THE SEDIMENTS AND ASSOCIATED INVERTEBRATE COMMUNITIES OF JERVIS BAY

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INTRODUCTION

Unconsolidated sediments cover over 110 km^2 of the area of Jervis Bay below mean high water mark. The present-day sediments, which provide habitats for a wide variety of marine organisms, are the products of Quarternary geological events, including dramatic sea level changes.

This paper reviews the information available regarding the geological history of the sediments in Jervis Bay, their present-day characteristics and the types of organisms that can be found inhabiting them. The subaerial sediments are described by Thom, in this volume.

THE PAST

During the Pleistocene Epoch the sea level off the New South Wales coast (and indeed throughout the world) underwent significant changes. Thom & Chappell (1975) have documented the last major change in sea level to affect this coast, including the Jervis Bay area, when sea levels were approximately 130m below that of the present. During this period an old river system drained through what is now Jervis Bay, and the location of the ancient creek and river valleys has been ascertained using sparker surveys by Albani, Carter & Johnson (1973) and Taylor (1971). This river system brought with it fluvial sediments derived from the erosion of the Permian sandstones that comprise the Bay's catchment.

Taylor (1971) suggested that Hare Bay was once open to the sea through what is now Warrain Beach. The possibility that Carama Inlet was once part of a much larger river system was also considered by Albani, Carter & Johnson (1973).

THE PRESENT

The rise in sea level to that of the present day is known as the Holocene Marine Transgression and began about 15,000 years ago, culminating around 6,000 years BP (Before Present).

As the sea invaded the land, offshore marine sediments moved shoreward and thus the material for beach and dune construction was made available. These sediments were almost exclusively siliceous in composition and had undergone long periods of reworking by wave action. Studies by Taylor (1971) and Dames & Moore (1985) have concluded that very little sediment is currently entering the Bay from either seaward or landward sources. The relict nature of the sediment suite has been inferred from the following sediment characteristics:

1. Small proportion of rock fragments - unstable minerals in the sediment suite break down faster than siliceous material and are thus carried away relatively quickly.
2. High percentage of fine and rounded grains - this indicates prolonged periods of abrasion and reworking by wave action.
3. No sediment structures (e.g. deltas) or sediments indicating significant inputs from creeks in the area. The large wedge of sediment being pushed into the Bay between Bowen Island and Governors Head is marine in origin and composed of relict sands.
4. Sediments are generally well sorted, i.e. the range of grain sizes is small, reflecting the gradual removal of fine grains and the attrition of larger particles.

In the absence of major fluvial inputs the major agents affecting sediment movements would be expected to be wave and/or tidal currents. According to Dames & Moore (1985), there is little evidence for the latter and wave induced ripples are the dominant bedform to be found in Jervis Bay. The influence of wave action is expressed in the sediment suite in several ways (Taylor 1971, Dames & Moore 1985), as follows:

1. An increase in roundness, better sorting and decreased mean grain size towards the margins of the Bay, indicating higher wave energies in the shallower areas (Fig 1A.). Note that the Dames & Moore study found that the grain size increased towards the Bay's margins but this result is probably due to the location of the sampling grid which did not sample the sediments in very shallow waters off the beaches.
2. A tendency for minerals with a low specific gravity or which are unstable to be moved towards the centre of the Bay where energy conditions are relatively low (Fig 1B.).

Physical factors are not solely responsible for influencing sediment movements. The actions of both plants and animals are widespread and easily observable in Jervis Bay.

