella purpurascens  
Waldeckia sp.

Plaxiphora albida  
Septa parthenopea  
Serpulorbis siphonaria  
Siphonaria funiculata  
Thais orbita  
Thaliota sp.  
Trichomusculus barbatus  
Trichomya hirsuta  
Tugali sp.  
Venerupis crenata  
Venerupis fabagella  
Vulsella vulsella

## ECHINODERMATA

## OTHERS

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<u>Amphiura micra</u>	Acoela spp. (PLATYHELMINTHES)
<u>Ophiactis resiliens</u>	<u>Epinephelus</u> sp. (PISCES)
<u>Ophionereis schayeri</u>	<u>Herdmania momus</u> (UROCHORDATA)
<u>Ophiothrix</u> ( <u>Ophiothrix</u> )	Nemertean ?sp.1 (NEMERTINEA)
<u>cilaris</u>	
<u>Ophiothrix</u> ( <u>Ophiothrix</u> )	Nemertean ?sp.3 (NEMERTINEA)
<u>caespitosa</u>	Pycnogonid spp. (PYCNOGONIDA)
<u>Uniophora granifera</u>	<u>Pyura gibbosa</u> (UROCHORDATA)
	<u>Sipunculan</u> spp. (SIPUNCULIDA)

## APPENDIX 5

SITE: MUNGANNO POINT

HABITAT: SUBTIDAL SAND, AIRLIFTED

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Arabella n.sp.1  
Branchiomma nigromaculata  
Diopatra dentata  
Idanthyrus pennatus  
Lepidonotus sp.3  
Owenia fusiformis  
Pomatoceros sp.1  
Protodorvillea sp.  
Syllid ?sp.1

Ampelisciphotis sp.  
Birubius muldarpus  
Cumacean spp.  
Eurydice ?binda  
Myodocopa spp.  
Siphonoecetes spp.

Bittium sp.  
Eurytrochus strangei  
Gena impertusa  
Guraleus pictus  
Mesoginella cf.translucida  
Mitrella sp.  
Musculus sp. (juv.)  
Nassarius glans particeps  
Nassarius pauperatus  
?Notocallista sp.

OTHERS

Nemertean ? sp.1 (NEMERTINEA)  
Nemertean ? sp.3 (NEMERTINEA)



## APPENDIX 6

SITE: MURRUMBULGA POINT

HABITAT: INTERTIDAL ROCK PLATFORM

## POLYCHAETA

Arabella n.sp.1  
Australonereis ehlersi  
Branchiomma nigromaculata  
Ceratonereis aequisetis  
Diopatra dentata  
Dorvillea australiensis  
Eumida cf. sanguinea  
Eunice cf. australis  
Eunice tridentata  
Galeolaria caespitosa  
Harmothoe sp.2  
Idanthyrus pennatus  
Lanassa sp.  
Leitoscoloplos normalis  
Lepidonotus sp.1  
Lepidonotus sp.4  
Lysidice cf. collaris  
Marphysa sanguinea  
Nematonereis unicornis  
Perinereis amblyodonta  
Podarke angustifrons  
Pomatoceros sp.1  
Pomatoceros sp.2  
Sabellastarte indica  
Scoloplos (Scoloplos)  
  cylindrifer  
Scoloplos (Scoloplos)  
  novaehollandiae  
Scoloplos (Scoloplos)  
  simplex  
Serpula jukesii  
Syllid ?sp. 1  
Syllid ?sp. 3  
Terebella pappus  
Thelepus n.sp.3

## CRUSTACEA

Alpheus euprosyne  
  richardsoni  
Amphoroidea angustata  
Apanthura xanthorrhoea  
Axiopsis australiensis  
Birubius mayamayi  
Birubius cf. nammuldu  
Carcinus maenas  
Catomerus polymerus  
Ceradocus sp.  
?Ceradocus sp.  
Chamaesipho columna  
Chthamalus antennatus  
Cirolana australiense  
Corophium sp.  
Cyclograpsus audouinii  
?Cymodopsis sp.  
Elminius covertus  
Eurylana arcuata  
Exosphaeroma sp.  
Gondogeneia  
  microdeuteropa  
Halicarcinus ovatus  
Hyale crassicornis  
Hyale maroubrae  
Hyale rubra  
Hyale sp.  
Ibla quadrivalvis  
Ianiropsis sp.  
Jaeropsis sp.1  
Leptograpsus variegatus  
Maera viridis  
Melita sp.  
Notomegabalanus  
  algicola  
Orchestia sp.  
Ozius truncatus  
Pachygrapsus  
  laevimanus  
Palaemon serenus  
?Paramoera sp.  
Paranthura senecio  
Parawaldeckia dilkera  
Pilumnopus  
  serratifrons  
Sesarma erythroductyla  
Tanaidacean spp.

## MOLLUSCA

Acanthochitona retrojecta  
Acar botanica  
Agnewia tritoniformis  
Astraea tenforiformis  
  sirius  
Austrocochlea concamerata  
Austrocochlea constricta  
Austrocochlea sp. (juv.)  
Barbatia pistachia  
Bedeve hanleyi  
Bembicium auratum  
Bittium sp.  
Cantharidella picturata  
Cellana tramoserica  
Chiton jugosus  
Chiton pelliserpentis  
  maugeanus  
Cominella lineolata  
Conus anemone  
Diodora lineata  
Euriclanculus floridus  
Eurytrochus strangei  
Granata imbricata  
Haustrum vinosum  
Herpetopoma aspersa  
Hinea braziliana  
Ischnochiton australis  
Ischnochiton cariosus  
Ischnochiton elongatus  
  crispus  
Ischnochiton lentiginosus  
Ischnochiton smaragdinus  
Ischnochiton sp. 1  
Ischnochiton sp. 2  
Ischnochiton versicolor  
Lasaea australis  
"Lepsiella" reticulata  
Mesoclanculus plebejus  
Mitrella pulla  
Mitrella sp.  
Montfortula rugosa  
Morula marginalba  
Mytilus edulis  
Nerita atramentosa  
Nodilittorina pyramidalis  
Nodilittorina unifasciata  
Notoacmea flammea

