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Some Aspects of Sea Cucumber, *Holothuria scabra* (Jaeger, 1935), along the Coast of Dar es Salaam

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***Abstract*—**Some aspects of the biology of the sea cucumber *Holothuria scabra* Jaeger, 1935 were studied along the coast of Dar es Salaam. Samples of *H. scabra* were collected from Kunduchi and Buyuni between January and December 1999. The abundance of *Holothuria scabra* was higher in Buyuni (3951) than in Kunduchi (1176). However, the level of exploitation per year from far reefs was higher in Kunduchi than in Buyuni. Sea cucumber harvesting by villagers is done monthly on intertidal areas and from reef flats near to the villages. Higher catches from Buyuni were recorded during August and November (perhaps due to light winds such that trips could be made to far-off reefs), while the catch from Kunduchi was relatively low throughout a year. The length-frequency distribution of *H. scabra* was found to be unimodal, with most individuals ranging between 8.5 cm and 26.5 cm. The species showed continuous breeding with peaks between May and September and December. The average size at first maturity in *H. scabra* was 16.8 cm.

INTRODUCTION

Sea cucumbers have a long time history of exploitation in East Africa. However, the work by Frontier-Tanzania on Mafia Island, Songo Songo and Mtwara (Horsfall, 1998) has shown that catches have fallen drastically over the last few years. Since sea cucumbers are slow-growing, populations in shallow water are easily overexploited. The average size of animals caught has become much smaller as the larger animals are taken first especially since the trade is not regulated. The foreign exchange earnings from sea cucumbers increased from US$ 442,335.60 in 1988 to US$ 884,169 in 1994. However, Fisheries Division records shows that since 1995 there has been a decrease in catch in Tanzania.

Sea cucumbers are found in large numbers in sheltered shallow water sediments in the tropics (Bakus, 1973; Conand, 1997). However, holothurians are not a traditional food and fishery in Tanzania, and their harvest is mainly commercial. *Holothuria scabra* is one of the commercially important holothurians harvested in Dar es Salaam coastal waters and sells for US$ 10–15 per kg dry weight.

For quite some time *H. scabra* has been collected from nearshore waters by coastal people, mainly for sale to foreigners. Coastal dwellers in Dar es Salaam, Bagamoyo, Zanzibar and Mtwara collect holothurians for export to Japan and China. Around Dar es Salaam the collection of *H. scabra* is done at Kunduchi and Buyuni.

Most of the research so far carried out on sea cucumbers in Tanzania has been part of wider programmes of work with general data, often lacking in specific details. Hornel (1917), Sachithananthan (1972), Anonymous (1979) and Gentle (1979) reported on numerous sea cucumber species harvested from shallow tropical waters

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over a vast area from the East African coast for export to Hong Kong, Singapore, Malaysia and Thailand. Conand (1997) reported on locally fished sea cucumbers along the coast of Tanzania that are exported to the Far East after processing. Horsfall (1998) wrote generally on sea cucumber ecology, growth, exploitation and market in Mafia Island, Songo Songo archipelago and Mtwara.

Recently the sea cucumber catch in Tanzania has fallen drastically and the average size of animals for the market has become much smaller (Horsfall, 1998).

The available data on *H. scabra* along the Tanzanian coast are insufficient to discern their distribution, and diagnose and analyse current exploitation trends in Dar es Salaam. There is lack of information on the biology, abundance, distribution and fishery of *Holothuria* around Dar es Salaam, and this may result in the unrecorded loss of some species. This paper reports on some aspects on the biology and distribution of *H. scabra,* including its reproductive biology, size at first maturity, and stock size, important information for successful management, and for raising awareness of the resource's economic potential.