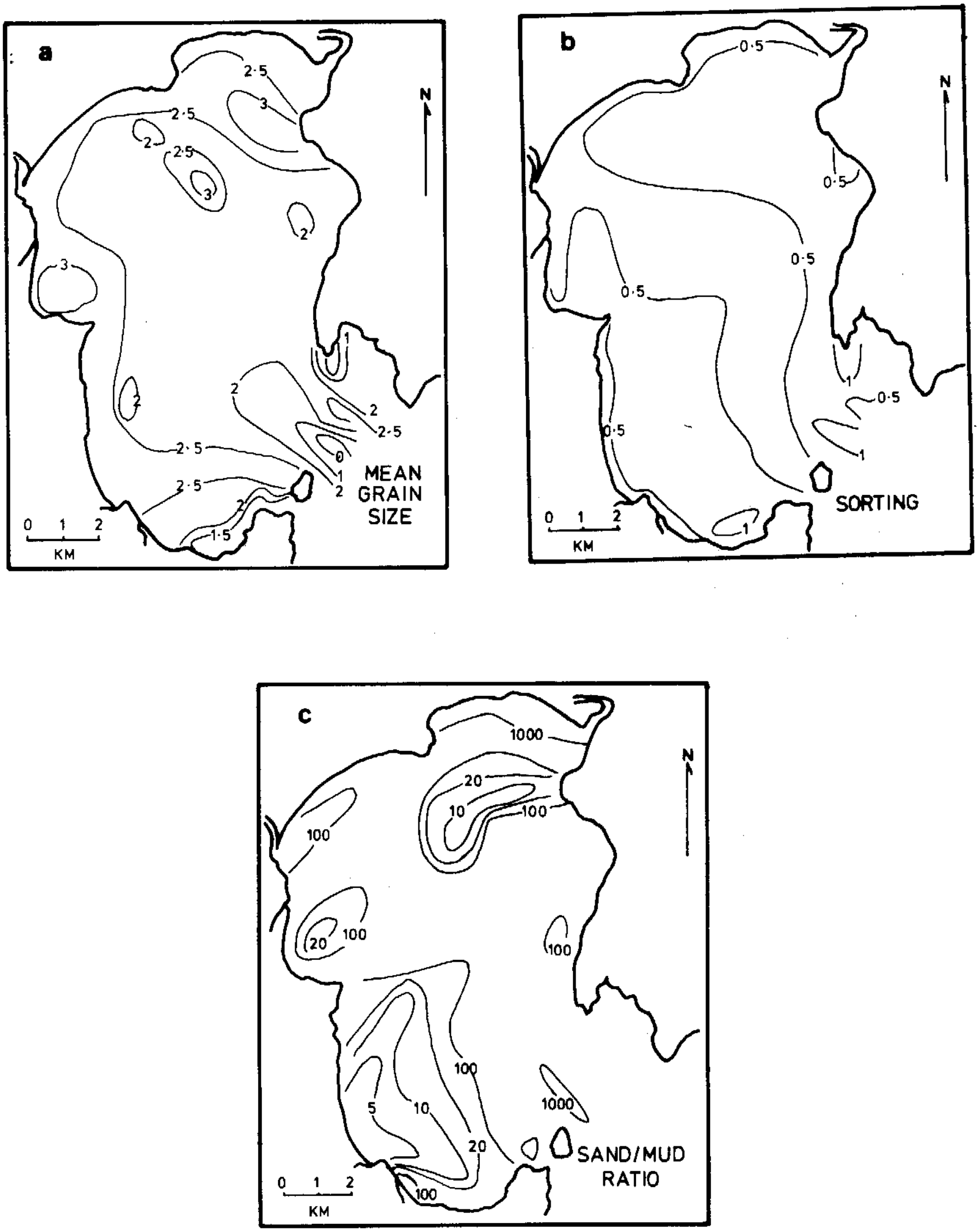

Fig. 1. Distribution of sediment types in Jervis Bay.

Seagrasses, for example, reduce the capacity of waves to suspend and transport sediments, thus trapping fine grains within the leaf canopy. Seagrasses are used as habitats by a wide variety of organisms utilising calcium carbonate for shell or skeleton construction and thus there is often a significant proportion of coarse, angular grains composed of carbonate represented in the sediment suite associated with seagrass beds. Turbulence around the leaves causes an irregular arrangement of scours and hummocks and the roots and rhizomes bind the sediment and increase its resistance to erosion.

