Journal of Shellfish Research, Vol. 17, No. 1, 51–58, 1998.

COASTAL SHELLFISH RESOURCE USE IN THE QUIRIMBA ARCHIPELAGO, MOZAMBIQUE

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ABSTRACT The level, types, and influences of use of intertidal and subtidal molluscs and crustaceans were examined on four islands of the Quirimba Archipelago in northern Mozambique. Artisanal collecting was restricted to spring low tidal periods and involved at least 5% of the population of the study islands. Twenty-two mollusc species and five decapod crustascean species (*Palinuridae* and *Portunidae*) were collected, of which the large gastropods *Chicoreus ramosus* (Muricidae) and *Fasciola trapezium* (fasciolaridae), were the most important on coral reef rubble shore regions. The bivalves *Pinctada nigra* and *Barbatia fusca* were the most important species in seagrass (*Hathodule* sp. and *Cymodocea* sp.) areas. The diversity and identity of target species and proportions of species taken by intertidal collectors differed between study islands. The mean length of the gastropods *C. ramosus* and *F. trapezium* collected on the larger islands of Quirimba and Quisiva have significantly decreased on the basis of examinations of previously collected middens. Those collected at Quirimba and Quisiva Islands were also smaller than current collections at the nearby smaller islands of Quilaluia and Sencar.

KEY WORDS: resource use, mozambique, intertidal, shellfish, fisheries

INTRODUCTION

Mozambique has the largest amount of coastline (2,700 km) of any country on mainland East Africa and one of the greatest dependencies on it (Macia and Hernroth 1995, Coughanowr et al. 1995). Toward the end of its 16-y internal conflict, in 1990, the gross national product per capita of Mozambique was estimated at $80 U.S. (World Resources Institute 1993, Coughanowr et al. 1995), making it one of the poorest countries of the world. Approximately two-thirds of the 16 million of the country's population live in the coastal zone, but there are still large coastal regions of mangrove and coral reef that are relatively undisturbed. The growth of the urban centers along the western Indian Ocean coastal zones coupled with the degree of countries' dependence on them has created much concern for the implementation of an Integrated Coastal Zone Management plan (Holdgate 1993, Linden 1993, Coughanowr et al. 1995). However, to date, Mozambique does not have such a plan, reflecting the overall lack of human and financial resources to perform studies on coastal management issues at the national level. The creation of strategic intertidal and marine reserves has become an important, and arguably the most effective, management tool for preserving and boosting complex multispecies fisheries, not only in East Africa (Crawford and Bower 1983, Kennedy 1990, Andersson and Ngazi 1995), but throughout the world's tropical and subtropical regions (Alcala and Russ 1990, Roberts and Polunin 1991).

East African coastal resource use takes a variety of forms besides fisheries. Many, such as live coral mining (Dulvy et al. 1995), sand mining causing coastal erosion (Semesi and Ngoile 1995), dynamite fishing (Andersson and Ngazi 1995), and mangrove deforestation (Coughanowr et al. 1995), have proved highly damaging, but in the short term are financially rewarding in often difficult socioeconomic conditions. The coastal zone of northern Mozambique is little developed, and the level of resource use is mainly limited to artisanal fisheries (local consumption), although some commercial fisheries also operate. The near-shore marine biology and resource use of northern Mozambique is poorly studied, virtually unmanaged, and little known. The only coastal region of Mozambique that has approached the level of study afforded to much of the East African coastline is that of Inhaca Island (Gove 1993, Longomane 1995, Santana Afonso 1995), by virtue of its close proximity to Maputo. Studies of intertidal invertebrate resource use have, at Inhaca Island as with virtually all other Indo-Pacific study locations, been very general in scope and focused little on the detail of species used and influences on individual species populations.

In this study, we report on the level and type of use of molluscs and decapod crustaceans on four islands of the Quirimba Archipelago in northern Mozambique, based on interviews with artisanal intertidal collectors, observations of collections, and target species identifications and measurements. The findings are discussed relative to the most studied location in Mozambique, Inhaca Island, as well as resource use in other areas of East Africa and the Indo-Pacific states.