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Tesseropora rosea  
Tetraclitella  
purpurascens  
Xanthias elegans

Notoacmea petterdi  
Onchidella patelloides  
Patella peroni  
Patelloida alticostata  
Patelloida latistrigata  
Patelloida mufria  
Phasianotrochus eximus  
Phasianotrochus sp.  
Pleurobranch sp.1  
Ranella australasia  
Saccostrea commercialis  
Scutus antipodes  
Scutus sp. (juv.)  
Siphonaria denticulata  
Siphonaria diemenensis  
Siphonaria funiculata  
Solemya australia  
Teredo sp.  
Thais orbita  
Thaliota sp.  
Trichomya hirsuta  
Turbo undulatus  
Venerupis crenata  
Xenostrobus securis

## ECHINODERMATA

## OTHERS

Amphipholis squamata Acoela spp. (PLATYHELMINTHES)  
Coscinasterias calamaria Nemertean ?sp. 1 (NEMERTINEA)  
Heliocidaris erythrogramma Nemertean ?sp. 4 (NEMERTINEA)  
Patiriella exigua Phlyctenactis tuberculosa (COELENTERATA)  
Petricia vernicina Sipunculan spp. (SIPUNCULA)

## APPENDIX 7

SITE: MURRUMBULA POINT

HABITAT: SUBTIDAL ROCK PLATFORM

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

<u>Amphiglena mediterranea</u>	<u>Amaryllis</u> sp.1	<u>Acanthochitona pilsbryi</u>
<u>Anaitides longipes</u>	<u>Amaryllis</u> sp.2	<u>Acanthochitona retrojecta</u>
<u>Arabella iricolor iricolor</u>	<u>Amaryllis</u> sp.3	<u>Acanthochitona</u> sp.1
<u>Arabella</u> n.sp.1	<u>Anamixis</u> sp.	<u>Astraea tenforiformis</u>
<u>Autolytus</u> sp.4	<u>Ampelisca euroa</u>	<u>sirius</u>
<u>Axiothella</u> sp.	<u>Ampelisciphotis</u> sp.	<u>Astraliu</u> sp.
<u>Boccardia chilensis</u>	<u>Amphoroidea angustata</u>	<u>Agnewia tritoniformis</u>
<u>Boccardiella</u> sp.	<u>Ampithoe</u> sp.1	<u>Barbatia pistachia</u>
<u>Branchiomma nigromaculata</u>	<u>Ampithoe</u> sp.2	<u>Bedeve hanleyi</u>
<u>Ceratonereis aequisetis</u>	<u>Ampithoe</u> sp.4	<u>Bittium</u> sp.
<u>Chrysopetalum</u> sp.1	<u>Aora maculata</u>	? <u>Cellana tramoserica</u>
<u>Diopatra dentata</u>	<u>Aora mortoni</u>	<u>Chiton jugosus</u>
<u>Dodecaceria</u> sp.	<u>Apanthura xanthorrhoea</u>	<u>Crepidula aculeata</u>
<u>Dorvillea australiensis</u>	<u>Atylus homochir</u>	<u>Euriclanculus floridus</u>
<u>Eunice aphroditois</u>	<u>Balanus trigonus</u>	<u>Eurytrochus strangei</u>
<u>Galeolaria caespitosa</u>	<u>Birubius quearus</u>	<u>Gena impertusa</u>
<u>Harmothoe</u> sp.2	<u>Brolgus tattersalli</u>	<u>Granata imbricata</u>
<u>Hydroides</u> cf. <u>brachyacantha</u>	<u>Caprella danilevskii</u>	<u>Haliotis ruber</u>
<u>Idanthyrus pennatus</u>	<u>Cerceis</u> ? <u>obtusa</u>	<u>Herpetopoma aspersa</u>
<u>Isolda pulchella</u>	<u>Ceradocus ramsayi</u>	<u>Ischnochiton cariosus</u>
? <u>Laonice</u> sp.	<u>Ceradocus rubromaculatus</u>	<u>Ischnochiton elongatus</u>
<u>Lepidonotus</u> sp.2	<u>Ceradocus serratus</u>	<u>crispus</u>
<u>Lepidonotus</u> sp.3	<u>Ceradocus</u> sp.	<u>Ischnochiton smaragdinus</u>
<u>Longicarpus modesta</u>	? <u>Ceradocus</u> sp.	<u>Ischnochiton versicolor</u>
<u>Lysidice</u> cf. <u>collaris</u>	<u>Cheiriphotis</u> sp.	<u>Kerguelenella stoweai</u>
<u>Lysidice</u> sp.	<u>Cilicaea tenuicauda</u>	" <u>Lepsiella</u> " <u>reticulata</u>
<u>Megalomma</u> sp.	<u>Cilicaeopsis</u> cf.	
<u>Neovermilia globula</u>	<u>whiteleggei</u>	<u>Mesoclaculus plebejus</u>
<u>Nicolea amnis</u>	<u>Cirolana australiense</u>	<u>Mitrella lincolnensis</u>
<u>Phyllocid</u> n.sp. 1	<u>Corophium</u> sp.	<u>Mitrella pulla</u>
<u>Pista</u> n.sp.	<u>Cymodoce haswelli</u>	<u>Mitrella</u> sp.
<u>Podarke angustifrons</u>	<u>Cymodoce</u> spp.	<u>Monia zealandica</u>
<u>Pomatoceros</u> sp. 1	? <u>Cymodopsis</u> sp.	
<u>Pomatoceros</u> sp. 2	<u>Cyproidea ornata</u>	<u>Musculus</u> sp. (juv)
<u>Prionospio</u> cf. <u>cirrifera</u>	<u>Dulichchiella australis</u>	<u>Nassarius glans particeps</u>
<u>Reterebella</u> n.sp.	<u>Erichthonius</u> sp.	<u>Nassarius pauperatus</u>
<u>Sabellastarte indica</u>	<u>Gabophilias olono</u>	<u>Nassarius</u> sp. (juv.)
<u>Schistomeringos loveni</u>	<u>Gammarella berringar</u>	<u>Notoplax</u> cf. <u>rubrostrata</u>
<u>Serpula jukesii</u>	<u>Gammarella mokari</u>	<u>Patella chapmani</u>
<u>Serpula rubens</u>	<u>Gammaropsis</u> sp.	<u>Patella mufria</u>
<u>Serpula</u> sp.1	? <u>Gammaropsis</u> sp.1	<u>Phasianotrochus</u> sp.
<u>Syllid</u> ?sp.1	? <u>Gammaropsis</u> sp.2	<u>Pleurobranch</u> sp.1
<u>Syllid</u> ?sp.2	? <u>Gammaropsis</u> sp.3	<u>Scutus antipodes</u>
<u>Syllid</u> ?sp.3	<u>Halicarcinus ovatus</u>	<u>Thais orbita</u>
<u>Syllid</u> ?sp.6	<u>Haliophasma carnea</u>	<u>Trichomusculus barbatus</u>
<u>Terebella pappus</u>	<u>Haswellia</u> cf. <u>juxtacarnea</u>	<u>Turbo torquatus</u>
<u>Thelepus</u> n.sp.3	<u>Heteromysis</u> sp.	<u>Turbo undulatus</u>

