Corals of the South-west Indian Ocean: VI. The Alcyonacea (Octocorallia) of Mozambique, with a discussion on soft coral distribution on south equatorial East African reefs

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Key words: Mozambique; East African reefs; Octocorallia; Alcyonacea.
A list of 46 species of Alcyonacea is presented for the coral reefs of the Segundas Archipelago and northwards in Mozambique, as well as a zoogeographical record for the Bazaruto Archipelago in southern Mozambique. Among the 12 genera listed, *Rhytisma, Lemnalia* and *Briareum* were recorded on Mozambican reefs for the first time and the study yielded 27 new zoogeographical records. The survey brings the number of soft coral species listed for Mozambique to a total of 53. A latitudinal pattern in soft coral diversity along the south equatorial East African coast is presented, with 46 species recorded in Tanzania, 46 along the northern coast of Mozambique, dropping to 29 in the Bazaruto Archipelago in southern Mozambique and rising again to 38 along the KwaZulu-Natal coast in South Africa. Only Indo-Pacific genera occur in Mozambique with no intrusion of any endemic South African soft coral fauna. Species of the family Alcyoniidae have a wider latitudinal distribution on south equatorial reefs than zooxanthellate members of the families Nephtheidae and Xeniidae, both of which are confined to lower latitudes.

Introduction

The soft coral fauna (Octocorallia: Alyonacea) on the reefs in sub-equatorial East Africa have been the subject of various studies conducted over the last decade in several localities, including Tanzania (Ofwegen & Benayahu, 1992), Mozambique (Benayahu & Schleyer, 1995) and South Africa (e.g., Benayahu, 1993; Benayahu & Schleyer, 1995, 1996; Ofwegen & Schleyer, 1997; Williams, 2000). Those studies have shown that soft corals are abundant in these countries, include descriptions of several new species, and list numerous new zoogeographical records for Tanzania (7°S), Bazaruto in Mozambique (21°S) and the KwaZulu-Natal coast in South Africa (27.5°S). The results stimulated our interest in latitudinal gradients in soft coral species-richness on reefs in East Africa (see also Benayahu & Schleyer, 1996) and led us to further investigate the soft corals in the region.

The coastline of Mozambique extends from 10°S to 27°S, encompassing a full spectrum of reef types, from the fringing and island reef complexes found on either side of the Mozambique-Tanzanian border (Hamilton & Brakel, 1984; Wells, 1988; Obura et al., 2000; Rodrigues et al., 2000a) to the high-latitude marginal reefs of southern Africa (Schleyer, 2000). The present study deals with soft corals collected on the low latitude reefs in the Segundas Archipelago and northwards in Mozambique (12-16ºS). We pro-