MATERIALS AND METHODS

Study area

The study was conducted at Kunduchi and at Buyuni along Dar es Salaam. Kunduchi is situated at 6° 40' S, 39° 13' E and is 20 km north of Dar es Salaam. It is a semi-sheltered sandy beach, most exposed and disturbed by human activities. Its intertidal area is mainly bare, characterised by sand bars/ridges. During low spring tides much of the shore is exposed.The site has very shallow water and very few large tidal pools, sparse patches of seagrasses and very rudimentary remains of mangroves on the southern part. The dominant seagrass species include *Thalassia hemprichii, Cymodocea rotundata, Syringodium isoetfolium, Halodule wrightii,* while the common algae are *Halimeda discoidea, Chaetomormopha crassa, Turbinaria decurrens, Ulva fasciata* and *Sargassum binderii.*

Buyuni is about 50 km south of Dar es Salaam at 6° 60', 39° 30' E. The shore is characterised by a wide range of benthic shallow water habitats with rocky cliffs on its south and a wide intertidal area bearing both silt and rocky substratum with terrigeneous sediments brought by the Buyuni river, which discharges here. Buyuni is semi-sheltered, with very shallow water, particularly in the southern half. The northern parts have diverse seagrasses, with macroalgae sandwiched between mangrove stands in the intertidal region. The seagrass genera found here include *Thalassodendron, Halophila, Syringodium, Halodule, Cymodocea* and *Enhalus.* The algae include *Enteromorpha, Gracilaria, Hypnea, Jania, Laurencia, Chaetormorpha, Ulva, Padina, Halimeda, Amphiroa, Acanthophora, Sargassum, Turbinaria* and *Dictyota* spp.

The two sites were selected for their difference in accessibility, level of human disturbances and richness in biodiversity.

Field sampling

At each site an area of 15,000 m^2 was designated within the intertidal region. Three 10-m-wide transect belts were established at the site, running perpendicular to shore from the upper shore to the lowest spring tide mark. Three stations were established along each transect according to the level of shore. Ten random 1 m^2 quadrats were placed at each station and *H. scabra* falling within each quadrat were collected and counted. Each site was sampled weekly between January and December 1999. From the weekly collections in each site, 20 animals were randomly picked up for biological studies.

Laboratory work

In the laboratory, each animal was weighed and its length measured, then dissected to determine the presence of gonads. Gonads were carefully removed, blotted to remove extra fluids and classified to approximate maturity stage using modified scales (Tuwo, 1999), and weighed.

Data analysis

The gonad-somatic index was estimated by expressing the gonad weight as a percentage of the total wet weight of the animal. The size at first

maturity was determined by plotting the percentage frequency of maturity of 240 individuals against length. The size at which 50 % of the individuals are mature gave the size at first maturity.

Reproductive periodicity was determined by observing trends of percentage of individuals with gonads and increase in gonad wet weight and GSI (gonad-somatic index) (Tuwo, 1999). Mean abundance of *H. scabra* for the two study sites were compared by Friedman's test.

RESULTS

Abundance of *H. scabra*

The colour morphs of *H. scabra* found in both sites were (1) grey to black dorsally with black bands and white on the ventral surface, (2) black upper side with white bands across the body, lower side white in colour, (3) light grey dorsally and white ventrally, and (4) black dorsally and white ventrally. The total catch of *H. scabra* at Buyuni was higher throughout the study period (3951 animals collected) than that from Kunduchi (1176 animals collected). Out of 1176 *H. scabra* collected from Kunduchi 300 (about 25%) were grey to black dorsally and the rest were of categories 2, 3 and 4, while in Buyuni out of 3951 individuals, 5 (about 0.15 %) were grey to black and the rest were of categories 2, 3 and 4. Abundance between the two sites was highly significantly different ($P < 0.001$).

Size composition

The length-frequency distribution for 240 specimens of *H. scabra* measured between January and December is illustrated in Fig. 1. The frequency distribution was unimodal, with most individuals ranging in length between 8.5 and 26.5 cm. The most frequent length category was 17.5 cm. The total catch consisted of individuals measuring between 7 and 27 cm.

Size at first maturity

Holothuria scabra matures at different sizes. The size of first maturity is a length corresponding to maturity of 50 % of the individuals (Sparre & Venema, 1992). Figure 2 illustrates the plot of the percentage maturity against length of the individuals for the determination of length at first maturity. From the graph this was 16.8 cm.

Spawning season

The monthly percentage occurrence of individuals with gonads during the study period is illustrated in Fig. 3. Presence of gonads was observed throughout the year with the highest number of individuals with gonads occurring between May and September.