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

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<u>Ianiropsis</u> sp.	<u>Tugali</u> sp.
<u>Iathrippa</u> sp.	<u>Venerupis crenata</u>
<u>Jaeropsis</u> sp.2.	<u>Venerupis fabagella</u>
<u>Lemboides australis</u>	<u>Vulsella vulsella</u>
<u>Lembos aequimanus</u>	
<u>Leptanthura diemenensis</u>	
<u>Leucothoe boolpooli</u>	
<u>Leucothoe commensalis</u>	
<u>Liljeborgia aequabilis</u>	
<u>Limnoria</u> sp.	
<u>Maera viridis</u>	
<u>Maera</u> sp.	
? <u>Maera</u> sp.	
<u>Melita</u> sp.	
<u>Mesanthura dianella</u>	
<u>Meteusiroides</u> sp.	
<u>Myodocopa</u> spp.	
<u>Notomegabalanus algicola</u>	
<u>Orthoprotella</u> cf. <u>mayeri</u>	
? <u>Paracilicaea</u> sp.	
<u>Paradexamine churinga</u>	
<u>Paradexamine lanacoura</u>	
<u>Paradexamine</u> ? <u>thadalee</u>	
<u>Paraleucothoe novaehollandiae</u>	
<u>Paraproto spinosa</u>	
<u>Parawaldeckia dilkera</u>	
<u>Petalomera lateralis</u>	
<u>Photis</u> sp.1	
<u>Pilumnus rufopunctatus</u>	
<u>Plagusia chabrus</u>	
<u>Podocerus</u> sp.1	
<u>Podocerus</u> sp.2	
<u>Podocerus</u> sp.3	
<u>Sphaeromatid</u> sp.1	
<u>Sphaeromatid</u> sp.3	
<u>Sphaeromatid</u> sp.4	
<u>Stenetrium</u> cf. <u>armatum</u>	
<u>Syndexamine</u> cf. <u>runde</u>	
<u>Synalpheus tumidomanus</u>	
<u>Tanaidacean</u> spp.	
<u>Tethygeneia nalgo</u>	
<u>Tryphosella camelus</u>	
<u>Xenocheira fasciata</u>	

## ECHINODERMATA

## OTHERS

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<u>Amhiura micra</u>	<u>Acoela</u> spp. (PLATYHELMINTHES)
<u>Clarkcoma pulchra</u>	<u>Herdmania momus</u> (UROCHORDATA)
<u>Coscinasterias calamaria</u>	<u>Heterclinus heptaeolus</u> (PISCES)
	<u>Magellania flavescens</u> (BRACHIOPODA)
<u>Heliocidaris erythrogramma</u>	<u>Nemertean</u> ?sp.2 (NEMERTINEA)

## ECHINODERMATA

## OTHERS

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Heliocidaris tuberculata  
Ophionereis schayeri  
Pentacta ignava  
Pseudocnus sp.

