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DISTRIBUTION AND ABUNDANCE OF CRUSTACEANS OF COMMERCIAL IMPORTANCE IN TANZANIA MAINLAND COASTAL WATERS

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ABSTRACT

Crustacean species of commercial importance were identified and their abundance and distribution along the Tanzanian coastline (820 km) were determined. A total of eight lobster species, eight prawn species, and two crab species were identified. Among the spiny lobster species (Palinuridae), *Panulirus ornatus* was the most widely distributed and the most abundant species with 42% of the total individuals sampled and *P. homarus* and *P. penicillatus* were the least abundant. The non-spiny lobster *Thanus orientalis* and two other scyllarid (Scyllaridae) species, *Parribacus antarcticus* and *Scyllarides squamosus* were also found in Tanzania, though in very small numbers and of least or no commercial value in the area. Among the prawn species, *Metapenaeus monoceros* was the most widely distributed, and the most abundant species comprising of about 45% of the total individuals sampled. Lowest distribution and abundance were recorded for *Penaeus japonicus* (1.2%). The commercially important crabs were *Portunus pelagicus* and *Scylla serrata* (Portunidae) and their abundance and distribution were the same. These crustaceans are a major source of income for some local fishermen, but does not contribute as one of the major sources of protein for the population of Tanzania.

Crustaceans include lobsters, prawns (and shrimps), crabs, woodlice, barnacles, water fleas and other less farmiliar groups. For the purpose of this study, the taxon Crustacea has been used to refer to lobsters, prawns (and shrimps), and edible crabs. Prawns and shrimps are synonymous terms, used interchangeably in different parts of the world and in this study, the term prawns has been used.

Crustaceans are distinguished from closely related arthropods by having a gill breathing mechanisim and two pairs of antennae. Like arthropods, crustaceans are either wholly or partially covered by a thin, but hard, flexible, chitinous exoskeleton. The part of this exoskeleton arising from the posterior margin of the cephalon, and extending anteriorly and posteriorly, often covering the head and thorax, is the carapace. The structure of the carapace is highly variable and distinctive in different groups and, hence, an important taxonomic character. Morphology and variations in colour of appendages among groups, have also been used for identification and classification of crustaceans (e.g., Bwathondi, 1973; Burukovskii, 1982; Bianchi, 1985).

Crustaceans are an important source of food for humans and animals. Smaller species link the food chains of marine systems by feeding on primary producers, and being themselves preyed upon by larger ones in different structural food webs (e.g., Raymont, 1983), while larger ones are of economic importance to humans (Siegel, 1986). Crustacean fishery could generate significant foreign exchange for Tanzania and also provide income, in addition to being a good source of protein for the local people. Attempts to cultivate prawns, and the problems associated with the practice in developing countries have been reviewed by Pedlan (1982). Prawns are cultured in many countries, for example, in the Philippines alone, six species of prawns namely *Penaeus monodon* (grass shrimp), *P. merguensis* (banana shrimp), *P. indicus* (white shrimp), *Metapenaeus ensis* and *M.*

monoceros (sand shrimps) and *M. brevicornis* (yellow shrimp) are commonly found and cultured (Pedlan, 1982). Prawns have also been cultivated in some African countries for example *Penaeus indicus* in Kenya (Ardill, 1982) and *P. duorarum* in Ghana (Denyoh, 1982). The crab *Scylla serrata* is monocultured in Taiwan (Pedlan, 1982), Kenya, Madagascar and Mauritius (Ardill, 1982), while another crab *Callinectes latimanus* is caught in lagoons and estuaries in Ghana (Denyoh, 1982).

Prawns (penaeid) are more abundantly found in the tropical and sub-tropical waters around the world (roughly from 40°N to 40°S) and they are by far the most commercially important (FAO, 1983). Yap et al (1979) reported that there are 318 species of prawns in the world. Speices of the genus *Penaeus* consists of over 70% of the world's catch (Richard and Maris, 1985) and regionally the catch composition is species specific (Dall, 1957). Penaeidae from the East coast of Africa have been reported by Hall (1964), while Haule (1981) reported that four species of prawns, namely: *P. monodon*, *P. japonicus*, *P. semisulcatus* and *M. monoceros* occur in the Kunduchi mangrove creek in Dar es Salaam. Siegel (1986) reported that the catch and amounts of commercially important crustaceans in Tanzania consisted of only three prawn species, namely: *P. indicus* (58.7%), *M. monoceros* (20.3%) and *P. monodon* (10.6%). He also noted that other marketable species could be found in large numbers in Tanzanian coastal waters.

Spiny lobsters (palinurids) are widely distributed throughout the Indo-West Pacific and Atlantic waters (Table 3; George and Holthius, 1965). The distribution of spiny lobsters in East African has been described for seven species: *P. ornatus*, *P. longipes*, *P. homarus*, *P. penicillatus*, *P. versicolor*, *P. polyphagus*, and *P. stimpsoni* (George, 1968). Bwathondi (1973) reported that 5 species of lobsters, namely: *P. ornatus*, *P. versicolor*, *P. longipes*, *P. penicillatus* and *P. homarus* occur in the Dar es Salaam (Tanzania) area. FAO (1985) indicated that there is yet another species, *Thanus orientalis*, that is not common in the Tanzanian coastal waters. As for the crabs, they show an extreme versatility in distribution. However, most of the edible and commercially important species are marine and brackish water dwellers found in all climatic regions of the world (Haefner, 1985). The portunid crabs *S. serrata* and *Portunus pelagicus* are common in fishery landings in Dar es Salaam (Bashemererwa, 1981; Mwaiseje, 1982; Siegel, 1986; and personal observations before the study). Both crab species, however, are not raised commercially.