Animals too, bind the sediment. Mounds caused by dense aggregations of tube-forming polychaete worms are commonly raised over 50cm above the surrounding sediment and can be up to 2 metres in diameter. These features occur in areas of moderate wave energy in the Bay and are relatively common. Other species of polychaetes and many molluscs burrow into the sediment and create a "moonscape" of craters, thus completely destroying any wave-induced sedimentary structures.

THE SOFT-BOTTOM COMMUNITIES

As a habitat suitable for exploitation by plants and animals the unconsolidated sediments present some major problems, primarily related to their mobility as discussed above. These problems include, for example, collapsing of burrows, anchoring, turbidity and light availability. Despite the difficulties associated with living in such a dynamic environment, many organisms can be found living on, in or associated with, the unconsolidated sediments.

Dexter (1983) provided a very brief description of the fauna inhabiting the intertidal zone of Collingwood, Callala, Hyams and Green Patch Beaches. Collett *et al.* (1984) have sampled the benthic infauna of the *Posidonia* seagrass beds of the Murrays Beach area and McCormick (1978) described the benthic macro fauna of Currambene Creek. Ivanovici (in press) describes the flora and fauna of many of the shallow water habitats in the Bay and some of the information presented below is reproduced with her kind permission.

The present author has conducted reconnaisance dives around Green Point, Montagu Point, Bindajine Cove, Honeymoon Bay, Bristol Point and Huskisson Island. Further, more detailed studies are needed and the information available to date should be used as a guide to planning such studies.

Much of the information available on the types of plants and animals to be found in these areas was gathered as part of the Sediment and Seagrass Study for the Department of Housing and Construction undertaken by Dames & Moore in 1984. This study provides a preliminary overview of the major organisms to be found and is not a definitive description of the distribution and abundance of the soft bottom biota.

Dames & Moore (1985) collected information from over 160 sites within the Bay, in depths ranging from 4 to 38 metres. The interpretation of the information collected should take into account the following limitations:

1. The data are semi-quantitative, i.e. organisms were counted and categorised into groups such as rare, abundant, very abundant, etc.
2. The community types are based on the most common organisms visible, and as such these organisms are generally those living on, rather than in, the sediment.
3. The Study was carried out over a period of three weeks in winter and is therefore a "snapshot" of what was present. Seasonal or yearly variations are likely in not only the distributions but also the abundances of the organisms described.

The communities delineated are depicted in Figure 2, and described briefly as follows:

Community Type 1 - Heart Urchin Community

The heart urchin *Echinocardium* can be found at densities of up to 200/sq metre in areas of moderate wave energy and in clean to silty sands. These urchins are found about 1-5cm below the sediment surface. Very few other organisms are found associated with this community except for occasional sea pens, ascidians and red algae.

Community Type 2 - Mud Oyster/Mussel Community

This was the most diverse community identified in the study. In relatively low energy areas of the Bay clusters of mud oysters (*Ostrea angasi*) and mussels (*Mytilis planulatus*) can be found associated with a variety of other organisms. A common member of this community is a type of polychaete worm that builds branching, parchment-like tubes support a dazzling variety of bryozoans, sponges, red algae, hydroids, anemones and echinoderms, including the delicate white and blue crinoid *Antedon loveni*. Also to be found are several types of ascidians including the bagpipe ascidian, *Herdmania momus*, and the occasional edible scallop (*Pecten fumatus*).

Community Type 3 - Seagrass and Polychaete Community

Moderately dense stands of seagrasses (*Zostera, Posidonia* and/or occasionally *Halophila*) growing on hummocks formed by densely packed polychaete casings comprise this community. The casings are the tubes formed by polychaete worms using sand and mucus to create a strong yet pliable home. The yellow-throated ascidian and the swimming anemone are common along with mud oysters, hydroids, scallops and the starfish *Astropecten*.