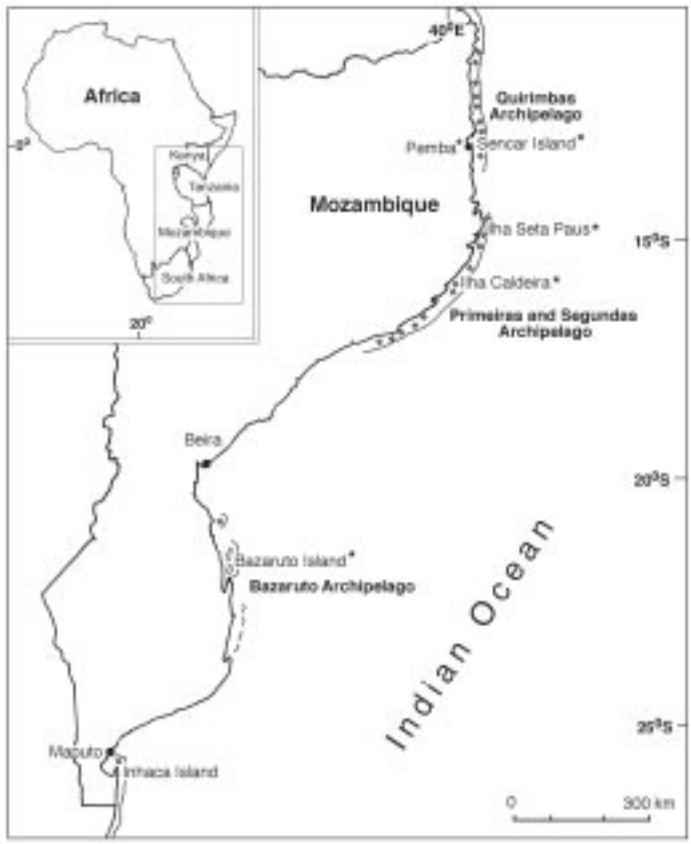

Fig. 1. Map of Mozambique showing the major reefs. Soft corals were collected at the sites marked with an asterisk. Inset shows south equatorial East African coastline.

vide a systematic list of soft corals for the area and note new zoogeographical records for Mozambique. The findings also enable us to describe the latitudinal patterns found in soft coral diversity and their distribution along some of the south equatorial East-African reefs.

Methods

Collections were made by M.H.S. at Ilha Caldeira (16°38′22″S; 39°43′10″E) in the Segundas Archipelago, Mozambique in June 2000 and at Ilha Sete Paus (14°58.572′S; 40°47.389′E) near Mozambique Island as well as Pemba (12°58.317′S; 40°32.433′E) and Sencar Island (12°29.533′S; 40°37.350′E) in the Quirimbas Archipelago in November 2000 (Fig. 1). The collection sites were visited by boat and a variety of habitats were surveyed in detail by SCUBA diving on onshore reefs, in lagoons and on deeper reefs to 28.5 m depth. Approximately 120 soft coral samples were collected, comprising most species found on the reefs. In addition, we examined a specimen from Bazaruto

collected in 1994. Samples were fixed in 4% formalin in seawater, rinsed in fresh water after 24 hours, and then transferred to 70% ethyl alcohol. Sclerites were obtained by dissolving the tissues in 10% sodium hypochlorite. Identification of species of the family Alcyoniidae was in great part facilitated by comparisons with permanent sclerite-preparations of type material kept in the Zoological Museum, Department of Zoology, Tel Aviv University, Israel (ZMTAU), where all the material has been accessioned. Some additional members of the family Nephtheidae were also collected and are still being examined.

Results

This current study presents the findings for the soft corals of the families Tubiporidae, Alcyoniidae, Nephtheidae, Xeniidae and Briareidae. The collection comprises 47 species for reefs in the Segundas Archipelago and northwards in Mozambique (Table 1, collection number of each specimen indicated) and includes *Briareum hamrum* (Gohar, 1948) from Bazaruto Island. Among the 12 genera listed for these families, *Rhytisma, Lemnalia* and *Briareum* were recorded on Mozambican reefs for the first time, and the study yielded 27 new geographical records (Table 1). The collection yielded 36 species of Alcyoniidae, six Xeniidae, three Nephtheidae, the single member of the Tubiporidae and one of the Briareidae. The genus *Sinularia*, with 20 species, was notably found to be the most diverse soft coral.

Discussion

An early study by Tixier-Durivault (1960) listed only 13 species of soft corals for Inhaca Island (26°S), Mozambique. This low diversity may have been due to the fact that these reefs are weak, marginal formations (Hamilton & Brakel, 1984). Six species from the original list (*Cladiella madagascarensis, Lobophytum crebriplicatum, Xenia viridis, Heteroxenia membranacea, H. rigida* and *H. elisabethae*) were not found in a later study on the prominent and extensively sampled reefs at Bazaruto Island (Benayahu & Schleyer, 1996), nor in this study. While Inhaca is undoubtedly a site of interest that requires further study, numerous recent visits to the island indicate that the soft coral fauna has become impoverished (Schleyer et al., 1999; Rodrigues et al., 2000b; Motta et al., 2002) and the continued survival of most of Tixier-Durivault's (1960) species appears dubious (Schleyer, pers. obs.).

