BORNEO SCIENCE 9: 61-67, June, 2001

CO-EXISTENCE AND MICROHABITAT USE IN SEA CUCUMBER COMMUNITY IN LOW ENERGY COASTAL BAYS OF KUDAT, NORTH BORNEO

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ABSTRACT. *Distribution, abundance and habitat preferences of sea cucumbers in the region of Kudat were studied. Seven species, namely* Holothuria scabra, H. atra, H. nobilis, H. impatiens, H. graeffei, Stichopus herrmanni *and* S. vastus *were recorded. Their population appeared to be influenced more by habitat parameters than by food, competition or predation. Co-existence of several sea cucumber species implied adaptive strategies involving specialization to microhabitats. Occurrence pattern that showed presence of different size groups in the same area and distribution of many species of varied sizes in different grounds with similar physical attributes suggested the importance and stability of microhabitat use. Distribution was uneven, with* H. scabra *overwhelmingly dominant, forming 70 85.9% of the total population. For species that did not occur in large numbers, the community organization was not markedly heterogeneous spatially or temporally.*

KEY WORDS. Microhabitat, sea cucumber, coastal bays, Sabah

INTRODUCTION

Sea cucumbers are exclusively marine and bottom dwelling echinoderms. They belong to class Holothuroidea that comprises 25 families, 200 genera and 1400 species worldwide (Forbes, 1999). Borneo, the world's third largest island in the Pacific Ocean, is one of the major regions in Southeast Asia known for widespread occurrence of sea cucumbers. However, scientific data on the biology of sea cucumbers from this island is inadequate. Two recent publications that deserve mention are those of Baine (1999) and Forbes (1999) containing results of exhaustive studies on sea cucumbers of Malaysia, including the population of this group of animals in the east Malaysian state of Sabah in Borneo. Kudat is one of the major regions in Sabah known to have rich resources of sea cucumbers but intense exploitation has depleted the population, and in fact wiped out some of the once thriving fishing grounds. Because of high larval mortality, a sufficiently large population of sea cucumbers must reproduce for effective recruitment.

However, excessive fishing driven by market demands, and is due to easy access to sea cucumber grounds and convenient collection, has caused a drastic decline in breeding population and stock regeneration. Their depleted stocks can take decades to recover unless new ways are explored to manage and restore them (Conand, 1997). Increasing the harvests beyond historical levels through stock enhancement has a considerable potential in Sabah if information on their biology and habitat use is available. This work is an attempt in this direction.

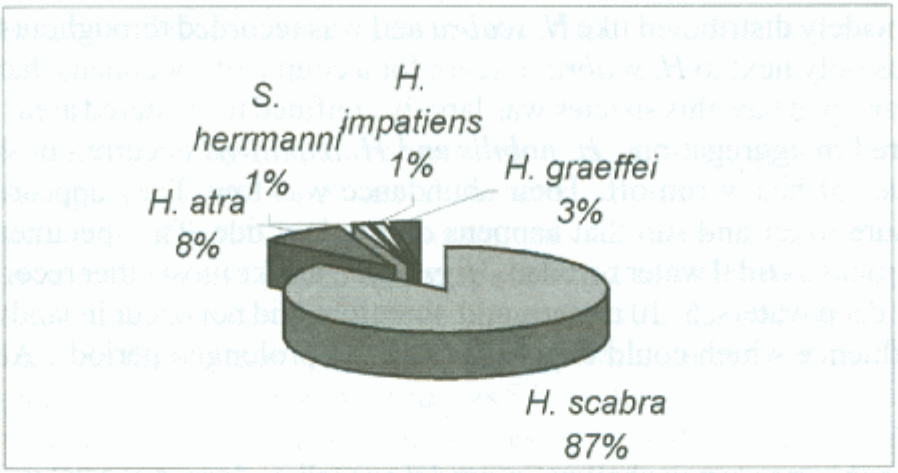
MATERIALS AND METHODS

This study was based on sea cucumber population from Sabah. Sabah covers some 72,500 km^2 of the territory on northeast Borneo, 4 6° north of the Equator and has a coastline that measures 1,802 km. It faces South China Sea on the west coast, and Sulu Sea and Sulawesi Sea on the east. Samplings were done along the coast of Kudat. GPS readings of the sampling stations were 06° 46.253 N - 06° 46.385 N and 116° 51.555 E 116° 51.955 E. Observations were carried out on a monthly basis from October to December 2000. A sample size comprised 100 specimens. Collection was done randomly and the component species were identified using the taxonomic keys given by Forbes (1999). Procurement of sea cucumber samples was greatly assisted by the fishermen that traditionally capture sea cucumbers from the area. Some of the distinct advantages of this approach were that the fishermen who have been scouring the region since long are better informed of the sea cucumber grounds and the survey could be more thorough since several boats were utilized rather than just one research vessel. Randomness in sampling was not compromised due to non-selective capture by the fishermen and by our field protocol guidelines. A multi-probe analyzer recorded the environmental parameters. Evenness was determined by the method suggested by Pielou (1977).