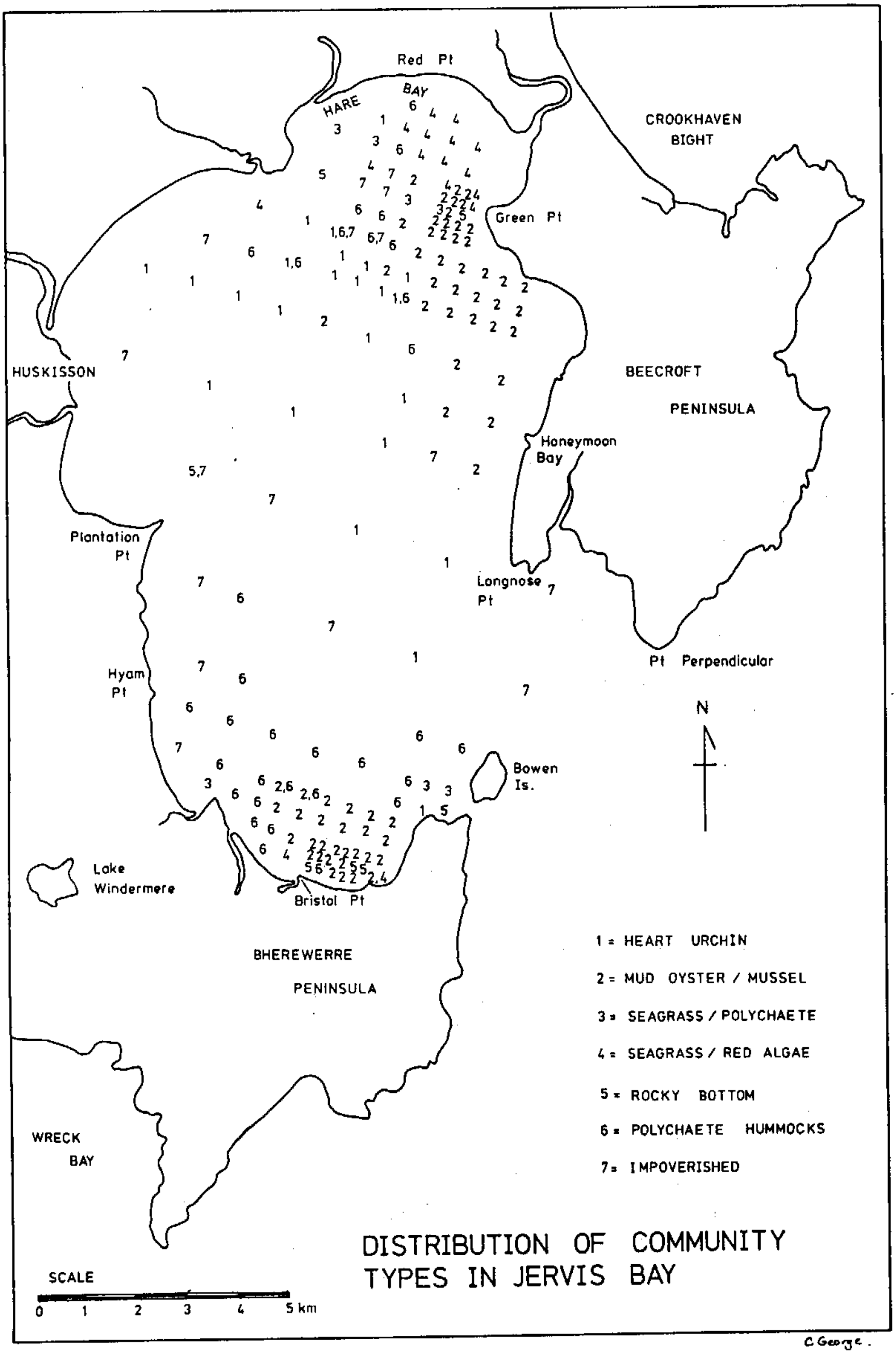
Red Pt
HARE BAY
CROOKHAVEN BIGHT
Green Pt
HUSKISSON
BEECROFT PENINSULA
Honeymoon Bay
Plantation Pt
Longnose Pt
Pt Perpendicular
Hyam Pt
N
Bowen Is.
Lake Windermere
Bristol Pt
BHEREWERRE PENINSULA
WRECK BAY
1 = HEART URCHIN
2 = MUD OYSTER / MUSSEL
3 = SEAGRASS / POLYCHAETE
4 = SEAGRASS / RED ALGAE
5 = ROCKY BOTTOM
6 = POLYCHAETE HUMMOCKS
7 = IMPOVERISHED
DISTRIBUTION OF COMMUNITY TYPES IN JERVIS BAY
SCALE
0 1 2 3 4 5 km
C George.