In general, information on the commercially important crustaceans in Tanzania is not clearly known, especially the types and number of such crustacean species had not been explicitly reported. Identification key for these species in Tanzanian waters were either lacking or inadequately explained (Bianchi, 1985). Therefore, the present study was undertaken to identify all species of crustaceans which are commercially important and provide information on their distribution and abundance in the Tanzanian mainland coastal waters. Previous studies were carried out in and around Dar es Salaam (Bwathondi, 1973), whereas this study covered the whole Tanzanian coastline of about 820 km from Tanga in the north to Mtwara in the south.

Materials and Methods

Study Area.—The Tanzanian mainland coastline extends from 4°7′N to 10°5′S and 39°0′E to 40°15′E, covering a distance of approximately 820 km from north to south (Fig. 1). Study sites were selected from areas where people have long-established customs of eating sea foods and hence fishing practices. These sites were Tanga, Bagamoyo, Saadani, Dar es Salaam (Dar es Salaam Ferry

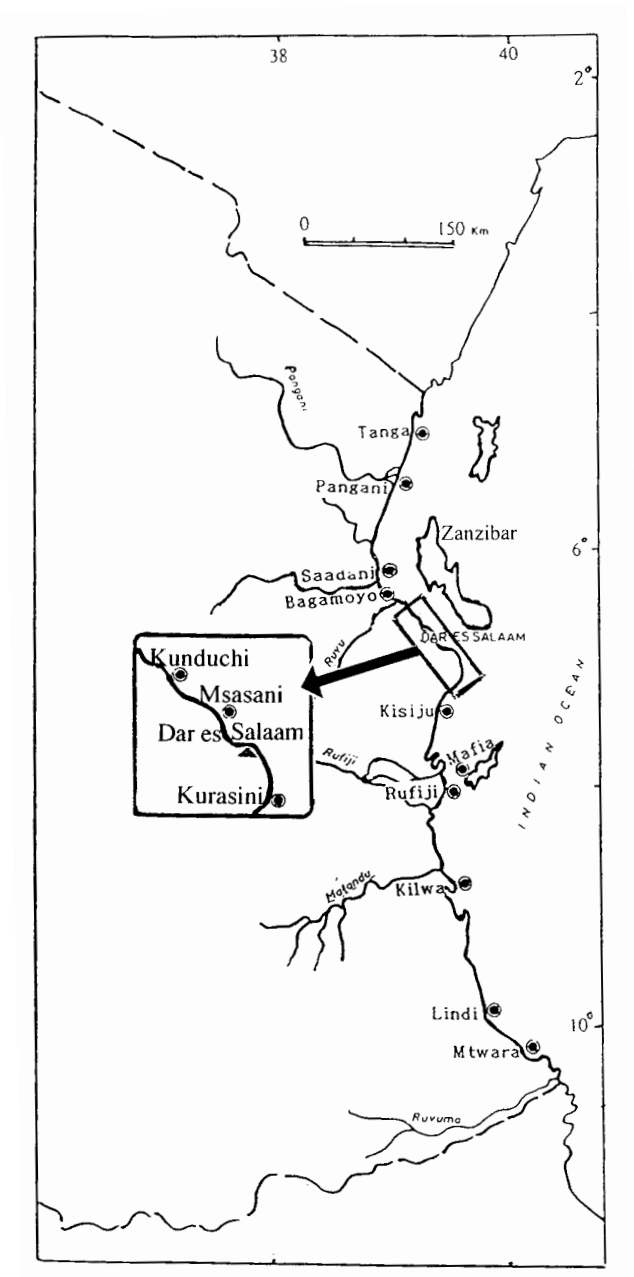

Figure 1. The coastline of Tanzania showing study sites (black dots) and the Dar es Salaam sites (inset map).

[for species identification only], Kurasini, Msasani and Kunduchi [these sites are also used as landing sites for fishery resources from adjacent islands like Bongoyo, Pangavini and Mbudya, not shown on the map, and from areas as far as Bagamoyo and Zanzibar], Rufiji, Kisiju, Mafia Island, Mtwara, Kilwa and Lindi.

Lobsters.—Lobsters were studied from two sources: from local fishermen's landings and from samples collected by employing professional divers. The latter collected samples from coral rich areas and from benthic habitats. Two methods are used by divers to collect lobsters; (1) by diving with spear gun and (2) diving with a hand net using octopus (Bwathondi, 1973). The second method is more effective and encouraged (and this is the one which was used) because it causes less damage to the resources. The minimum and maximum waiting time for the diver to deliver the lobster sample was 4–8 h, respectively. Lobster fishermen usually go fishing around midnight and return after midday. Samples collected by these divers were each treated as one sample, counted and their individual sizes measured as defined below. All other lobsters brought by fishermen at landing sites were identified to species. A total length (TL) of the body was used as the size measurement of an individual. This length is defined as the distance from the notch between eyestalks to the end of the telson, inclusive. Sexes were not identified.