RESULTS AND DISCUSSION

Distribution and abundance of sea cucumbers are influenced by physical, chemical and biological factors of the environment. Nature of the substrate and hydrodynamic features of the coastal areas are some of the most conspicuous factors. It appears that in a highly sedentary marine animal like sea cucumber, the population is limited more by habitat parameters than by food, competition or predation.

As many as 7 species were encountered in the study area, out of which 4 5 occurred in all the months (Figure 1). *Holothuria scabra* was widely distributed, occurring in all the sampling stations and in all the months of the study period. This species dominated over all other sea cucumbers. It was seen in dense aggregations, especially close to the coast in areas that were exposed to terrigenous inputs. This species was very intimately tied to the substratum, spending most of the time burrowing in the sediments in the intertidal zone.



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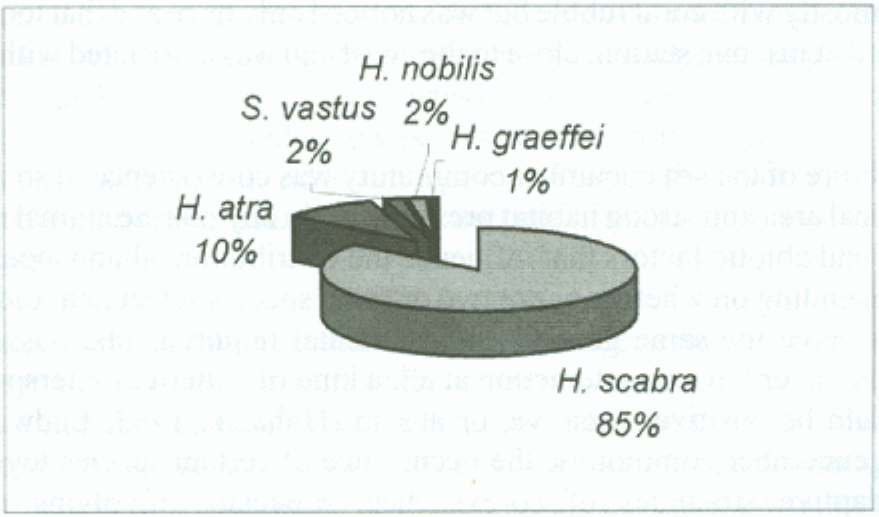

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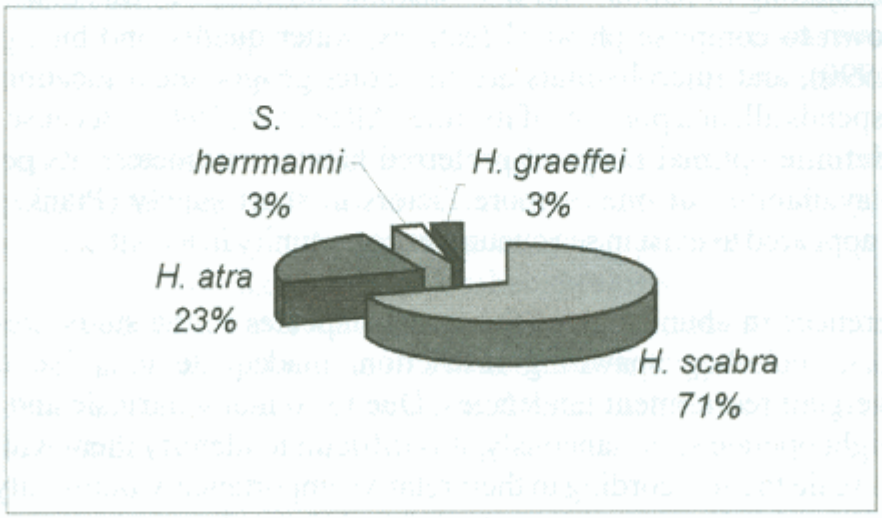

C

Figure 1. Composition and relative abundance of sea cucumber species in samples collected in the months of October (A), November (B) and December (C).

H. atra was also widely distributed like *H. scabra* and was recorded throughout the study period. Its abundance was only next to *H. scabra*. Except for a couple of specimens that were noticed in seagrass beds of an open bay, this species was largely confined to sheltered areas, not far from the coast, and occurred in aggregations. *H. nobilis* and *H. impatiens* occurred in shallow areas but away from places of heavy run-off. Their abundance was low. They appeared to avoid long periods of exposure to air and sun that happens during low tide. The specimens could be seen concealed under rocks as tidal water receded. *H. graeffei*, unlike most other recorded species, was seen in relatively deep waters, 5 10 meters, and, therefore, did not occur in landward areas under strongly tidal influence which could expose it to air for prolonged periods. Abundance of this species was poor.