THE COASTAL ENVIRONMENT

The Quirimba Archipelago in the Cabo Delgado province of northern Mozambique consists of 27 islands of various sizes, of which Quirimba Island itself is one of the largest at 6.5 by 2.5 km (Fig. 1). The bathymetry of the marine area enclosed by the ar-

TABLE 1.

Molluscs and crustaceans harvested in the Quirimba Island Archipelago.

Scientific name	English name	Value	Intertidal Reef	Intertidal Seagrass	Intertidal Mangrove	Subtidal Reef and Seagrass
Molluscs						
Class *Bivalvia*						
Family *Arcidae*						
Barbatia fusca	Almond ark	5,000/k		2		
Family *Pinnidae*						
Atrina vexillum	Giant pen shell	1,000 e				
Pinna muricata	Pinna shell	2,000/k		5		
Family *Pteriidae*						
Pinctada nigra	Pearl oyster	5,000/k		1		
Family *Tridacnidae*						
Tridacna squamosa	Fluted giant clam	3,000 e				
Class *Gastopoda*						
Family *Cassidae*						
Cassis cornuta	Horned helmet	15,000 e				
Cypraecassis rufa	Bullmouth helmet	15,000 e				5
Family *Conidae*						
Conus litteratus	Lettered cone	1,000 e				
Family *Cymatidae*						
Charonia tritonis	Trumpet triton	120,000 e				2
Family *Cypraeidae*						
Cypraea tigris	Tiger cowrie	100 e	5			
Family *Fasciolaridae*						
Fasciola trapezium	Tulip shell	250 e	2	4		
Family *Harpidae*						
Harpa major	Major harp	5,000 e				
Family *Melongenidae*						
Volema pyrum		Not sold				
Family *Mitridae*						
Mitra mitra	Mitra shell	8,000 e				
Family *Muricidae*						
Chicoreus chicoreus	Murex shell	10,000 e				
Chicoreus ramosus	Ramose murex	5,000 e	1	3		
Family *Naticidae*						
Polinices mamilla	Pear moon shell	Not sold				
Family *Potamidae*						
Terebralia palustris	Mud whelk	Not sold				
Family *Strombidae*						
Lambis chiragra	Arthritic spider	10,000 e				
Lambis lambis	Common spider	10,000 e	4			1
Strombus mutabilis	Humpback conch	Not sold			2	
Family *Turbinidae*						
Turbo coronatus	Turban shell	Not sold				
Family *Turbinellidae*						
Vasum turbinellum		Not sold				
Class *Cephalopoda*						
Octopus vulgaris	Common octopus	3,000/k	3			
Crustacea (Decapoda)						
Family *Palinuridae*						
Panulirus homarus	Scalloped lobster	10,000 e				3
Panulirus versicolor	Painted lobster	10,000 e				4
Family *Portunidae*						
Portunus pelagicus	Pelagic swimmer	Not sold				
Scylla serrata	Mud crab	5,000/k			1	
Thalamita crenata	Widefront swimmer	Not sold				

The value (in Meticais) and importance of species are shown for three intertidal habitats and the subtidal (e = each, /k = per kilo). The five numbered species in each of the four habitats are the most important species harvested (1 being most important of these and 5 being the least). The index was calculated from an average of importance in terms of the number of specimens collected, and the number of harvesters collecting each particular species.

TABLE 2.

The proportions of mollusc and crustacean species harvested in the Quirimba Island Archipelago.