Prawns and Crabs.—These two groups are usually collected together, however, when the target group is only crabs for special purchase orders, other methods are employed to maximize collection. At every study site, a beach seine net of 50 m length, 3 m wide and 12 mm mesh size was rented. Two helpers (fishermen) were hired to set, haul and drag the net towards the shore for a total operation time of 15–20 min. Each such collection constituted one sample. The sample was sorted to species and individuals of each species counted either in the field or preserved on ice and taken to the laboratory. This exercise was repeated for a maximum of 4 d at each site. Large samples(of prawns) were thoroughly mixed and sub-sampled by two handfulls for their body length measurements. Sexes were not identified and, therefore, female conditions (ovigerous or non-ovigerous) are not discussed in this study. A total body length (TL) was determined as described above. Crab sizes were not determined. Additional identification of species, particularly for prawns, was done from samples collected by capture fishery using other methods.

Local People and Crustaceans.—Local fishermen and elders at study sites were visited and interviewed. The information sought from them, among other things, included knowledge of crustacean species (by local names) present in their respective areas and crustacean utililization, e.g., how much is sold to increase their incomes or as a main source of income and at what prices, and how much is retained for consumption as a protein source.

Data Presentation and Analysis.—Identified species at each site were listed and indicated as present or absent. A mean was calculated from the total number from a maximum of 4 d sampling (i.e., four different samples) of individuals of each species. Percentage abundance of each species was calculated from the total species sample within each site. Relative abundance and relative size distribution of each species was determined from the species totals of the entire study area from north to south of the coastline. The data obtained for several of the prawn and lobster species were not normal distributed and, therefore, multiple comparisons of abundance, relative abundance and size distribution were determined using non-parametric tests (Kruskal-Wallis).

Results

Species Distribution.—*Lobsters*.—Eight species of lobsters were identified (Table 1, lobsters). Five of these were spiny lobsters (Palinuridae, Gray 1847), *P. longipes*, *P. ornatus*, *P. penicillatus*, *P. versicolor*, *P. homarus* and 3 were non spiny lobsters (Scyllaridae), *T. orientalis*, *Parribacus antarcticus* and *Scyllarides squamosus. Portunus ornatus*, *P. longipes* and *P. versicolor* were the most common and most widely distributed species, and were found at almost all sites. Mafia island had the highest lobster species occurence, while not a single species was found at Saadani, Kurasini or Rufiji.

Prawns and Crabs.—Six marine and two estuarine/freshwater species of prawns were identified. The marine prawn species (Penaeidea, Dana 1852) were *M. monoceros*, *Penaeus semisulcatus*, *P. latisulcatus*, *P. japonicus*, *P. monodon* and *P. indicus*. Freshwater species

Table 1. Species distribution on the Tanzanian coastal waters during May to December 1995. * = species landed here from Bongoyo and Mbudya Islands (not shown on Fig. 1), os = off season, (P) = present by anecdotal information.

1 Lobsters

Site	*P. longipes*	*P. ornatus*	*P. penicillatus*	*P. versicolor*	*P. homarus*	*Thanus orientalis*	*Par. antarcticus*	*Scy. squamosus*
Tanga	+	+	+	+	+	+	?	?
Pangani	+	+		+	+	+	?	+
Saadani		+					(P)	
Bagamoyo	+			+	+	(P)	?	
Dar es Salaam								
Kunduchi	+	+		+	+	+		+
Msasani	+	+	+	+	+	+	+	+
Kurasini		+			+		+	
Kisiju		+		+		+		
Rufiji								
Mafia Island	+	+		+		+		+
Kilwa	+	+	+	+	+	(P)	+	?
Lindi	+	+		+		(P)	(P)	
Mtwara	+	+		+		(P)		

Par. = *Paribacus*, *Scy.* = *Scyllarides*

2 Prawns

Site	*M.* spp	*N. tenuipes*	*M. monoceros*	*P. semisulcatus*	*P. latisulcatus*	*P. japonicus*	*P. monodon*	*P. indicus*
Tanga	?	?	+	+	+	+	(P)	(P)
Pangani	+	+		+			+	+
Saadani			+				+	+
Bagamoyo	+	?	+	+				
Dar es Salaam								
Kunduchi			+	+		+		(P)
Msasani*			+	+	+			+
Kurasini			+	+				+
Kisiju		(P)	+				+	+
Rufiji	+			+			+	+
Mafia Island	+							
Kilwa							os	os
Lindi	+		+	+			+	+
Mtwara			(P)	(P)			(P)	(P)

M. spp= *Macrobrachium* species*; N.* = *Nematopalaemon; M.monoceros*=*Metapeneaus*

3 Crabs

Site	*Scylla serrata*	*Portunus pelagicus*	*P. sanguinolentus*	*Thalamita* spp.
Tanga	+	+	+	
Pangani	+	+		
Saadani		+		
Bagamoyo	+	+	+	
Dar es Salaam				
Kunduchi	+	+	+	+
Msasani		+	+	+
Kurasini	+	+		(P)
Kisiju	+	+		
Rufiji	+			(P)
Mafia Island	(P)	+	+	
Kilwa	+	+		
Lindi	(P)			
Mtwara	+	(P)		

were *Macrobrachium* sp. and *Nematopalaemon tenuipes* (Table 1, prawns). At the 13 study sites (Fig. 1), *M. monoceros*, *P. semisulcatus* and *P. indicus* were the most widely distributed species. No prawn fishing activity was observed around Mafia island. Only two prawn pecies were found at Bagamoyo and five species were found at Tanga, Dar es

Table 2. Species Abundance (%) along the Tanzanian coastal waters during May to December 1995.