Amendment of the list of soft corals found at Bazaruto Island (Benayahu & Schleyer, 1996) by Benayahu et al. (1998), who synonymized *Sinularia dura* with *S. brassica*, together with our present discovery of *Briareum hamrum* in the Bazaruto collection (Table 1), brings the number of species for this area to 27. The current survey also brings the number of soft coral species recorded for the entire coast of Mozambique to a total of 53 as seven species recorded on the Bazaruto reefs were not found on the northern Mozambican reefs. The six species mentioned above for Inhaca (see Tixier-Durivault, 1960) are not included for the reasons given above.

The southernmost reef-coral communities on the East African coast and in the western Indian Ocean are found on the Maputaland coast of northern KwaZulu-Natal at 27-28°S (Schleyer, 2000). Here, 38 species of alcyonaceans have been recorded at

Sodwana Bay (27.5°S; Benayahu, 1993; Benayahu & Schleyer, 1995, 1996). The coastal survey by Robertson et al. (1995) suggests that southern Mozambican reefs (26-27°S) share much of the Sodwana fauna but they are not as diverse.

An interesting pattern emerges on consideration of the accumulated data on soft corals along the south equatorial East African reefs. The latitudinal species diversity and distribution varies in this region (see also Benayahu & Schleyer, 1996), with 46 species recorded in Tanzania (7°S; Ofwegen & Benayahu, 1992) and 46 along the northern coast of Mozambique (12 – 16°S; this study), dropping to 27 in the Bazaruto Archipelago (21°S; Benayahu & Schleyer, 1996), and rising again to the 38 species mentioned above at Sodwana Bay (27.5°S). Considering the limited reef area surveyed in Tanzania (Ofwegen & Benayahu, 1992), the finding for this region probably represents an underestimate of its soft coral biodiversity, but this must await further study. The above results are thus indicative of a pattern in soft coral species attenuation from the equator, with an increase in biodiversity again on the marginal coral reefs in South Africa. Williams (2000) found that Indo-Pacific genera make the largest contribution to the South African soft coral fauna, followed by genera with a widespread distribution and southern African endemics, the remainder being shared with the Atlantic and Antarctic or Southern Ocean. The soft corals found on the Maputaland reefs were all Indo-Pacific species (see Benayahu, 1993), or were locally or regionally endemic, i.e. *Efflatounaria sodwanae* (Benayahu, 1993), *Sinularia schleyeri* (Benayahu, 1993) and *Eleutherobia aurea* (Benayahu & Schleyer, 1996). Therefore, the high diversity of soft corals on the Maputaland reefs can be explained at least in part by local speciation. Schleyer (1999) found that species richness in general on these high latitude reefs constitutes a biodiversity peak and attributed it to the admixture of tropical and temperate fauna in the region. The findings in the present survey on soft corals indicate that only Indo-Pacific genera are encountered in Mozambique and there is no intrusion of any South African endemic fauna. It can thus be stated that, unlike the remarkable degree of endemism found in the South African octocorallian fauna (see Williams, 2000), the soft coral fauna of Mozambique belongs entirely to the Indo-Pacific zoogeographic province.

All the studies conducted on the south equatorial East African reefs reveal that the family Alcyoniidae contributes their most conspicuous soft coral fauna, comprising the majority of the species (South Africa: 74%, Bazaruto: 89%, northern Mozambique: 76% and Tanzania: 83%). *Sinularia* is the dominant genus with the highest number of species: South Africa has 15, Bazaruto 12, northern Mozambique 20 and Tanzania 19 (after amendments following Vennam & Ofwegen, 1996; Benayahu et al., 1998). The significance of *Sinularia* to soft coral biodiversity in the region is further demonstrated by its contribution of over 40% to the total soft coral species richness. This finding corroborates the recent work of Ofwegen (2002) who summarized the status of knowledge of *Sinularia* diversity in the Indo-Pacific region.