Commercial species	Quirimba Island n = 16,756 (83)	Quisiva Island n = 1,682 (77)	Quilaluia Island n = 505 (12)	Sencar Island n = 65 (8)
Molluscs				
Class *Bivalvia*				
Family *Arcidae*				
Barbatia fusca	10.3 (44.3)	23.8 (10.4)	78.8 (25.0)	3.1 (12.5)
Family *Pinnidae*				
Atrina vexillum	Negligible	—	0.2 (8.3)	—
Pinna muricata	2.8 (8.3)	—	—	—
Family *Pteriidae*				
Pinctada nigra	78.9 (54.2)	0.1 (1.3)	0.6 (8.3)	—
Family *Tridacnidae*				
Tridacna squamosa	—	0.5 (6.5)	—	—
Class *Gastopoda*				
Family *Cassidae*				
Cassis cornuta	—	Subtidal only	Subtidal only	Subtidal only
Cypraecassis rufa	—	0.5 (3.9)	0.4 (8.3)	4.6 (25.0)
Family *Conidae*				
Conus litteratus	Negligible	3.2 (5.2)	—	—
Family *Cymatidae*				
Charonia tritonis	—	0.2 (3.9)	Subtidal only	—
Family *Cypraeidae*				
Cypraea tigris	0.1 (7.2)	1.8 (7.8)	2.4 (8.3)	—
Family *Fasciolaridae*				
Fasciola trapezium	0.2 (13.2)	32.0 (76.6)	4.2 (50.0)	18.5 (37.5)
Family *Harpidae*				
Harpa major	—	—	—	3.1 (12.5)
Family *Melongenidae*				
Volema pyrum	0.3 (13.2)	—	—	—
Family *Mitridae*				
Mitra mitra	Negligible	—	—	4.6 (12.5)
Family *Muricidae*				
Chicoreus chicoreus	Negligible	—	0.2 (8.3)	—
Chicoreus ramosus	2.6 (22.9)	22.1 (44.2)	7.5 (41.7)	6.2 (12.5)
Family *Naticidae*				
Polinices mamilla	Negligible	—	—	—
Family *Potamidae*				
Terebralia palustris	*	—	—	—
Family *Strombidae*				
Lambis chiragra	0.3 (6.0)	—	—	—
Lambis lambis	—	0.2 (5.2)	—	—
Strombus mutabilis	0.1 (9.6)	2.3 (13.0)	0.8 (16.6)	21.5 (25.0)
Family *Turbinidae*				
Turbo coronatus	3.7 (2.4)	—	—	—
Family *Turbinellidae*				
Vasum turbinellum	0.2 (1.2)	1.9 (1.3)	—	—
Class *Cephalopoda*				
Octopus vulgaris	0.1 (8.4)	8.5 (55.8)	4.6 (25.0)	38.5 (62.5)
Total Molluca	99.8 (93.9)	91.8 (97.4)	99.6 (81.8)	96.9 (87.5)
Crustacea (Decapoda)				
Family *Palinuridae*				
Panulirus homarus	—	Subtidal only	Subtidal only	Subtidal only
Panulirus versicolor	—	Subtidal only	Subtidal only	Subtidal only
Family *Portunidae*				
Portunus pelagicus	0.1 (4.8)	—	—	—
Scylla serrata	Negligible*	—	—	—
Thalamita crenata	Negligible	—	—	—
Total Crustacea	0.2 (7.2)	0	0	0

The total sample size of specimens is illustrated under each island heading together with the sample size of harvesters in parentheses. The values (percent) for each species are the proportion of total number of individual specimens harvested at each island sampled during the study period. The proportion of harvesters collecting each species is shown in parentheses. Species that were only collected subtidally are illustrated as such. The two species marked with an asterisk are important within the archipelago but were not collected to any great degree on any of these four islands. Dashes indicate species not collected at that site.