Species	Site										
	Tanga	Pangani	Saadani	Bagamoyo	Dar es Salaam	Kisiju	Rufiji	Mafia Is	Kilwa	Lindi	Mtwara
1 Lobsters											
P. longipes	21.4	8.0	0.0	25.0	25.4	22.3	0.0	22.2	4.9	0.0	14.3
P. ornatus	28.5	52.0	0.0	25.0	18.6	33.0	0.0	37.0	63.4	0.0	57.1
P. penicillatus	7.1	0.0	0.0	0.0	20.3	0.0	0.0	7.4	0.0	0.0	0.0
P. versicolor	14.4	8.0	0.0	12.5	11.8	22.2	0.0	22.2	24.4	0.0	28.5
P. homarus	21.4	30.0	0.0	37.5	5.1	0.0	0.0	3.7	4.7	0.0	0.0
Parribacus	0.0	0.0	0.0	0.0	3.4	0.0	0.0	11.6	0.0	0.0	0.0
Scyllarides	0.0	0.0	0.0	0.0	4.1	0.0	0.0	3.7	0.0	0.0	0.0
Thanus	7.1	12.0	0.0	0.0	10.2	22.5	0.0	2.1	2.6	0.0	0.0
2 Prawns											
M. monoceros	15.0	11.8	18.0	94.3	59.7	14.3	(P)	0.0	0.0	0.0	(P)
P. semisulcatus	36.0	52.0	0.0	5.7	9.9	0.0	9.0	0.0	0.0	85.0	0.0
P. indicus	0.0	14.1	32.0	0.0	28.2	66.7	63.0	0.0	0.0	11.5	0.0
P. japonicus	9.3	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
P. latisulcatus	39.5	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
P. monodon	0.0	22.3	50.0	0.0	0.0	19.0	28.0	0.0	0.0	4.0	0.0
3 Crabs											
P. pelagicus	33.0	14.6	50.0	77.2	48.8	57.1	9.0	41.6	13.3	13.3	(P)
P. sanguinoleuntus	13.3	0.0	0.0	0.0	15.1	0.0	0.0	8.3	0.0	0.0	0.0
Scylla serrata	53.3	50.0	50.0	13.6	17.4	42.8	90.9	41.6	86.6	86.6	(P)
Thalamita spp.	0.0	4.1	0.0	9.0	18.6	0.0	0.0	(P)	0.0	0.0	0.0

Salaam and Lindi, and four at Rufiji (Table 1). Crabs are usually caught in prawn nets, but only portunids were identified as *P. pelagicus*, *S. serrata*, *P. sanguinolentus* and *Thalamita* sp. (Table 1, crabs). Crabs were widely distributed along the entire coastline, however, *S. serrata* was not found along the coastline of Mafia island. Only *S. serrata* and *P. pelagicus* are commercially important, and are discussed in detail.

Species Abundance.—Abundance of spiny lobster species is shown in Table 2 (lobsters). *P. ornatus* was least abundant at Dar es Salaam, whereas it was most abundant at Kilwa (63.4%). There was a significant difference in abundance of *P. ornatus* among sites ($H = 23.34$, $P = 0.01$). Other lobsters (scyllarids) were observed only at Dar es Salaam Ferry Market, Mafia and Zanzibar (for *T. orientalis* only). According to the local people and fishermen's information, these Scyllarids are found as by-catches in very smal numbers (2–3 individuals) at fishing grounds like Zanzibar and Bagamoyo and brought to Dar es Salaam for sale.

The most abundant prawn species at Tanga was *P. latisulcatus* (39.5%). *P. semisulcatus* was most abundant at Lindi (85.0%) and Pangani (52.0%), while *M. monoceros* was most dominant at Bagamoyo comprising 94.3% of the total prawns collected in that area. *P. indicus* dominated the Rufiji delta with 66.7 and 63.0% for Kisiju and Rufiji, respectively. The highest number of *P. monodon* was recorded at Saadani and accounted for 50% of the total population (Table 2, prawns). There was no statistical significant differences in the abundance of prawn species among sites.

For crabs, *P. pelagicus* was most abundant at Bagamoyo (77.2%), and *S. serrata* at Rufiji (90.9%) (Table 2, crabs). *S. serrata* was more abundant than *P. pelagicus* at other sites except at Bagamoyo, Saadani, Dar es Salaam and Kisiju. However, there was no

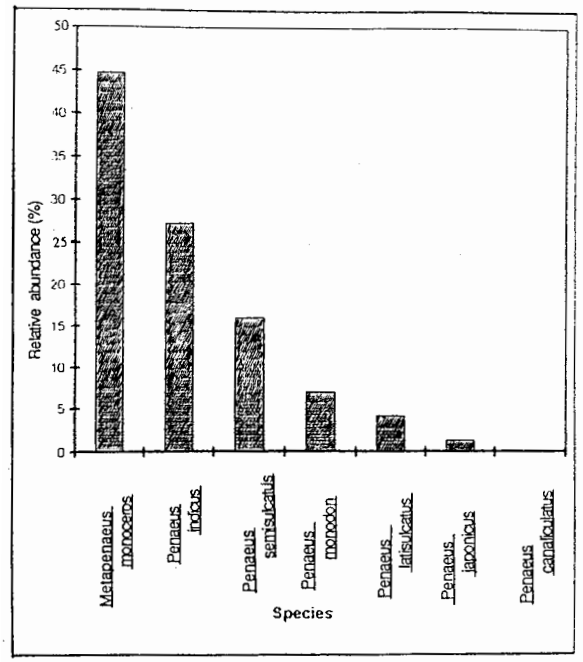

Figure 2. Relative abundance (%) of prawn species along Tanzania mainland coastal waters during May–December 1995.