Among the Nephtheidae, the azooxanthellate genus *Dendronephthya* is found sporadically on the southern African reefs (i.e., Sodwana Bay and Bazaruto), either in conspicuous, dense patches of numerous colonies or in isolated colonies scattered in deep habitats below 22 m (unpublished data). However, the zooxanthellate genus *Nephthea* is very rare in the south and occurs only as small colonies. The zooxanthellate Indo-Pacific genera of the Nephtheidae are much more common on the lower lati-

tude reefs of south equatorial East Africa, including northern Mozambique and Tanzania, and comprise species of *Lemnalia* (Ofwegen & Benayahu, 1992, this study) and *Litophyton* (Ofwegen & Benayahu, 1992). A similar distributional pattern is found in the family Xeniidae, which becomes more prominent on lower latitude reefs, with the appearance of the genus *Cespitularia,* which is not encountered at Bazaruto or on the southern reefs (Benayahu, 1993; Benayahu & Schleyer, 1996).

The accumulated data thus clearly indicate that a diversity of soft coral assemblages inhabits the East African reefs. The Indo-Pacific family Alcyoniidae has a wider latitudinal distribution there than the families Nephtheidae or Xeniidae, with both of the latter being mostly confined to low latitude or equatorial reefs. Interestingly, these biogeographic affinities are further enhanced by recent findings on the soft coral fauna in Kenya (4°S, in prep.). Further surveys throughout the whole region will further contribute to our knowledge on the biogeographic patterns of this group.

Recent threats affecting the coral reefs of Mozambique include El Niño Southern Oscillation (ENSO) related bleaching (1998), crown-of-thorn starfish (*Acanthaster planci*) outbreaks, fishing, tourism and other human activities (Obura et al., 2000; Rodrigues et al., 2000a). The impacts of these threats and, primarily, the massive consequences of the 1998 ENSO related coral bleaching, highlight the value of programs in which changes in coral diversity and distribution on the Mozambique reefs are being monitored (Schleyer et al., 1999; Rodrigues et al., 2000b; Motta et al., 2002). The high diversity and faunistic importance of soft corals in this area illustrate the need for further soft coral surveys that will encompass the full spectrum of reef types in Mozambique, especially at unstudied sites. This will make a valuable contribution to the development of appropriate reef management and conservation policies in the region.

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Table 1. List of Octocorallia of the order Alcyonacea Lamouroux, 1816 (emended by Bayer, 1981), from north Mozambique with indication of Museum inventory numbers (ZMTAU Co). NR = New Record in Mozambique.

Classification	New Record
Tubiporidae Ehrenberg, 1828	
Genus *Tubipora* Linnaeus, 1758	
Tubipora musica Linnaeus, 1758	
ZMTAU Co 31260	
Alcyoniidae Lamouroux, 1812	
Genus *Cladiella* Gray, 1869	
Cladiella australis (Macfadyen, 1936)	
ZMTAU Co 31240, 31303	
Cladiella brachyclados (Ehrenberg, 1834)	NR
ZMTAU Co 31243	
Cladiella kashmani Benayahu & Schleyer, 1996	
ZMTAU Co 31270, 31304	
Cladiella krempfi (Hickson, 1919)	
ZMTAU Co 31283, 31293	
Cladiella laciniosa (Tixier-Durivault, 1944)	NR
ZMTAU Co 31289, 31301	
Cladiella latissima (Tixier-Durivault, 1944)	NR
ZMTAU Co 31269	
Cladiella pachyclados (Ehrenberg, 1834)	NR
ZMTAU Co 31300	
Cladiella tulearensis (Tixier-Durivault, 1944)	NR
ZMTAU Co 31287	
Genus *Lobophytum* von Marenzeller, 1886	
Lobophytum crassum von Marenzeller, 1886	
ZMTAU Co 31256, 31263, 31295, 31302	
Lobophytum depressum Tixier-Durivault, 1966	NR
ZMTAU Co 31254	
Lobophytum patulum Tixier-Durivault, 1956	
ZMTAU Co 31252, 31294	
Lobophytum venustum Tixier-Durivault, 1957	
ZMTAU Co 31250	
Genus *Rhytisma* Alderslade, 2000	
Rhytisma fulvum fulvum (Forskål, 1775)	NR
ZMTAU Co 31241, 31307, 31318	
Genus *Sarcophyton* Lesson, 1834	
Sarcophyton ehrenbergi von Marenzeller, 1886	NR
ZMTAU Co 31248, 31257, 31311	
Sarcophyton glaucum (Quoy & Gaimard, 1833)	
ZMTAU Co 31246, 31265	
Sarcophyton trocheliophorum von Marenzeller, 1886	
ZMTAU Co 31262, 31290, 31305	
Genus *Sinularia* May, 1898	
Sinularia abrupta Tixier-Durivault, 1970	
ZMTAU Co 31284, 31309, 31454	
Sinularia brassica May, 1898	
ZMTAU Co 31247, 31261, 31273, 31299	
Sinularia compressa Tixier-Durivault, 1945	NR
ZMTAU Co 31272, 31292	