Nemertean ?sp.3 (NEMERTINEA)  
Nemertean ?sp.4 (NEMERTINEA)  
Pycnogonid spp. (PYCNOGONIDA)  
Pyura gibbosa (UROCHORDATA)  
Sipunculan spp. (SIPUNCULIDA)

APPENDIX 8  
 SITE: QUARANTINE BAY  
 HABITAT: POSIDONIA, AIRLIFTED SEDIMENT

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

<u>Anaitides longipes</u>	<u>Alpheus</u> sp.	<u>Acrosterigma cygnorum</u>
<u>Arabella iricolor iricolor</u>	<u>Amaryllis</u> sp.2	<u>Bedeва hanleyi</u>
<u>Arabella n.sp.1</u>	<u>Ampelisca euroa</u>	<u>Bedeва</u> sp. (juv.)
<u>Augeneria verdis</u>	<u>Ampelisciphotis</u> sp.	<u>Bittium</u> sp.
<u>Axiothella</u> sp.	<u>Ampithoe</u> sp.2	<u>Bulla quoyi</u>
<u>Branchiomma nigromaculata</u>	<u>Aora mortoni</u>	<u>Caldukia affinis</u>
<u>Carazziella victoriensis</u>	<u>Apanthura xanthorrhoea</u>	<u>Eumarcia fumigata</u>
<u>Ceratonereis aequisetis</u>	<u>Atylus homochir</u>	<u>Eurytrochus strangei</u>
<u>Dorvillea australiensis</u>	<u>Birubius quearus</u>	<u>Guraleus pictus</u>
<u>Glycera tridactyla</u>	<u>Ceradocus rubromaculatus</u>	<u>Mitrella lincolnensis</u>
<u>Leitoscoloplos normalis</u>	<u>Ceradocus serratus</u>	<u>Nassarius burchardi</u>
<u>Lysidice cf. collaris</u>	? <u>Ceradocus</u> sp.	<u>Nassarius cf. burchardi</u>
<u>Nephtys australiensis</u>	<u>Cirolana australiense</u>	<u>Nassarius pauperatus</u>
<u>Owenia fusiformis</u>	<u>Corophium</u> sp.	<u>Nassarius</u> sp. (juv.)
<u>Perinereis amblyodonta</u>	<u>Cumacean</u> spp.	<u>Phasianotrochus</u> sp.
<u>Phyllodoce novaehollandiae</u>	<u>Cymadusa</u> sp.2	<u>Philine cf. angasi</u>
<u>Podarke angustifrons</u>	<u>Cymodoce</u> spp.	<u>Solemya australis</u>
<u>Polydora</u> spp.	<u>Cyproidea ornata</u>	<u>Tellina deltoidalis</u>
<u>Pomatoceros</u> sp.1	<u>Diogenes senex</u>	<u>Tellina</u> sp.
<u>Pomatoceros</u> sp.2	<u>Erichthonius</u> sp.	<u>Timoclea cardiodes</u>
<u>Prionospio cf. cirrifera</u>	<u>Gammaropsis</u> sp.	<u>Venerupis fabagella</u>
<u>Psammolyce cf. antipoda</u>	<u>Gnathia ferox</u>	<u>Wallucina assimilis</u>
<u>Schistomeringos loveni</u>	<u>Halicarcinus ovatus</u>	
<u>Scoloplos (Scoloplos)</u>	<u>Haustoriopsis</u> sp.1	
<u>simplex</u>	<u>Haustoriopsis</u> sp.2	
	<u>Hippolyte caradina</u>	
	<u>Iphiplateia whiteleggei</u>	
	<u>Lemboides australis</u>	
	<u>Lembos aequimanus</u>	
	<u>Leptanthura diemenensis</u>	
	<u>Leucothoe boolpooli</u>	
	<u>Liljeborgia aequabilis</u>	
	<u>Liljeborgia</u> sp.1	
	<u>Mesanthura dianella</u>	
	<u>Myodocopa</u> spp.	
	<u>Narapheonoides mullaya</u>	
	<u>Orthoprotella cf. mayeri</u>	
	<u>Paguristes squamosus</u>	
	<u>Palaemon affinis</u>	
	<u>Paradexamine lanacoura</u>	
	<u>Paradexamine ?quarallia</u>	
	<u>Paradexamine ?thadalee</u>	
	<u>Parajassa</u> sp.	
	? <u>Paraprotos</u> sp.	
	<u>Parawaldeckia dilkera</u>	
	<u>Penaeus plebejus</u>	
	? <u>Penaeus</u> sp. (juv.)	
	<u>Photis</u> sp.1	

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

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Podocerus sp.2  
Podocerus sp.3  
Portunus pelagicus  
Syncassidina aesturia  
Syndexamine sp.1  
 Tanaidacean spp.  
Tethygeneia nalgo  
Wildus sp.

## ECHINODERMATA

## OTHERS

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<u>Amphiura constricta</u>	Acoela spp. (PLATYHELMINTHES)
<u>Amphiura micra</u>	Nemertean ?sp.1 (NEMERTINEA)
<u>Coscinasterias calamaria</u>	Nemertean ?sp.2 (NEMERTINEA)
	Nemertean ?sp.3 (NEMERTINEA)
	Sipunculan spp. (SIPUNCULIDA)

## APPENDIX 9

SITE: QUARANTINE BAY

HABITAT: POSIDONIA, CRYPTIC FAUNA

## POLYCHAETA

Anaitides longipes  
Arabella n.sp.1  
Branchiomma nigromaculata  
Ceratonereis aequisetis  
Euclymene trinalis  
Galeolaria caespitosa  
Harmothoe sp.1  
Harmothoe sp.2  
Lepidonotus sp.2  
Lysidice cf. collaris  
Nicolea amnis  
Perinereis amblyodonta  
Pista n.sp  
Podarke angustifrons  
Polydora socialis  
Pomatoceros sp.2  
Reterebella n.sp  
Sabellastarte indica  
Serpula jukesii  
Serpula rubens  
Syllid ? sp.1  
Syllid ? sp.3  
Thelepus n.sp.3

## CRUSTACEA

Alpheus sp.  
Ampelisciphotis sp.  
Ampithoe sp.2  
Aora mortoni  
Atylus homchir  
Birubius quearus  
Ceradocus rubromaculatus  
Ceradocus serratus  
?Ceradocus sp.  
Cerapus sp.  
Cirolana australiense  
Corophium sp.  
Cumacean spp.  
Cymodoce spp.  
Cyproidea ornata  
Erichthonius sp.  
Halicarcinus ovatus  
Lemboides australis  
Leptanthura diemenensis  
Leucothoe boolpooli  
Leucothoe commensalis  
Mesanthura dianella  
Notomithrax minor  
Notomithrax ursus  
Paradexamine ?thadalee  
Parajassa sp.  
Parawaldeckia dilkera  
Photis sp.1  
Podocerus sp.3  
Syndexamine sp.1  
Tanaidacean spp.  
Tethygeneia nalgo  
Tryphosella camelus  
Wildus sp.