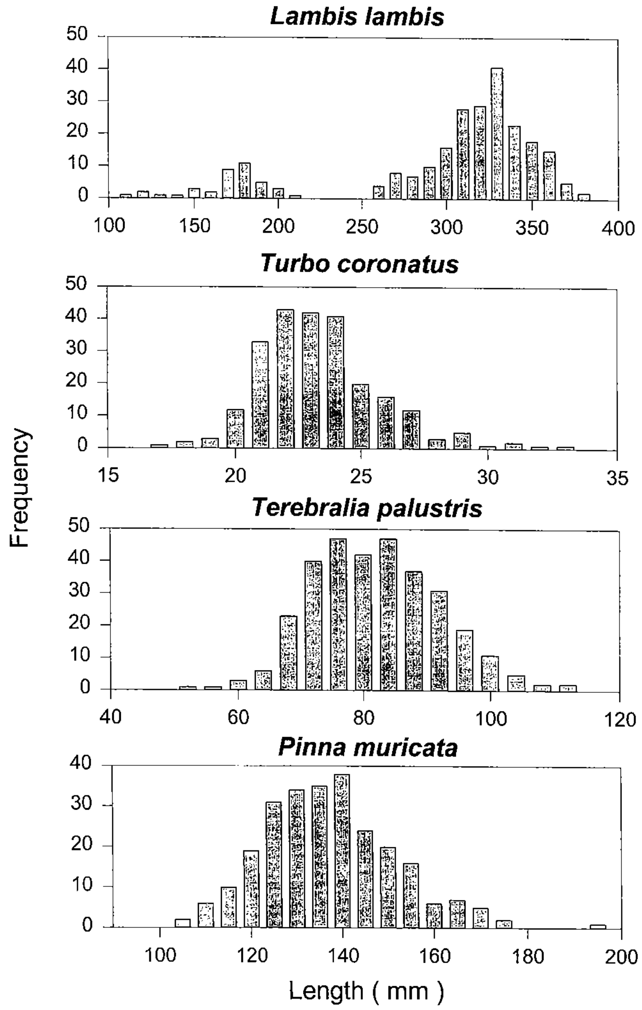

Figure 3. Length-frequency histograms of exploited molluscs at Quirimba Island. Samples of specimens were measured from harvester collections to illustrate the size range of each species being used. The smaller of the two peaks seen in the *L. lambis* histogram was the result of intertidal collections, and the larger peak to the right was the result of subtidal snorkel-aided collections.

collected were between 40 and 60 mm long. The mean length of *C. ramosus* shells from terrestrial middens, harvested on Quirimba Island from years previous was 117.3 (SD 15.6) mm, and the smallest shells collected were between 80 and 90 mm long. Although there was considerable overlap in the length of *C. ramosus* shells collected in 1996 and from previous years (Fig. 4), the average length has significantly decreased (Student $t = 96.6$, $p < 0.001$). Similarly, the average length and smallest length of *F. trapezium* collected on Quirimba Island have significantly decreased (Student $t = 94.7$, $p < 0.001$) from 130.9 to 103.9 and from over 100 to 70, respectively. Shells of *F. trapezium* from the other (seasonally) well-populated study island, Quisiva, illustrated a similar pattern (Fig. 5). The lengths of *F. trapezium* collected at Quilaluia Island and Sencar Island (both of which have low permanent population) were 114.5 and 115.8 mm, respectively. These were both significantly larger than collected *F. trapezium* from Quirimba and Quisiva Islands (Student $t = 22.1$, $p < 0.001$). On Quilaluia and Sencar Islands, the average length of *F. trapezium* had also significantly decreased from old collections on the same islands (Student $t = 3.4$, $p < 0.01$ and $t = 3.0$, $p < 0.01$, respectively).

Within an area of the lower shore, between 20 and 80 m wide for 0.75 km, the large semiburied bivalve *Pinna muricata* dominated the seagrass benthos of Quirimba Island, averaging 18/m^2 but with occasionally up to 60/m^2 (Barnes, unpubl.). In contrast to the size reduction of intertidal representatives of the gastropod species *C. ramosus* and *F. trapezium,* length measurements suggested that populations of the *P. muricata* have so far been unaffected by the current and previous levels of collection at Quirimba Island. The size of collected specimens was not significantly (Student $t = 0.6$, $p > 0.05$) different from the size of those found to have died of natural causes.

Most adult intertidal fishermen studied or interviewed rejected or claimed to reject shells of each species below a certain size. Causal but unquantified observations suggested that this varied between adults and that children collected smaller shells. All of the species of mollusc shells found in old collections were still collected in 1996, but some species, notably many of the low-value species (e.g., *Polinices mamilla, Turbo coronatus, Vassum turbinellum*), were not represented in old midden collections.