Sinularia erecta Tixier-Durivault, 1945
ZMTAU Co 31277, 31297
Sinularia firma Tixier-Durivault, 1970 NR
ZMTAU Co 31242, 31275
Sinularia fungoides Thomson & Henderson, 1906 NR
ZMTAU Co 31285
Sinularia grandilobata Verseveldt, 1980
ZMTAU Co 31255, 31279, 31280
Sinularia gravis Tixier-Durivault, 1970
ZMTAU Co 31267, 31276, 31278, 31286, 31308
Sinularia heterospiculata Verseveldt, 1970
ZMTAU Co 31239
Sinularia inelegans Tixier-Durivault, 1970 NR
ZMTAU Co 31291
Sinularia leptoclados (Ehrenberg, 1834)
ZMTAU Co 31259, 31281, 31282
Sinularia lochmodes Kolonko, 1926 NR
ZMTAU Co 31264, 31271
Sinularia macrodactyla Kolonko, 1926
ZMTAU Co 31249, 31312
Sinularia macropodia (Hickson & Hiles, 1900) NR
ZMTAU Co 31274
Sinularia numerosa Tixier-Durivault, 1970 NR
ZMTAU Co 31244
Sinularia polydactyla (Ehrenberg, 1834)
ZMTAU Co 31310
Sinularia rotundata Tixier-Durivault, 1970 NR
ZMTAU Co 31251
Sinularia terspilli Verseveldt, 1971 NR
ZMTAU Co 31258, 31453
Sinularia triangula Tixier-Durivault, 1970
ZMTAU Co 31266
Sinularia vrijmoethi Verseveldt 1971 NR
ZMTAU Co 31238, 31245, 31288
Nephtheidea Gray, 1862
Genus *Lemnalia* Gray, 1868
Lemnalia africana (May, 1898) NR
ZMTAU Co 31338, 31340, 31344
Lemnalia flava (May, 1898) NR
ZMTAU Co 31341
Lemnalia humesi Verseveldt, 1969 NR
ZMTAU Co 31339, 31343, 31345
Xeniidae Ehrenberg, 1828
Genus *Anthelia* Lamarck, 1816
Anthelia glauca Lamarck, 1816
ZMTAU Co 31313, 31317
Genus *Cespitularia* Milne-Edwards & Haime, 1850
Cespitularia caerulea May, 1898 NR
ZMTAU Co 31296
Cespitularia densa Tixier-Durivault, 1966 NR
ZMTAU Co 31253
Cespitularia erecta Macfadyen, 1939 NR
ZMTAU Co 31316, 31337

Genus *Heteroxenia* Kölliker, 1874	
Heteroxenia fuscescens (Ehrenberg, 1834)	NR
ZMTAU Co 31237, 31298	
Genus *Xenia* Lamarck, 1816	
Xenia crassa Shenck, 1896	NR
ZMTAU Co 31236, 31306	
Briareidae Blainville, 1830	
Genus *Briareum* Blainville, 1830	
Briareum hamrum (Gohar, 1948)	NR
*ZMTAU Co 31319	

* Specimen collected at Chilola, Bazaruto Is.