## MOLLUSCA

Acrosterigma cygnorum  
Anomia ione  
Bedeva hanleyi  
Bedeva sp. (juv.)  
Bittium sp.  
Fulvia tenuicostata  
Gena impertusa  
Ischnochiton australis  
Ischnochiton cariosus  
Ischnochiton elongatus  
crispus  
Ischnochiton smaragdinus  
Ischnochiton versicolor  
Mitrella leucostoma  
Mytilus edulis  
Nassarius pauperatus  
Patelloida mufria  
Scutus antipodes  
Tellina deltoidalis  
Wallucina assimilis

## ECHINODERMATA

Amphipholis squamata  
Coscinasterias calamaria  
Helicoidaris erythrogramma  
Ophionereis schayeri

## OTHERS

Nemertean ?sp.1 (NEMERTINEA)  
Nemertean ?sp.3 (NEMERTINEA)  
Ruboralga ergastulorum (PISCES)  
Sipunculan spp. (SIPUNCULIDA)  
Styela plicata (UROCHORDATA)



APPENDIX 10  
SITE: QUARANTINE BAY  
HABITAT: BAITED TRAP

ECHINODERMATA

CRUSTACEA

MOLLUSCA

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Coscinasterias calamaria Cirolana australiense  
Cymothoid sp.

APPENDIX 11  
 SITE: NULLICA RIVER ESTUARY  
 HABITAT: INFAUNA

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Arabella n.sp.1  
Australonereis ehlersi  
Axiothella sp.  
Ceratonereis aequisetis  
Harmothoe sp.2.  
?Laonice sp.  
Leitoscoloplos normalis  
Lepidonotus carinulatus  
Nephtys australiensis  
Owenia fusiformis  
Perinereis amblyodonta  
Phyllodoce  
  novaehollandiae  
Pista n.sp.  
Podarke angustifrons  
Polydora sp.  
Prionospio cirrifera  
Schistomeringos loveni  
Sigalion bandaeensis  
Syllid ?sp.1  
Terebella pappus  
Thelepus n.sp.3

Alpheus euprosyne  
  richardsoni  
 Cumacean spp.  
Diogenes senex  
Callianassa arenosa  
Heloecius cordiformis  
Hymenosoma hodgkini  
Macrophthalmus latifrons  
Mictyris longicarpus  
 Oniscoidean sp.1  
Palaemon affinis  
Paracorophium  
  ?excavatum  
Penaeus plebejus  
Pilumnopus serratifrons  
Pseudolana towrae  
Syncassidina aesturia  
Tottungus ?tungus  
Urohaustorius metungi  
Victoriopisa australiensis

Ambuscintilla praemium  
Bedeve hanleyi  
Corbula smithiana  
Donax sp.  
Eumarcia fumigata  
Laternula cf. creccina  
Nassarius burchardi  
Polinices melastomum  
Pyrazus ebeninus  
Salinator fragilis  
Spisula trigonella  
Tellina deltoidalis  
Velacumantus australis

## OTHERS

Arenigobius bifrenatus (PISCES)  
Favonigobius tamarensis (PISCES)  
Nemertean ?sp.1 (NEMERTINEA)  
Nemertean ?sp.2 (NEMERTINEA)  
Nemertean ?sp.3 (NEMERTINEA)  
Pseudogobius olorum (PISCES)  
Sipunculan spp. (SIPUNCULIDA)

APPENDIX 12  
 SITE: NULLICA RIVER ESTUARY  
 HABITAT: INTERTIDAL ROCKS

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Ceratonereis aquisetis  
Galeolaria caespitosa  
Lepidonotus carinulatus  
Lepidonotus sp.1  
Nephtys australiensis  
Perinereis amblyodonta  
Syllid ?sp.1

Elminius covertus  
Paracorophium ?excavatum  
Pilumnopeus serratifrons  
Sesarma erythroductyla

Austrocochlea constricta  
Bedevea hanleyi  
Bembicium auratum  
Bembicium nanum  
Cellana tramoserica  
Chiton pelliserpentis  
maugeanus  
Crassostrea gigas  
Lasaea australis  
Mytilus edulis  
Nerita atramentosa  
Nodilittorina pyramidalis  
Nodilittorina unifasciata  
Onchidella patelloides  
Ostrea angasi  
Patelloida mimula  
Pyrazus ebeninus  
Saccostrea commercialis  
Siphonaria diemenensis  
Trichomya hirsuta  
Velacumantus australis  
Venerupis crenata

OTHER

Nemertean ?sp.1

APPENDIX 13  
 SITE: SHADRACKS CREEK  
 HABITAT: INFAUNA

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Ceratonereis aequisetis  
Leitoscoloplos normalis  
Nephtys australiensis  
Owenia fusiformis  
Perinereis amblyodonta  
Phyllodoce  
  novaehollandiae  
Prionospio cirrifera  
Scoloplos (Scoloplos)  
  simplex  
 Syllid ? sp.4