The mean carapace width of the portunid *S. serrata* collected (mainly from the mangroves adjacent to Ibo Island) was 147.6 mm (minimum, 104 mm; maximum, 200 mm). *S. serrata* was rarely observed to be collected from the mangroves of any of the study islands, although those on Quirimba Island have apparently supported brief periods of collection in the past (Joachim Gessner, pers. comm.). The sizes of both populations and individuals of Quirimba Island *S. serrata* were small.

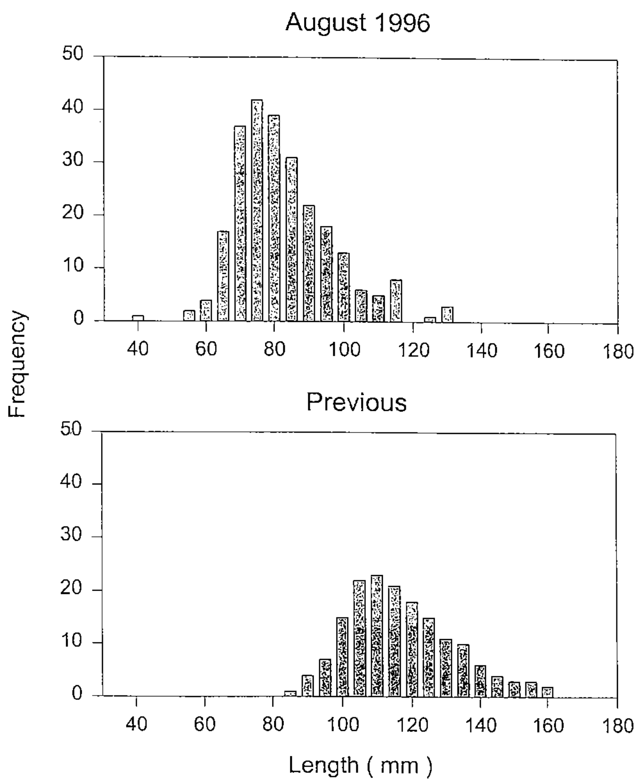

Figure 4. Length-frequency histograms of *C. ramosus* collections at Quirimba and Quisiva Islands. The upper histogram represents collections made during the study period (1996), and the lower histogram represents midden collections.

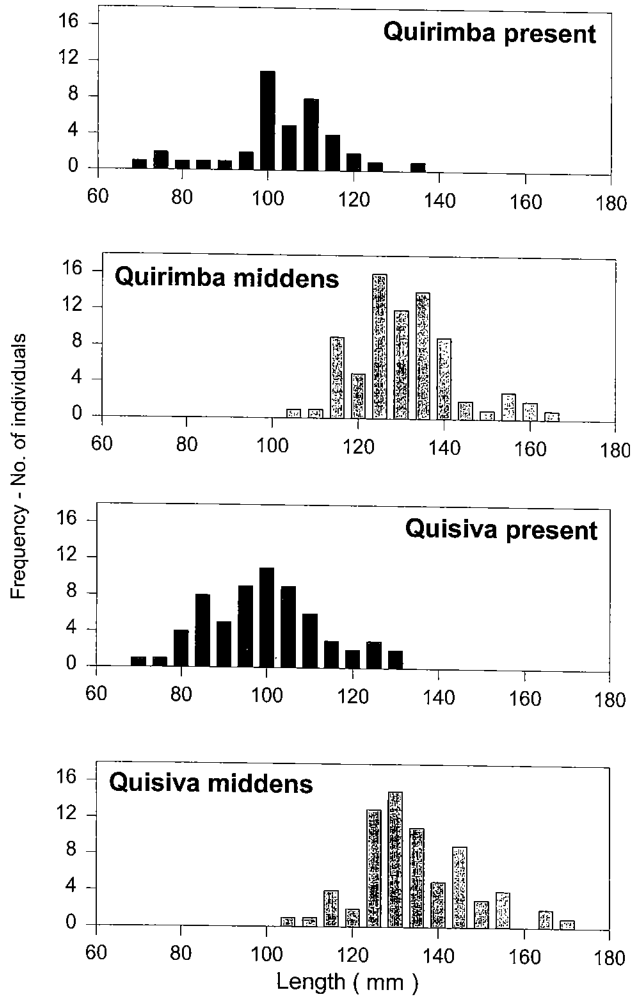

Figure 5. Length-frequency histograms of *F. trapezium* collections at Quirimba and Quisiva Islands. The darker shaded histograms represent collections made during the study period (1996), and the lighter shaded histograms represent old collections dug up from now unused middens.