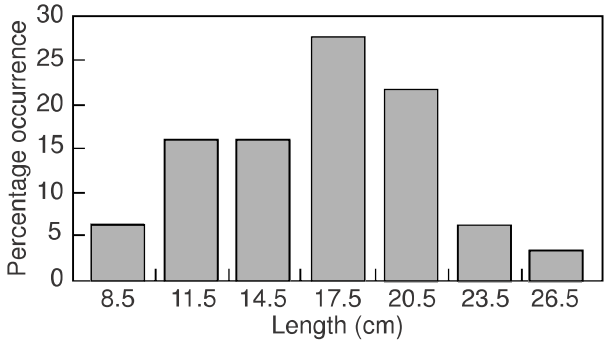


Fig. 1. Size frequency distribution of 240 *Holothuria scabra* individuals

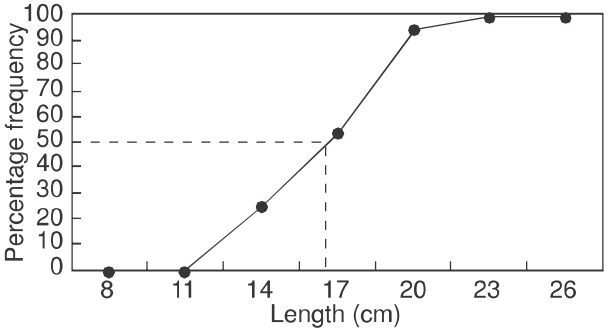


Fig. 2. Size at first maturity of *Holothuria scabra* along the coast of Dar es Salaam

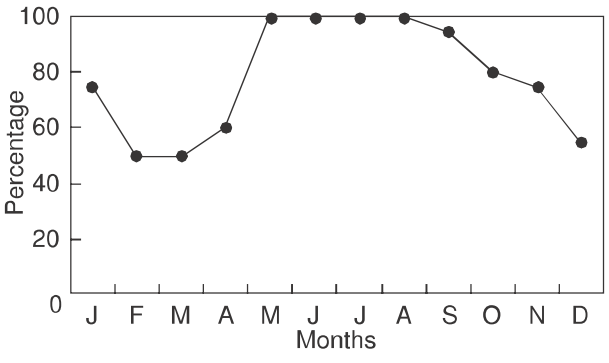


Fig. 3. Monthly percentage of *Holothuria scabra* with gonads

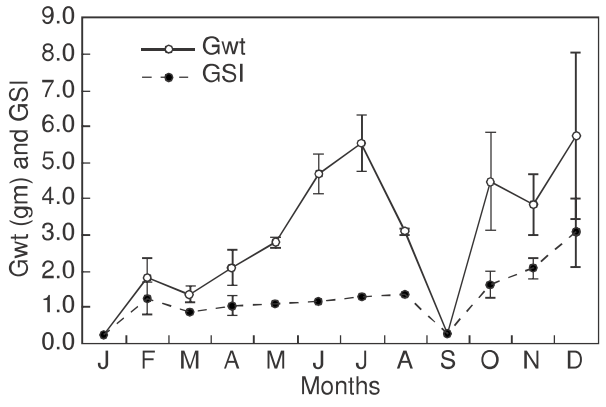


Fig. 4. Mean changes in gonad weight (Gwt) and gonad-somatic index (GSI) for 20 individuals of *Holothuria scabra* dissected every month

Graphical analysis based on gonad wet weight shows that there are two spawning seasons, the first one during July–August and the second one during December–January (Fig. 4). The plot of the gonad-somatic index (GSI) against time also depicts the spawning seasons. The peaks seen are quite in agreement with times of higher percentages of individuals with gonads (Fig. 3).

DISCUSSION AND CONCLUSION

Abundance

The study showed that Buyuni has higher abundance of *H. scabra* compared with Kunduchi. This is likely due to the fact that Buyuni is semi-sheltered by rocks and has a great number of microhabitats while Kunduchi is an exposed sandy beach. During high tide, the water reaches the site in Buyuni without turbulence. These conditions have been suggested to favour good settlement of particles (Mercier et al., 1999), which is the food of most sea cucumbers and larvae (Bakus, 1973). Most holothurians prefer wave-protected shores (Sloan & Bodungen, 1980). *Holothuria* colour morphs were more apparent at Kunduchi than at Buyuni. The variety of colour morphs agrees to those observed in India, Indonesia and Philippines (Hamel et al., 2001).