Cyathura hakea  
Melita matilda  
Oniscoidean sp.1  
Palaemon affinis  
Paracalliope sp.  
Paracorophium ?excavatum  
Penaeus plebejus  
Syncassidina aesturia  
Victoriopisa australiensis

Eumarcia fumigata  
Nassarius burchardi  
Salinator fragilis  
Spisula trigonella  
Tellina deltoidalis

## OTHERS

Anguilla australis (PISCES)  
Nemertean ?sp.5 (NEMERTINEA)  
Scorpaenid sp. (PISCES)

APPENDIX 14  
 SITE: CURALO LAGOON  
 HABITAT: INFAUNA

## POLYCHAETA

Arabella n.sp.1  
Australonereis ehlersi  
Axiiothella sp.  
Capitella "capitata"  
Ceratonereis aequisetis  
Leitoscoloplos normalis  
Lysidice cf. collaris  
Nephtys australiensis  
Owenia fusiformis  
Perinereis amblyodonta  
Phyllodoce  
  novaehollandiae  
Scoloplos (Scoloplos)  
  simplex  
 Syllid ? sp.1  
 Syllid ? sp.2

## CRUSTACEA

Alpheus euprosyne  
  richardsoni  
Amarinus paralacustris  
Carcinus maenas  
 Cumacean spp.  
Melita matilda  
Ovalipes australiensis  
Palaemon affinis  
Paracalliope sp.  
Paragrapsus laevis  
Pilumnopeus serratifrons  
 ?Xanthid sp.

## MOLLUSCA

Aplysia sydneyensis  
Bankia sp.  
Eumarcia fumigata  
Laternula cf. creccina  
Salinator fragilis  
Sanguinolaria donacioides  
Tellina deltoidalis

OTHERS

Nemertean ?sp.1 (NEMERTINEA)  
Philypnodon grandiceps (PISCES)  
Pseudogobius olorum (PISCES)  
Pseudogobius sp. (PISCES)

APPENDIX 15  
 SITE: CURALO LAGOON  
 HABITAT: SALTMARSH

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

Ceratonereis aequisetis

Carcinus maenas

Assiminea tasmanica

Helograpsus haswellianus

Salinator fragilis

Orchestia ?australis

Salinator solida

Paragrapsus laevis

Theba pisana

Penaeus plebejus

(stranded)

OTHER

Nemertean ?sp.1 (NEMERTINEA)

APPENDIX 16  
 SITE: FISHERIES CREEK  
 HABITAT: INFAUNA

## POLYCHAETA

Arabella n.sp.1  
Australonereis ehlersi  
Ceratonereis aequisetis  
Harmothoe sp.2  
Leitoscoloplos normalis  
Nephtys australiensis  
Owenia fusiformis

Perinereis amblyodonta  
Phyllodoce  
  novaehollandiae  
Protodorvillea sp.  
Scoloplos (Scoloplos)  
  simplex  
Sigalion bandaeensis  
Spio pacifica

## CRUSTACEA

Carcinus maenas  
Melita matilda  
Mictyris longicarpus  
Orchestia ?austalis  
Ovalipes australiensis  
Palaemon affinis  
Paracorophium  
  ?excavatum  
Paracalliope sp.  
Paragrapsus laevis  
Penaeus plebejus  
Victoriopisa australiensis  
?Xanthid sp.

## MOLLUSCA

Bedeva hanleyi  
Donax sp.  
Eumarcia fumigata  
Mesodesma elongata  
Nassarius burchardi  
Salinator fragilis  
Sanguinolaria donacioides  
Spisula trigonella  
Tellina deltoidalis  
Velacumantus australis

## OTHERS

Anguilla australis (PISCES)  
Centropogon australis (PISCES)  
Nemertean ? sp.1 (NEMERTINEA)  
Pseudogobius olorum (PISCES)  
Scorpaenid sp. (PISCES)

APPENDIX 17  
 SITE: FISHERIES CREEK  
 HABITAT: INTERTIDAL ROCKS

## POLYCHAETA

Galeolaria caespitosa  
Perinereis amblyodonta  
Phyllodoce n.sp.1  
Syllid ?sp.1

## CRUSTACEA

Balanus variegatus  
Carcinus maenas  
Cyclograpsus audouinii  
Elminius coervetus  
Paracorophium  
?excavatum  
Paragrapsus laevis  
Pilumnopus serratifrons  
Sesarma erythroactyla

## MOLLUSCA

Austrocochlea constricta  
Bembicium auratum  
Cellana tramoserica  
Chiton pelliserpentis  
maugeanus  
Lasaea australis  
Mytilus edulis  
Onchidella patelloides  
Patelloida mimula  
Pyrazus ebeninus  
Saccostrea commercialis  
Venerupis crenata

OTHER

Nemertean ?sp.4 (NEMERTINEA)



APPENDIX: 18  
SITE: FISHERIES CREEK  
HABITAT: SALTMARSH

## POLYCHAETA

## CRUSTACEA

## MOLLUSCA

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<u>Carcinus maenas</u>	<u>Bembicium auratum</u>
<u>Helograpsus haswellianus</u>	<u>Onchidina australis</u>
<u>Oniscoidean sp.2</u>	<u>Ophicardelus ornatus</u>
<u>Orchestia ?australis</u>	<u>Ophicardelus quoyi</u>
<u>Paragrapsus laevis</u>	<u>Ophicardelus sulcatus</u>
<u>Sesarma erythroductyla</u>	<u>Salinator solida</u>



PLATE 1

Upper: Munganno Point intertidal rock platform at low-water, showing its steeply sloping nature. The woodchip loading wharf appears in the background.