DISCUSSION

The intertidal and immediate subtidal zones of Quirimba, Quisiva, Quilaluia, and Sencar Islands of the Quirimba Archipelago are a vital resource for local fisheries. These are operated by between 5 and 25% of the island populations, mostly by women and children. This translates to between 2 and 10 collectors per kilometer of intertidal zone (on spring tides). Intertidal collecting was only undertaken on spring low tides, and effort in terms of number of collectors was proportional to the tidal range. Such an intensity of collection is considerably lower than that both in Tanzania (Andersson and Ngazi 1995, Horril et al. 1996) to the north and on Inhaca Island (pers. obs.) to the south.

The proportions of species and actual species of molluscs and crustaceans harvested in the Quirimba Archipelago also differed considerably from those harvested in southern Tanzania and southern Mozambique. The number of artisanally important species was high, although a few species harvested at Inhaca Island were not collected in the Quirimba Archipelago (pers. obs.). This was because of rarity in some cases (e.g., *Modiolus phylipinarum* [horse mussel]) and probably lack of necessity (e.g., *Calappa hepatica* [box crab] and *Uca* sp. [fiddler crab]) because other more prized species such as *Portunus pelagicus* (*Portunidae*) were comparatively more abundant in the Quirimba Archipelago. Molluscs were proportionately much more important to the intertidal collectors of the Quirimba Archipelago and Tanzanian Islands than in the more southerly Inhaca Island, where the tonnage of molluscs, decapod crustaceans, and holothurians collected per unit time was approximately equal (Longomane 1995, Santana Afonso 1995, Macia and Hernroth 1995). Molluscs, particularly mussels, dominate the intertidal resources collected in much of South Africa (Hockey et al. 1988, Va Erkom Schurink and Griffiths 1990). The abundance of edible and search-time cost-effective mollusc species in the Quirimba Archipelago partly explains the lesser dependence on octopus compared with Tanzania (Andersson and Ngazi 1995).

The interpretation of the results from this study involves the assumption that changes in size distribution are due (or largely due) to fishing pressure and not other ecological factors. Although such an assumption may be an oversimplification, it has been used as the basis for studying various shell fisheries (e.g., in East Africa by Horril et al. 1996, in South Africa by Van Erkom Schurink and Griffiths 1990, and in Belize by Azueta 1993 unpubl.). The resource/environmental effect of the artisanal intertidal fisheries in the Quirimba Archipelago does not seem particularly marked when compared with the majority of tropical or subtropical fisheries of this type reported previously (Gomez et al. 1989, Alcala and Russ 1990, Andersson and Ngazi 1995, Coughanowr et al. 1995). There has been a significant decrease (Student $t = 94.7$, $p < 0.001$ and $t = 22.1$, $p < 0.001$ respectively) in the size of two of the most importantly collected mollusc species (*F. trapezium* and *C. ramosus*). The timeframe over which this has happened is unknown. The data collected by this study suggest that the length of harvested individuals of these species has decreased less on the shores of the two smaller islands (Quilaluia and Sencar), where fishing pressure is lower, than on the other, larger islands of Quirimba and Quisiva (*F. trapezium,* Student $t = 2.03$, $p < 0.05$ and $t = 2.12$, $p < 0.05$; *C. ramosus,* Student $t = 2.77$, $p < 0.01$ and $t = 2.72$, $p < 0.01$, respectively). Although the differences are small, they may illustrate the effect of increased collection pressure on the populations of these species.