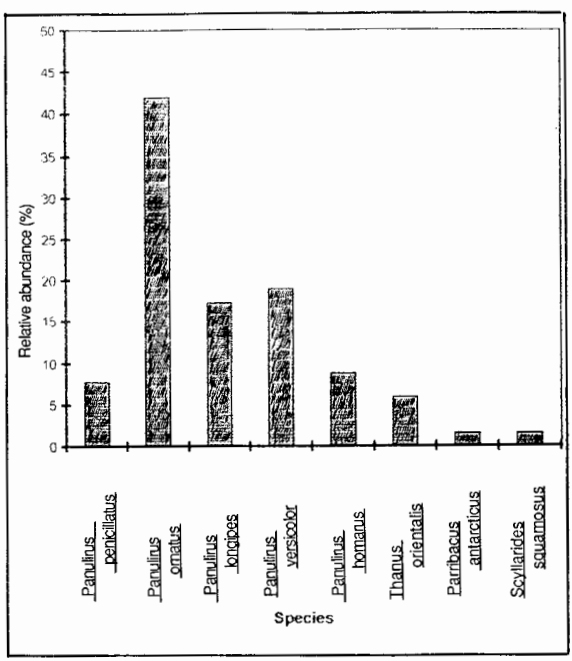

Figure 3. Relative abundance (%) of lobster species along Tanzania mainland coastal waters during May–December 1995.

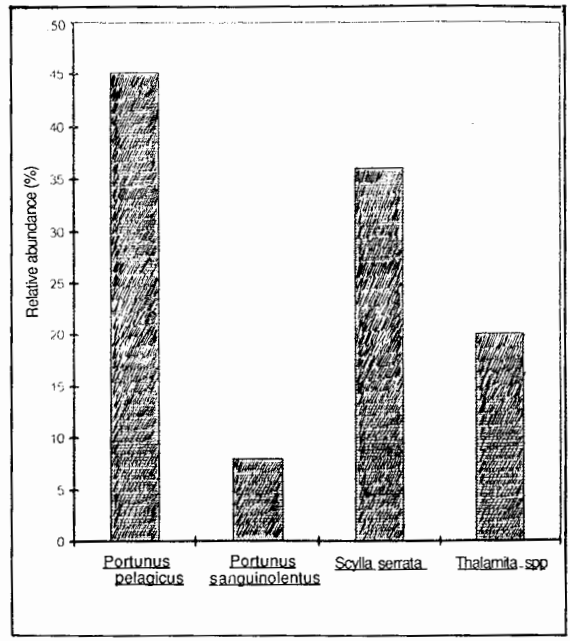

Figure 4. Relative abundance (%) of crab species along Tanzania mainland coastal waters during May–December 1995.

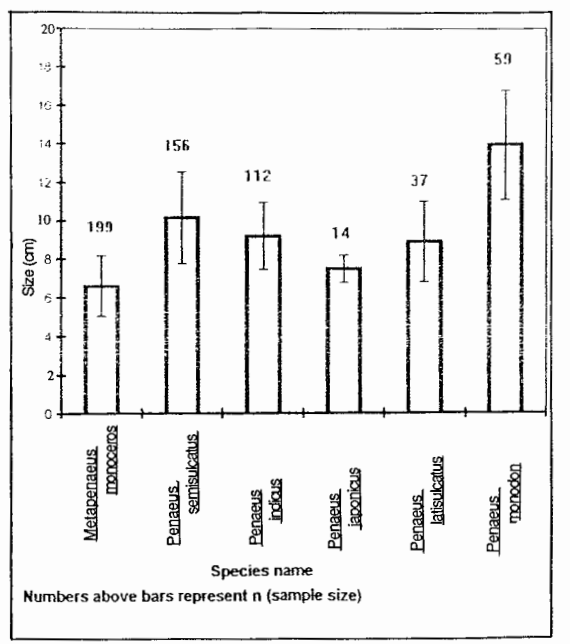

Figure 5. Relative size (TL, cm) distribution of prawn species species during May–December 1995 (presented as mean ± SD; sexes combined).

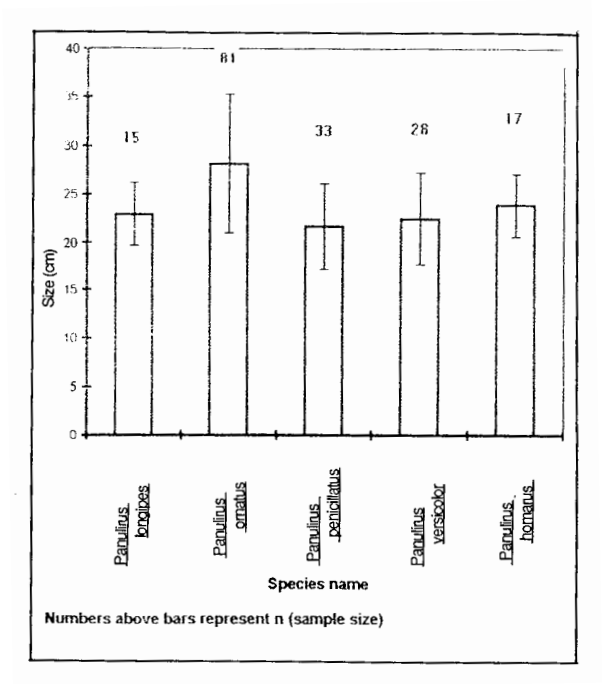

Figure 6. Relative size (TL, cm) distribution of spiny lobsters species during May–December 1995 (presented as mean ± SD; sexes combined).

statistical significant difference in the abudance of the two commercially important crab species among sites.