Fig.2.

Community Type 4 - Seagrass and Red Algae Community

The most common seagrass in the Bay, *Posidonia* , can be found associated with a large variety of red algae, as well as numerous species of brown and some green algae. Extensive meadows of seagrass can be found in shallow (to 9m) (Larkum 1973), low wave energy areas on coarse to silty sands. The seagrass leaves support numerous bryozoans, tube worms and ascidians whilst the quiet water between the leaves provides a habitat for zoanthids, sponges, hydroids and fish. Collett *et al.* (1984) compared the benthic infauna of the Murrays Beach *Posidonia* beds with nine other stations in New South Wales. It was found that the Murrays Beach fauna ranked third in terms of species richness and fifth in terms of the numbers of animals present per square meter.

Community Type 5 - Rocky Bottom Community

The rocky promontories of the Bay support a flora and fauna typical of many of the rocky shores along the south coast. The kelp, *Ecklonia radiata*, forms forests that provide cover for a wide variety of fish and invertebrates. Bryozoans, encrusting sponges, zoanthids, hydroids and ascidians are common on the rocks along with a variety of red and green algae such as the delicate *Caulerpa cactoides* . This community is discussed further in the paper by Ivanovici in this issue.

Community Type 6 - Polychaete Hummock Community

In deep (5-20cm), moderate energy areas large numbers of a polychaete worm form dense aggregations which cause hummocks to form on the bottom. These hummocks may be up to 1m in height and cover several square metres. Associated with this community are sponges, anemones, the starfish *Luidia australiae* and several types of ascidians.

Community Type 7 - Impoverished Macro-Benthic Community

Few organisms were to be found in the deeper, high energy areas of the Bay, particularly in the mouth. Grey sand hydroids and the occasional starfish were the most commonly observed invertebrate fauna, whilst in depths of 10-15m strands of red algae can be found.

Ivanovici (in press) describes the invertebrate fauna of the shallow (< 9m in depth) and deep (> 9m in depth) sand beds of the Bay, and also describes the sand delta projecting inside the Bay between Bowen Island and Governors Head as a separate environment. Octopi are common in both shallow and deep sandy areas whilst the large starfish *Luidia* and *Astropecten* are more common in deeper areas.

On the sand delta sea pens such as *Sarcoptilus grandis* and the striped nudibranchs which feed on them are common along with starfish and numerous types of bivalves and gastropods.

The Honeymoon Bay to Green Point area supports large tracts of seagrass beds. In particular, the interface between the sublittoral rocky shore and the sediments supports an extremely diverse flora and fauna. Seagrasses occur in stands of two and commonly three species, and occasionally in combination with several species of the alga, *Caulerpa* . The area north of Montagu Point is the only area the author knows of where *Posidonia* occurs in a rock pool. The arenaceous tubes of the polychaete *Diopatra* may cover several square metres of the sediment and thus provide a surface upon which anemones, ascidians, bryozoans and zoanthids thrive. By contrast, the corresponding zone in the Bristol Point area is visibly less diverse.

CONCLUSIONS

Considerably more work is needed to describe the marine and estuarine communities and the flora and fauna of the Bay in general. In addition to ecological investigations for all environments, descriptive studies of the fauna and flora of mangrove creeks would provide useful information. Despite the popularity of SCUBA diving in Jervis Bay, there are few published descriptions of the sublittoral rocky shore fauna (see Ivanovici, this issue and Pollard 1973).

The pristine and undeveloped nature of the north-eastern quadrant of the Bay and its associated diverse collection of flora and fauna is unique. Even if development is deemed to have only negligible impacts on the communities of this area, its pristine nature will be irretrievably lost if construction of facilities, such as those presently proposed by the Navy in this area, proceeds.