Stichopus herrmanni was seen in shallow intertidal as well as deeper coastal waters. It preferred sandy bottoms but occurred in poor numbers. Unlike this species, *S. vastus* was seen close to the coast, associated mostly with coral rubble but was noticed only once and that too in small number. *S. vastus* was found at just one station, close to the coast and was associated with coral rubble, at a depth of 3 meters.

An interesting feature of the sea cucumber community was co-existence of so many species in a limited geographical area and strong habitat preferences. In any marine animal community, there are several biotic and abiotic factors that influence the distribution, abundance, and interactions of the species. Depending on whether or not two or more species select or avoid the same habitat or habitat factors, have the same general environmental requirements, possess some mutual attraction or repulsion, or have no interaction at all, a kind of pattern of interspecific association results, which could be positive, negative, or absent (Hubalek, 1982; Ludwig and Reynolds, 1988). In the sea cucumber community, the occurrence of certain species together in a habitat implied their adaptive strategies of co-existence, especially involving specialization to microhabitats that reduced competition and promoted sympatry. Perhaps, it is necessary to explain our understanding of habitat and microhabitat attributes. In this discussion, the habitat attributes are known to comprise physical features, water quality and biological components (Marcus *et al.*, 1990), and microhabitats are the exact geographical locations and conditions where an animal spends all, or a portion, of its time (Allee *et al.*, 1949). Because of the fact that an organism has a definite optimal range of preferred habitat parameters, its population is often governed by the availability of one or more factors in short supply (Pianka, 1988). No such critical condition appeared to exist in sea cucumber community in Kudat.

Significant differences in abundance of the various species in the study area could owe to a number of factors, including spawning restriction, inadequate microhabitat resources for settlement, or divergent recruitment tendencies. Due to so many intrinsic and extrinsic factors, some of which might operate simultaneously, it is difficult to identify them with a greater degree of exactitude or to scale them according to their relative importance. Community stability, energy pathways, resource partitioning, species-area relationships, and evolutionary processes could all account for a resultant pattern of relative abundances of species (McNaughton and Wolf, 1970; Kolasa and Biesiadka, 1984; McGuinness, 1984). Further investigations would be required for

a conclusive understanding of the basis of differences in the dynamics of the population density of sea cucumbers.

The species of sea cucumbers observed were not evenly distributed; the evenness index (which measures how the species abundances are distributed among the constituent species of a community) varied from 0.306 to 0.347. The maximum value of evenness index that varies from 0 to 1, suggests greatest evenness (when all the species in a sample are equally abundant). The evenness decreases toward zero as the relative abundances of the species diverge away from evenness. In this uneven distribution, *H. scabra* was overwhelmingly dominant, forming 70 85 % of the total population. In October, *H. scabra* was 87 % (October), 85 % (November) and 71 % (December) more abundant that the rest of the species combined. Aside from *H. scabra* and *H. atra*, other species were more evenly distributed. Relative abundance of each species in a community given in Figure 1 indicates how one species holds sway over all others in the sea cucumber community (which form a mostly homogeneous community organization). The apparent unevenness in the community is mainly on account of one species but that is ecologically important. However, relating evenness to organization of ecological communities is no simple solution. The most credible view is that centers on the concept of ecological niche. According to Whittaker (1972), the niche concept would imply the position of the species in the community, including resource use, activity, population interaction with other species, and several other factors.

Preference of sea cucumbers for sheltered and shallow-water areas, and avoidance of exposed shores with ripple marks (along the beach where water movement is strong), low organic matter, poor bacterial population and density of infauna low are some of these factors. It will be interesting to identify the possible link between sea cucumbers and particular species of infauna. In an isolated case, a couple of specimens of *H. atra* were reported to occur on an open beach but in that instance the shelter was provided my meadows of seagrass (*Enhalus acoroides*). This area was located more on the landward side of the intertidal that is exposed during low tide and where currents during high tide are unlikely to be strong. Not a single specimen was ever seen during this study in zones where waves break and dissipate a maximum of energy that produces the currents.

It appears that microhabitat use in sea cucumbers is quite stable due to presence of specimens of widely different sizes in the same place or in different grounds with similar physical attributes. Once the young ones settle down on the substrate after completing the ontogenetic processes, there do not seem to be any major size-related microhabitat shifts. Preference of the sea cucumber for substrate particles and slow water velocities of the sheltered bays continues to hold as they grow larger. In a tropical equatorial region of Borneo, where temperature remains consistently high and the variations in this physical factor are well within tolerance limits, microhabitat shifts in deposit-feeders are unlikely.

Knowledge of the physical characteristics of the habitat has practical importance in programs for sea cucumber conservation and stock enhancement. More data on the pattern of microhabitat use by sea cucumbers will be needed when attempting to enhance their depleted population in existing habitats or to identify new sites for ranching. In the

absence of microhabitat shifts as discussed above, the ranched sites are unlikely to lose sea cucumber stocks if environment is not significantly altered to their disadvantage.

ACKNOWLEDGEMENTS

Universiti Malaysia Sabah provided the facilities for this study and the work was partially supported by Third World Network of Scientific Organizations.

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