Relative Abundance of Species.—There were significant differences in abundance among species of all categories (data pooled from all sites, Kruskal-Wallis test). For lobsters, *P. ornatus* was the most abundant followed by *P. versicolor* and *P. longipes* (H = 16.6, P = 0.002) (Fig. 2). The abundance of *P. ornatus* was more than twice that of either *P. versicolor* or *P. Longipes.* For prawns, *M. monoceros* was the most abundant species followed by *P. indicus* (H = 15.3, P = 0.009). The former comprised 45% of the total individuals and was about 1.6 times as abundant as *P. indicus* (Appendix). The lowest abundance was observed for *P. japonicus* at 1.2% (Fig. 3). Crabs also showed a slight significant difference with *P. pelagicus* being the most abundant (H = 10.06, P = 0.02) (Fig. 4), comprising 45.2% of the total sample which also included the non-commercial portunids (*P. sanguinolentus* and *Thalamita* spp).

Relative Size of Species.—There were very significant differences in individual size among species of lobsters (Kruskal-Wallis test, H = 36.3, P = 0.001), and among species of prawns (H = 305, P = 0.001). The largest mean size (30 cm, TL) of lobsters was recorded for *P. ornatus* and the smallest size (21 cm, TL) was recorded for *P. longipes* (Fig. 6). The largest prawn species was *P. monodon* with a mean size of 15 cm (TL), and the smallest was *M. monoceros* with a mean size of 7 cm (TL) (Fig. 5).

Anecdotal Crustacean Information.—Fishing for crustaceans, especially for lobsters, is conducted throughout the year. In all zones, the peak fishing times for prawns is during the rainy season (December–April). There is a southward migration of prawns from Tanga to probably Saadani after the rainy period. This migration creates a peak fishing time at

Bagamoyo. One species, *P. indicus*, was said to be seasonal and it is found only during the rainy season at Tanga, Kilwa and Mtwara. At Rufiji, however, prawn fishing is carried out throughout the year. The breeding season for prawns was again associated with the rainy period, whereas very little was known about the breeding ecology of lobsters. Crabs were said to be found and breeding throughout the year, however, the migration patterns of crabs, remain uncertain.

Lobsters are exclusively caught for sale and are the most expensive compared with other crustaceans. Prices during this study ranged between US$1.80–18.00 kg^{-1} (being lowest in the southern areas in and highest in Dar es Salaam). Potential buyers from these local fishermen are the exporting companies (local and foreign) and city residents, especially those of the Asian origin. Prawns are also mostly for sale, but sometimes are locally consumed. Prices for prawns ranged between US$1–15 kg^{-1}, being lowest in the south and highest in Dar es Salaam. In Rufiji, crabs are discarded and wasted. In other areas, especially Tanga, crabs are locally consumed. Prices for crabs between the fisherman and local consumers range from US$0.2–0.3 each, while in Dar es Salaam, large crabs are mostly bought by local Asian-Tanzanians at US$1.20 each.

Discussion

Five species of palinurid and three species of scyllarid lobsters are found in Tanzania. Of these species, *P. ornatus* and *P. versicolor* , are most widely distributed, found at 10 or more of the 13 study sites followed by *P. longipes* at nine sites. On a global scale, however, lobster distribution shows that *P. penicillatus* is the most widely distributed species, found in 15 out of 18 regions of the world, followed by *P. versicolor* and *P. homarus* in 12 regions (Table 3). It is safe to conclude that Tanzania has all the most common spiny lobster species found in the world. *P. ornatus* is the most abundant species in Tanzania (see also Bwathondi, 1973). Three species not common in the Tanzanian literature (Bwathondi, 1973; Bianchi, 1985), *P. antarcticus*, *S. squamosus* and *T. orientalis* were found in small numbers in Tanzania especially at the Dar es Salaam Ferry Fish Market and Mafia island. It is possible that these species were caught from distant fishing grounds such as Bagamoyo and Zanzibar.

Abundance of lobsters probably could have been affected by the migration of individuals to different breeding sites as is in *P. ornatus* (Skewes et al., 1994). MacFarlane and Moore (1986) reported that the ornate rock lobster, *P. ornatus*, migrate during breeding season from Torres Strait fishing grounds to regions as far as Gulf of Papua, 500 km away, however there is no evidence that these animals migrate back to Torres Strait after the breeding season (Moore and MacFarlane, 1984).

The distribution of penaeids along the Tanzanian coast is defined by the extent of the fishing sites from Tanga in the north to Mtwara in the south. This distribution seems to be confined to coral-free areas. There is no prawn fishing activity in the coral fringing such as the Mafia island. Furthermore, major rivers like Pangani, Ruvu, Rufiji and Ruvuma constitute the highest number of fishing grounds for prawns because of the abundance prawn species in these areas. In some areas like Rufiji, prawn availability and fishing is almost all year round, while in Mtwara, prawns are mostly found during the rainy season.

Eight commercially important prawn species are found in Tanzanian coastal waters. Among these, *M. monoceros*, *P. semisulcatus* and *P. indicus* are very widely distributed

Table 3. Global distribution of spiny lobsters (*Panulirus* spp). (Adapted and modified from Bwathondi, 1973).