Lower: Murrumbulga Point intertidal rock platform at low-water.





PLATE 2

Upper: Nullica River looking upstream at low-water. Indicates the gradation from sand at the left, to mud and then Zostera seagrass in the channel at the right.

Lower: Emptying sediment corer into sieve at Nullica River.





PLATE 3

Upper: Oyster covered rocks occurring mid-channel, Nullica River.

Lower: View of the extensive intertidal sand and mud flats at Nullica River, looking upstream from the Princes Highway bridge.





PLATE 4

Upper: Sampling at Curalo Lagoon saltmarsh.

Lower: Fisheries Creek saltmarsh.

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# Colonisation of NSW by foreign marine species

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by P. Hutchings, J. van der Velde and S. Keable.

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IN ANY environment, a percentage of the animals and plants have been introduced by people. Some of these introductions are deliberate, others are accidental.

The majority of introductions fail but 30 species of mammals, 30 species of birds, 16 species of fish, one amphibian, an unknown number of insects and other invertebrates and at least 1400 species of plants have been introduced into Australia and have established breeding populations in the wild (Fox and Adamson, 1986).

The majority of these are terrestrial plants or animals, but introductions have also occurred in marine and freshwater environments.

Some introductions have proven beneficial, such as the introduction of trout and Atlantic salmon which have been commercially successful, whereas others have become pests.

The European carp was introduced into various ponds and creeks in Victoria and New South Wales through the 1800s and is widespread in southeastern Australia.

Carp feed on aquatic vegetation, pulling it up, increasing the turbidity of water and displacing native species of fish.

Another potential problem is the Japanese oyster *Crassostrea gigas* which was introduced into Pittwater near Hobart, Tasmania in 1947 as a commercial crop. It

has since been reported from various localities along the mainland coast of eastern Australia.

The Japanese oyster grows faster than the Sydney rock oyster, *C. commercialis*. If the Japanese oyster becomes established along the New South Wales coast, it may become the dominant oyster, replacing *C. commercialis*. A history of the introduction of *C. gigas* to Australia is given in a tabular form in the *Fisherman* Vol. 4, Pages 3-5 (Wolf and Medcof, 1973).

## Pests not only concern

Introductions which have the potential to become pests are always of greatest concern but in some cases the situation is complicated by other organisms (including bacterial diseases or pathogens) brought in accidentally with an otherwise beneficial introduction.

For example, Japanese oysters brought into Tasmania probably contained Japanese species of the mud worm *Polydora*. These species of *Polydora* may be able to infect Australian oysters as well as their native hosts.

A well-documented case of other organisms being brought in with a beneficial introduction is the oyster drill *Ocenebra japonica* which was introduced accidentally to North America in the early part of this century along with the Japanese oyster. The oyster drill

preyed upon the American native oyster *Ostrea lurida* rather than its traditional food, the Japanese oyster. Estimates of oyster mortality due to the oyster drill are between 15-22 per cent.

Introduced species may also carry diseases or pathogens which do not occur naturally in the region where the introductions are being made. Such diseases may be transmitted to the native fauna with serious effects.

## Accidental introductions

The majority of deliberate introductions of marine organisms involve commercially important species such as oysters or fish and prawns mainly to artificial breeding ponds.

Accidental introductions of marine species can occur as fouling organisms on the bottoms of ships, or as with the oyster drill, in association with another introduction.

The New Zealand barnacle *Elminius modestus* was probably introduced to Britain as a fouling organism (Allen, 1953). This may have been a very common form of introduction in the era of sailing ships.

Another method of introduction has been via ballast water. This has occurred only recently with the advent of highly specialised container ships which carry only one sort of cargo and travel one way empty except for ballast water.

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An example of this is the Japanese mysid (a small crustacean) *Neomysis japonica* which has been found breeding in Fullerton Cove, Hunter River. *Neomysis* now breeds in the Hunter River, but it seems likely that it was introduced via ballast water from container ships in Newcastle Harbour (Hutchings, 1983).

Two species of Japanese gobys have been introduced to Sydney Harbour. Hoese (1973) suggested that either the eggs or larvae were transported in ballast water or that eggs attached to encrusting fauna are carried on the bottom of ships from Japan, develop during the passage and hatch in Sydney Harbour.

In 1982 the Japanese sea bass *Lateolabrax japonicus* was recorded from eastern Australia. Again it is likely that they were transported as larvae in ballast water (Paxton and Hoese, 1985).

As this sort of specialised container shipping is increasing, and large quantities of ballast water are being discharged into every major port throughout the world, it is essential to document the sorts of animals which can be transported in ballast water, and to determine whether these animals establish populations and can pose any threat to local fisheries.

#### Ballast transport

In the late 1970s the New South Wales Department of Fisheries (now Department of Agriculture) began a study to document the transport of marine larvae in ballast water. They selected the woodchip boats which regularly visit Twofold Bay, NSW. These boats discharge ballast water as they take on woodchip.

The project, funded by the Fishing Industry Research Trust Account (FIRTA), identified 16 non-indigenous species of invertebrates alive in the ballast water tanks (Williams, *et al.*, 1982). Other invertebrate larvae were present, but could not be

identified to species, so it is uncertain whether they represented indigenous or non-indigenous fauna.

The Department, having established the presence in the ballast water, of species not normally occurring in the bay, needed to establish whether these species survived the discharge into the bay and could establish breeding populations. If this occurred, it was essential to determine whether they would pose any threats to the fishing industry in the region.

In order to answer these questions, it was first necessary to survey the marine fauna of Twofold Bay and to establish the present fauna of the bay. Only then could the presence of introduced species be ascertained.