The brachyuran crab *P. pelagicus* was the most important local crustacean fished. This species is important elsewhere along the East African Coast (pers. obs.), and crabs of the genus *Portunus* are also a major contribution of West African crustacean shellfisheries (Manning and Holthuis 1981). Grapsid crabs, although locally abundant, appear not to be collected, as in parts of West Africa, such as Ghana (Irvine 1947) and the Cape Verde Islands (Barnes unpubl.). No mention has been found of crabs of the genus *Thalamita* being caught elsewhere for food, although Rathbun (1921, in Manning and Holthuis 1981) mentions their ease of capture in the Congo intertidal zone.

The exploitation of the crustacean *S. serrata* does not appear high in the Quirimba Archipelago. However, over 11% of collected individuals had carapace widths smaller than would be allowed by law in South Africa (114 mm minimum in Cape Province and 115 mm minimum in Natal), and the size of individuals observed in the Quirimba Island mangroves was small and the species was rare. *S. serrata* has often been overexploited throughout its range, which spans the Indo-Pacific region (MacNae 1968). There are, however, extensive mangroves around Ibo Island and a substantial part of the northern Mozambique coastline. This region may, therefore, be one of the more important regions globally for the species, both from resource supply and conservation angles. The absence of freshwater (and the hardships associated with this) from Quilaluia, Quisiva, and Sencar may be an important factor in maintaining the relatively low overall current level of intertidal resource utilization (although the inshore and offshore fishing pressures may be considerably higher; Darwin/Frontier Moçambique Marine Research Programme unpubl.).

The absence of tourism and lack of suitable diving equipment, as well as an intertidal zone on which collection is easy, have resulted in little free or SCUBA diving for lobsters or larger molluscs. *L. lambis* (spider conch) shells are one of the most important species collected to sell, but there has been no obvious size or population effect discovered by this study. Lobsters of the genus *Panulirus* are often heavily exploited to the extent of catastophic population decrease, a problem being faced in both southern Tanzania and southern Mozambique, along with many other coastal tropical/subtropical urban areas. Throughout the Quirimba Archipelago, *Panulirus homarus* and *Panulirus versicolor* remain common in the subtidal zone (5–20 m; pers. obs.).

The diversity of molluscs exploited artisanally (22 species) is one of the highest reported of any Indo-Pacific local region known to the authors and probably reflects both the local marine biological diversity and the lack of local anthropogenic disturbance. This situation can be partly attributed to the extended period of civil conflict (ending in 1992), which heavily damaged the transport and communication infrastructure and precluded tourism, but also caused population shifts into the relative safety of the archipelago. The fact that the archipelago is farther from an international airport (Maputo is 2,000 km distant) than virtually any other stretch of coastline in Africa, combined with the lack of water on many of the islands, has also restricted development. The region could be arguably regarded as one of Africa's most remote mainland sites of marine biological diversity and cultural importance, but the islands are small and increased development will bring new and additional disturbances, changing the nature of the intertidal system. One of the principal aims of the ongoing studies of the Darwin/Frontier Moçambique Marine Research Programme is to ultimately provide key information and suggestions that could lead to an effective management plan to sustain the archipelago.

ACKNOWLEDGMENTS

This study was funded by the Darwin/Frontier Moçambique Marine Research Programme. This is a collaborative venture between the Society for Environmental Exploration (SEE) and the Ministépara a Coordenação de Acção Ambiental (MICOA) in Moçambique and is funded in part by the Darwin Initiative for the survival of Species (Department of the Environment, United Kingdom). The authors thank the logistics staff and volunteer research assistants of the project.

LITERATURE CITED

Alcala, A. C. & G. R. Russ. 1990. A direct test of the effects of protective management on abundance and yield of tropical marine resources. *J. Cons. Int. Explor. Mer.* 46:40–47.

Andersson, J. E. C. & Z. Ngazi. 1995. Marine resource use and the establishment of a marine park: Mafia Island, Tanzania. *Ambio.* 24:475–481.

Barnes, D. K. A. 1997. The ecology of tropical hermit crabs at Quirimba Island, Mozambique: distribution, abundance and activity. *Mar. Ecol. Prog. Ser.* 154:133–142.