Region	East Africa	Madagascar	Red Sea	Natal	Ceylon	Arab Coast	West India	West Thailand	China Sea	Japan and Formosa	Australia	New Guinea	E.Pacific (Galápagos)	California	Atlantic	Hawaii	Chile
Species																	
P.cygnus											p						
P.ornatus	p	p			p	p	p	p	p	p	p	p					
P.longipes	p	p			p			p	p	p	p	p					
P.versicolor	p	p	p	p	p	p	p	p	p	p	p	p					
P.penicillatus	p	p	p	p	p	p	p	p		p	p	p	p	p		p	
P.homarus	p	p		p	p	p	p	p	p	p	p	p					
P.dysypus					p				?	p	?	?					
P.argus														p			
P.gracilis													p	p			
P.polyphagus					p		p	p	p		p						
P.japonicus						p		p	p	p							
P.guttatus															p		
P.echinatus															p		
P.interruptus													p	p			
P.inflatus														p			
P.stimpsoni								p	p		p						
P.pascuensis																	p
P.marginatus																p	

p= present

from the north to the south. Estuarine species, *Macrobrachium* sp. and *N. tenuipes*, are distributed from the major river confluences to upstream of rivers, especially Pangani, Ruvu and Rufiji.

Although each of the 13 sites investigated was dominated by at least a different species compared with other sites, species abundance was not significantly different. Nhwani et al. (1993) reported that *P. semisulcatus* was predominant at Kurasini (Dar es Salaam) while *P. indicus* predominated at Rufiji. In the present study, Dar es Salaam was dominated by *M. monoceros*. However, the preponderance of *P. indicus* at Rufiji is also confirmed by the results from this study. In terms of relative abundance, *M. monoceros* was the most abundant species followed by *P. indicus*, whereas *P. japonicus* and *P. latisulcatus* are not very prominent species in Tanzanian waters. All abundant prawn species described in this study were found in Dar es Salaam. The richness of species at Dar es Salaam is probably due to the concentration of the fishing grounds, intensive fishing activities, and also because it is a major landing site of fishery resources from other localities. Fishing activities in this area is also enhanced by the market reliability and high prices of the fishery resources. Two commercially important crab species are found in Tanzania. They are *S. serrata*, found in muddy river channels, and *P. pelagicus* caught in clear ocean open waters. These two species are usually caught together with prawns.

Differences in species abundance and distribution of prawns may be explained by various reasons. One is seasonal variations in species composition due to possible seasonal changes in substrate, especially for those species which inhabit or visit the estuaries during their life cycles. Substrate is a major factor in penaeid distribution (Branford, 1981). *P. semisulcatus* and *M. monoceros* burrow rapidly in shallow pools and intertidal flats. Their presence in the sample will, therefore, depend very much on the timing of such behaviours during sampling. *P. indicus* is a non-burrower found in muddy areas (Richard and Maris, 1985) and seems to be very active during rainy seasons (Nhwani, et.al., 1993, anecdotal information in the present study). If changes in substratum occur seasonally, then variations in species composition and abundance may likely follow this seasonal change. *Penaeus canaliculatus*, believed to be found in Tanzanian waters (Bianchi, 1985), was not observed in the present study. Differences in methods of data collection (e.g., time, size of the net), and in breeding periods of different species (see for example Nhwani et al., 1993) may also affect species composition and abundance. Furthermore, species distribution and composition may be affected by variations in the activity patterns.

Different species may be active at times of a day or a month when other species are not active. Sampling of prawns and crabs in this study was done only during the day. *P. semisulcatus* is believed to be nocturnal and *P. indicus* diurnal in feeding habits (Garcia and Reste, 1981) and hence the sampling time may influence the abundance of these species in the catch. The abundance of crab species is often affected by methods of collection. Crabs are often unavailable to many types of gear used (Haefner, 1985).

Coastal indigenous people and local fishermen are very knowledgeable about crustaceans of commercial importance. They use different local names to identify them, e.g., "Kamba" for prawn and "Kaji" for *P. monodon* and "Zeruzeru" for *P. japonicus*; "Kamba mti/koche" for lobsters and "Fenicha" for *P. ornatus* and "Muanzi" for *P. versicolor*, etc. These animals are sold by local fishermen to sustain their daily needs. Crustaceans are also sold to foreigners, Asian-Tanzanians, and to the recently mushrooming export companies. Lobsters are the most expensive fisheries resources and of significant commercial interest in many countries, therefore, more attention has been paid to lobster fishing

than to other crustaceans (Holthius, 1991). In Tanzania, most people, even the local fishermen, do not get this important protein source.

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Literature Cited

Ardill, J. D. 1982. A general review of coastal aquaculture in African region. FAO. CIFA Tech. Pap. no. 9

Bashemererwa, J. F. 1981. Some aspects of the biology of *Scylla serrata* in Dar es Salaam. M. Sc. Thesis. Univ. Dar es Salaam, Tanzania.

Bianchi, G. 1985. Field guide to the commercial marine and brackish water species of Tanzania. Species indentification sheets for fishery purposes. FAO, Rome.

Burukovskii, R. N. 1982. Key to shrimps and lobsters. American Publishing Co. Ltd. New Delhi.

Bwathondi, P. O. J. 1973. The biology and fishery potential of palinurid lobsters in Tanzania. M. Sc. Thesis. Univ. Dar es Salaam, Tanzania.

Branford, T. R. 1981. Sediment and ditribution of penaeid shrimp in the Sudanese Red Sea. Estuar. Coast. Shelf. Sci. 13: 349–354.

Dall, W. 1957. A revision of Australian species of Penaeidea. Aust. J. Mar. Freshw. Res. 8: 136–230.