#### Museum survey

In 1984 the Australian Museum obtained a FIRTA grant to survey the marine fauna of Twofold Bay and determine whether any non-indigenous marine species had become established. If introduced species were found it would then determine whether any of them were pests or could become pests.

Prior to the woodchip boats visiting Twofold Bay, Eden had been an active port for almost a century. Consequently fouling organisms introduced by this earlier shipping could have already established populations, thereby creating problems for the researchers.

Another problem was that the fauna of Twofold Bay contains many undescribed species and species whose precise geographical distributions are unknown. The fauna of northern Japan where the ballast water is taken on board, is not well known either.

Some species may occur naturally in both Twofold Bay and northern Japan, so each species had to be considered separately to see whether it had been introduced to Twofold Bay, or whether it was a widely distributed species occurring in both areas.

It was not possible to undertake a complete survey of the bay, nor was it necessary. Only organisms which have pelagic larvae or are small and can be taken up with the ballast water as it is pumped into the ship, were likely introductions.

Such species tend to live as adults as encrusting organisms or in soft bottom or seagrass communities.

For these reasons, sampling was restricted to the following habitats, where introduced species are most likely to occur:

- fouling communities on wharfs and piles adjacent to the loading areas for woodchip where the ballast water is discharged;
- the seagrass communities at the mouth of Nullica River, Fisheries Creek, and Shadracks Creek;
- soft bottom communities and intertidal encrusting fauna in shallow estuarine areas at Nullica River, Fisheries Creek and Curala Lagoon;
- intertidal areas around the loading wharf, at the woodchip plant, and at Murrumbulga Point;
- the fauna of salt marshes next to Curala Lagoon and Fisheries Creek.

Collecting trips to Twofold Bay have been made at three monthly intervals over 15 months in order to obtain information on the seasonality of the fauna.

The fouling communities on the wharf piles and the encrusting fauna on the subtidal rocks around the loading area at the woodchip plant were sampled by scuba diving and scraping off the fauna into collecting bags. Collecting here was qualitative but we attempted to collect a representative fauna each time.

The seagrass beds and soft bottom communities were sampled using a hand operated corer. Replicate cores were taken on each trip.

The intertidal encrusting fauna



and the intertidal fauna at Murrumbulga Point and around the loading wharf were collected by scraping the fauna off the rocks, and collecting fauna in crevices, and under boulders.

The salt marsh fauna was collected by carefully searching along a vertical transect through the salt marsh including examining any dead wood or debris where many animals live.

### Sorting

All the fauna was preserved and returned to the Australian Museum for sorting and identification.

We concentrated on crustaceans, molluscs, echinoderms and polychaetes, as these groups dominate the habitats sampled, and many have pelagic larvae and could potentially be transported in ballast water.

Other organisms such as bryozoans (lace corals), sponges, sea anemones and ascidians were also collected but at this stage no one is available in Australia to identify these groups. All the material is retained at the Australian Museum where it will be available for future studies.

We are compiling species lists for each of the habitats. A large number of samples (429) has been sorted and 130 species of molluscs, and 11 species of benthic fish, 149 species of crustaceans, 57 species of polychaetes, 4 ascidians, and 22 species of echinoderms have been identified — a total of 373 species. This represents a fairly diverse fauna and is representative of the marine life found in this part of New South Wales. A detailed study of Merimbula Lake and Pambula Lake, just north of Twofold Bay yielded 245 species (Day and Hutchings, 1984).

### Identification

Once identification is complete we will be able to make more detailed comments on the marine fauna of the bay, and relate it to other areas on the New South Wales coast.

Already it is apparent that the fauna of the creeks and seagrass beds is fairly sparse but individual species are often abundant.

The diversity of fauna in these areas is related to the salinity regimes in the particular creek. In general, creeks regularly inundated by the sea have more diverse faunas than ones subjected to infrequent inundations. The subtidal environments in the bay are rich and diverse and typical of relatively exposed shores of southern New South Wales.

To date, the following introduced species have been found in Twofold Bay; the European shore crab, (*Carcinus maenas*), a barnacle (*Balanus algicola*) and a marine slater (*Eurylana arcuata*). None are indigenous to northern Japan and were probably introduced as fouling organisms on sailing ships.

The shore crab has been known in Victorian waters since 1901 (Allen, 1953). The 'Acorn' or sessile barnacle *Balanus algicola* was first described from South Africa. It was first mentioned locally in 1943, in Port Jackson (Allen, 1953).

The New Zealand marine slater (or cirrolanid isopod) *Eurylana arcuata* is commonly found in Twofold Bay. There are also reports of its presence in Merimbula Lake, South Coast, New South Wales (Day and Hutchings, 1984) and Newcastle Harbour, New South Wales (N. Bruce *in press*). It has also been found as far afield as Chile and San Francisco, USA (Bowman *et al.*, 1981).

We anticipate that by the completion of the survey in June 1986 we shall be able to give a fairly comprehensive account of the fauna of the habitats sampled and to list the species introduced to the bay.

We shall attempt to determine the probable time of their introduction to the bay, and comment on whether the more recently introduced species may have arrived via the ballast water.

Subsequently we will present

guidelines for planning and executing similar surveys in other ports or harbours where similar potential problems may occur.

If our survey does reveal successful introductions via ballast water, then different procedures may have to be adopted in the discharge of ballast water into our harbours and estuaries.

Finally, even if our survey reveals no introductions into Twofold Bay via ballast water, it does not rule out the possibility of future introductions. It is therefore essential that the fauna of all ports be regularly monitored for any introductions which could potentially pose problems for the local fishing industries.

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