ACKNOWLEDGEMENT

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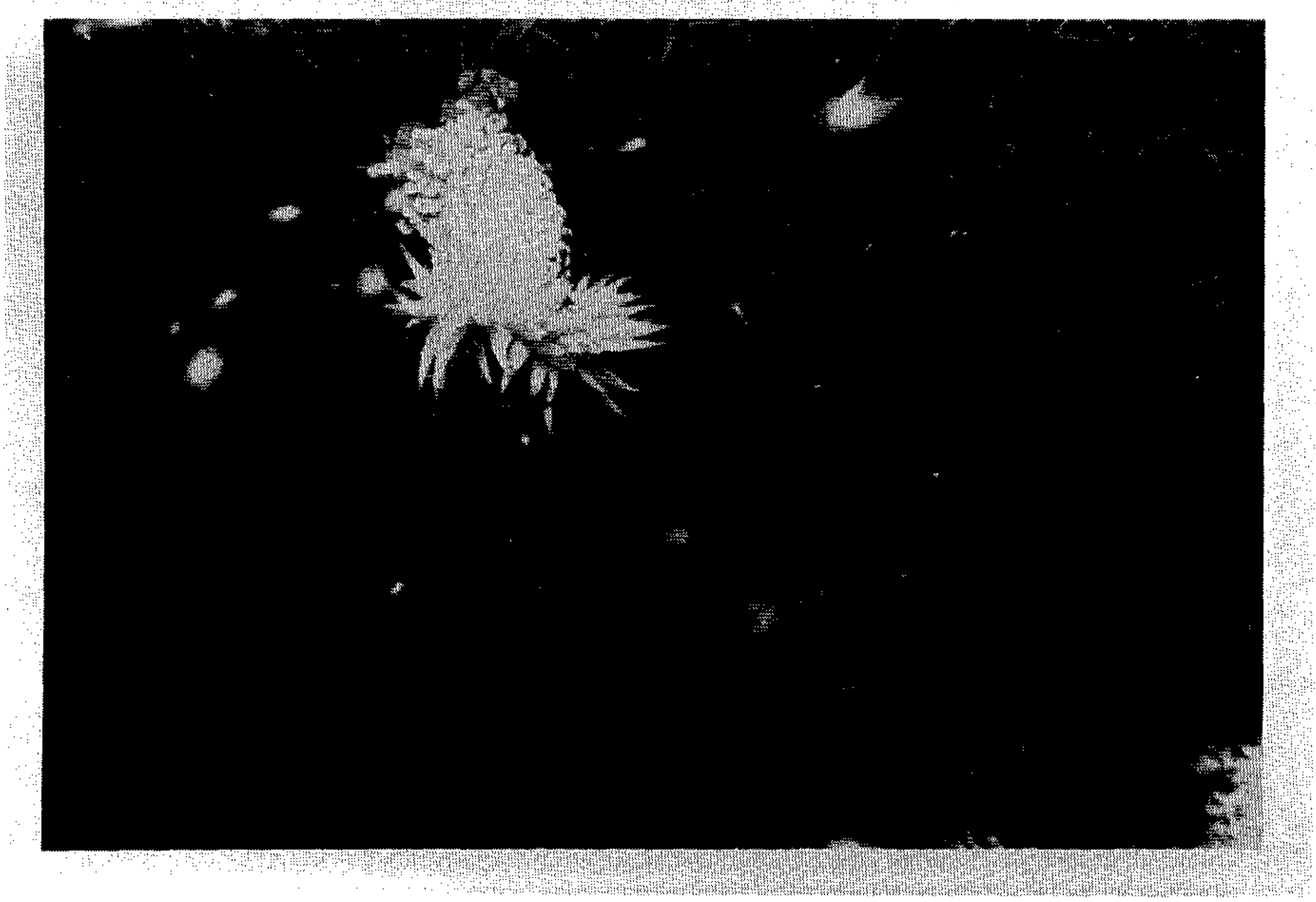

Swimming anemone feeding at night. (Photo. A. Ivanovici)