Denyoh, F. M. K. 1982. The utilization of coastal areas for aquaculture development. FAO. CIFA Tech. Pap. no. 9. FAO. 1983. Year book of fishery statistics: catches and landings. 52(2). Rome.

Garcia, S. and L. Le Reste. 1981. Life cycles, dynamics, exploitation and management of coastal penaeid shrimp stocks. FAO Fisheries Tech. Rpt. no. 203.

George, R. W. 1968. Tropical spiny lobsters, *Panulirus* spp. of Western Australia and Indo-west Pacific. J. Royal Soc. W. Aust. 51(2): 33–38.

Haefner Jr., P.A. 1985. The biology and exploitation of crabs. Pages 111–166 *in* D. E. Bliss, ed. The biology of crustacea 10. Academic Press, New York.

Hall, D. N. F. 1964. Penaeidea of the east coast Africa. CSA Specialist Meeting in Crustaceans, Zanzibar. OAU/STRC Publ. no.96: 86–97.

Haule, W. V. 1981. Some biological aspects of penaeid prawns of Kunduchi mangrove creek. M. Sc. Thesis. Univ. Dar es Salaam, Tanzania.

Holthius, L. B. 1991. FAO Species catalogue vol. 13. Marine lobsters of the world. FAO. Rome.

MaFarlane, J. W. and R. Moore. 1986. Reproduction of the ornate rock lobster *Panulirus ornatus* in Papua New Guinea. Aust. J. Mar. Freshw. Res. 37: 55–65.

Moore, R. and J. W. MacFarlane. 1984. Migration of the ornate rock lobster *Panulirus ornatus* in Papua New Guinea . Aust. J. Mar. Freshw. Res. 35: 197–212.

Mwaiseje, B. 1982. The potential for non-conventional fisheries in Tanzania. Univ. Dar es Salaam. Univ. Sci. J. 8: 35–42.

Nhwani, L. B. S., P. Mwaiko, A. I. Chande, G. V. J. Mwamsojo and H. A. Mhitu. 1993. Crustacea resource assessment in Rufiji and by-catch studies of prawn trawlers. Tanzania Fisheries Research Institute.

Pedlan, P. G. 1982. Pond culture of fish, shrimps and crabs in intertidal zones in the Far East. FAO CIFA Tech. Pap. no. 9. Rome.

Raymont, J. E. G. 1983. Plankton and productivity in the oceans. vol. 2. Zooplankton. Univ. Southampton.

Richard, A. N. and R. C. Maris. 1985. Fisheries biology of shrimps and shrimplike animals. Page 1–87 *in* D. Bliss, ed. The biology of crustacea 10. Academic Press, New York.

Siegel, P. R. 1986. The exploitation of crustacean resources of Tanzania mangrove habitats. *In* J. R Mainoya and P. R. Siegel, eds. Faculty of Science. Univ. Dar es Salaam, Tanzania.

Skewes, T. D., C. R. Pitcher and J. T. Trendall. 1994. Changes in the size structure, sex ratio and moulting activity of a population of ornate rock lobsters *Panulirus ornatus* caused by an annual maturation moult and migration. Bull. Mar. Sci. 54: 38–48.

Yap, W. G., F. D. Apud and J. H. Primanera. 1979. Manual on prawn farming. Aquacult. Ext. Man. no. 5. Southeast Asian Fisheries Development Center.

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Appendix 1. Total number of individuals of each species sampled relative to site. Vertical numbers in the species rows represent species groups of 1-lobsters, 2-prawns and 3-crabs beneath which are the totals per group (vertical) and per site (horizontal).

	P. penicillatus *M. monoceros* *P. pelagicus*			*P. ornatus* *P. semisulcatus* *P. sanguinolentus*			*P. longipes* *P. indicus* *Scylla serrata*			*P. versicolor* *P. japonicus* *Thalamita* spp.			*P. homarus* *P. latisulcatus* Other			*P. monodon*		Total		
Site	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	1	2	3
Tanga	1	13	5	4	31	2	3	0	8	2	8	0	3	34	0	1	0	14	86	15
Pangani	0	10	10	15	44	0	2	12	12	2	0	1	3	1	1	3	19	25	86	24
Saadani	0	9	4	0	0	0	0	16	4	0	0	0	0	0	0	0	25	0	50	8
Bagamoyo	0	50	17	2	3	0	2	0	3	1	0	2	3	0	0	0	0	8	53	22
Dar es Salaam																				
Kunduchi	0	80	22	9	22	0	3	14	2	2	0	3	0	6	0	1	0	15	122	37
Msasani	12	37	17	6	21	3	13	20	0	4	6	0	3	3	0	3	0	41	87	20
Kurasini	0	281	3	0	23	0	0	154	13	0	0	12	0	0	1	0	0	0	458	29
Kisiju	0	3	4	3	0	0	2	14	3	2	0	0	0	0	0	0	4	7	21	7
Rufiji	0	0	1	0	9	0	0	64	10	0	0	0	0	0	0	0	28	0	100	11
Mafia	2	0	5	10	0	0	6	0	5	6	0	0	1	0	0	1	0	26	0	10
Kilwa	0	0	2	20	0	0	3	0	13	9	0	0	2	0	0	1	0	35	0	15
Lindi	0	0	0	0	22	0	0	3	7	0	0	0	0	0	0	0	1	0	26	7
Mtwara	0	0	0	12	3	0	3	0	0	6	0	0	0	0	0	0	0	21	0	0
Total	15	483	90	81	175	15	37	297	80	34	14	18	15	43	2	10	77	192	1,089	205