Size composition

The observed size composition (8.5 to 26.5 cm) is inconsistent with others observations. For example, William et al. (2000) in Mafia reported generally the abundance of small individuals of sea cucumbers, ranging from 11–20 cm while in Songo Songo the range observed was 21–30 cm. Uthicke & Benzie (1999) reported the population range in the Great Barrier reefs, Australia to be 9.8–26.9 cm. These differences in size composition may be a function of fishing pressure, depth from which the sample was taken, environmental factors (Uthicke & Benzie, 1999) or substrate type (Mercier et al., 1999).

Breeding season

Most specimens of *H. scabra* had gonads. The major peak was between May and September with a minor one in January. Tuwo (1999) observed a major peak from June to October with the minor one between September and January in Indonesia. These differences can be explained by difference in geographical location and environmental factors.

Two phases of increase in gonad-somatic index were observed, a long one (February to July) and a short one (October to December). These increases in gonad-somatic index may be due to protein deposition while decreases may be due to vast spawning. These observations generally agree to the findings of other researchers in different parts of the world. Tuwo (1999) reported two peaks but in different months (April and October). The differences with the current observations might be caused by variations in temperature ranges at the study areas. From the percentage of individuals with gonads, changes of monthly mean gonad weights and mean gonad-somatic index, the spawning season can be confirmed to be twice a year (i.e. June–August and December–January). This is comparable to other findings; in Indonesia, June–October and February (Tuwo, 1999); in Battang, Philippines, June–July and December–January (Ong Che & Comez, 1985); in New Caledonia, December–February and August–October (Conand, 1989); in Worrier Reef, Torres Straight, Papua New Guinea, September and December (Lokani, 1995); and in Krusadi Island India, July–October (Pitt, 2001). These observations are in general agreement with those of this study, especially the start of the spawning

period (June), but differences occur in duration and finishing time. This could be explained in terms of differences in the interval between the dry / hot season and wet / cool season in different parts of the world. Several researchers have associated temperature elevations, to spawning induction in most sea cucumbers, (Horsfall, 1998) and specifically in *H. scabra* (Lokani, 1995; Conand, 1989). Battaglene (1999) reported that *H. scabra* could be induced to spawn the whole year round by increasing water temperature (by 2–4 °C) and *Chaetoceros muellerii* (gracillis) and red algae *Rhodomonas salina* levels. Perhaps the level of abundance of *Chaetoceros muellerii* (gracillis) and red algae *Rhodomonas salina* may also account for the different reported variations in spawning times in different areas.

Size at first maturity

Size analysis showed that around Dar es Salaam *H. scabra* attains maturity at the length of 16.8 cm. Lokani (1995) in Papua New Guinea reported the size of 14 cm. Siro & Hitoshi (1998) reported the general breeding stock size to be 30–50 cm in Japan. Battaglene & Bell (1998) termed 15-cm individuals juveniles in tropical Indo-Pacific. Long & Skewes (1997) termed individuals longer than 18 cm as breeding class (2 years old). Several factors have been attributed to the difference in size at first maturity. For instance different types of diet present in the study site may cause differences in size at first maturity. Morgan (1999; 2001) showed that the growth of juveniles and adults of *H. scabra* depends largely on phytoplankton for their food. These include *Chaetoceros* spp., *Skeletonema* spp. and *Rhodomonas* spp. (Pitt, 2001). Another factor that may contribute to the observed different size at first maturity could be the depth from which the sample was taken. Several divers have reported large-sized *H. scabra* in deep water compared to shallow water.

Recommendations

It is recommended that a legal size for collection of *H. scabra* (above 16.8 cm) be set to avoid the collection of juveniles. Collectors of *H. scabra* require to be trained in issues concerning sustainable harvesting. Since the spawning season has been established it is recommended that the collection of *H. scabra* be banned during August–September and December–January. Closure seasons should be initiated as a priority in the most overexploited shores. Further efforts should be made to ascertain the *Holothuria* stock size and behaviour along the entire coast of Dar es Salaam.

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