Coughanowr C. A., M. N. Ngoile & O. Linden. 1995. Coastal zone management in eastern Africa including the island states: a review of issues and initiatives. *Ambio.* 24:448–457.

Crawford, R. J. M. & D. F. Bower. 1983. Aspects of growth, recruitment and conservation of the brown mussel *Perna perna* along the Tsitsikamma Coast. *Koedoe.* 26:123–133.

Dulvy, N. K., D. Stanwell-Smith, W. R. T. Darwall & C. J. Horrill. 1995. Coral mining at Mafia Island, Tazania: a management dilemma. *Ambio.* 24:358–364.

Gomez, E., M. Mungeugs, A. Hothy, K. J. Kuan, R. Wu, A. Soegiarto & E. Deocadiz. 1989. State of the marine environment in the East Asian seas region. *UNEP Regional Seas Reports and Studies.* No. 123.

Gove, D. Z. 1993. Marine reserves of the Inhaca and Portugese Islands (Mozambique). Their status and management. *SAREC Conference Rep.* 1:245–249.

Hockey, P. A. R., A. L. Bosman & W. R. Siegfried. 1988. Patterns and correlates of shellfish exploratation by coastal people in Transkei: an enigma of protein production. *J. Appl. Ecol.* 25:353–363.

Holdgate, M. W. 1993. The sustainable use of tropical coastal resources—a key conservation issue. *Ambio.* 22:481–482.

Horrill, C. J., W. R. T. Darwall & M. Ngoile. 1996. Development of a marine protected area: Mafia Island, Tanzania. *Ambio.* 25:50–57.

Kennedy, A. D. 1990. Marine reserve management in developing nations: Mida Creek—a study from East Africa. *Ocean Shoreline Mgmt.* 14: 105–132.

Linden, O. 1993. Resolution on intergrated coastal zone management in East Africa signed in Arusha, Tanzania. *Ambio.* 22:408–409.

Longomane, F. A. 1995. Exploração das Areas Entremarés Pela População Humana no Saco da Ilha de Inhaca. Trabalho de Licenciatura. Universidade Eduardo Mondlane, Maputo, Mozambique. 57 pp.

Macia, A. & L. Hernroth. 1995. Maintaining sustainable resources and biodiversity while promoting development—a demanding task for a young nation. *Ambio.* 24:515–517.

MacNae, W. 1968. A general account of the fauna and flora of mangrove swamps in the Indo-West Pacific. *Adv. Mar. Biol.* 6:73–270.

Manning, R. B. & L. B. Holthuis. 1981. West African brachyuran crabs (Crustacea: Decapoda). *Smithsonian Crontrib. Zool.* 306:1–379.

Rathbun, M. J. 1921. The brachyuran crabs collected by the American Museum Congo expedition, 1909-1915. *Bull. Am. Mus. Nat. Hist.* 43: 379–474.

Roberts, C. M. & N. V. C. Polunin. 1991. Are marine reserves effective in management of reef fisheries? *Rev. Fish Biol. Fish.* 1:65–91.

Santana Afonso, P. 1995. Dinâmica e Crescimento de Modiolus phylipinarum (Hanley, 1854) no Banco de Sangala-Ilha da Inhaca. Trabalho de Licenciatura. Universidade Eduardo Mondlane, Maputo, Mozambique. 50 pp.

Semesi, A. K. & M. A. K. Ngoile. 1995. Status of the coastal and marine environment of the United Republic of Tanzania. pp. 291–313. *In:* O. Linden (ed.). Proceedings of the Arusha Workshop and Policy Conference on Intergrated Coastal Zone Management in Eastern Africa Including the Island States. SAREC Marine Program, Coastal Management Center, Manila, Phillipines.

Van Erkom Schurink, C. & C. L. Griffiths. 1990. Marine mussels of southern Africa—their distribution patterns, standing stocks, exploitation and culture. *J. Shellfish Res.* 9:75–85.

World Resources Institute. 1993. World Resources 1992-1993. Oxford University Press, Oxford.