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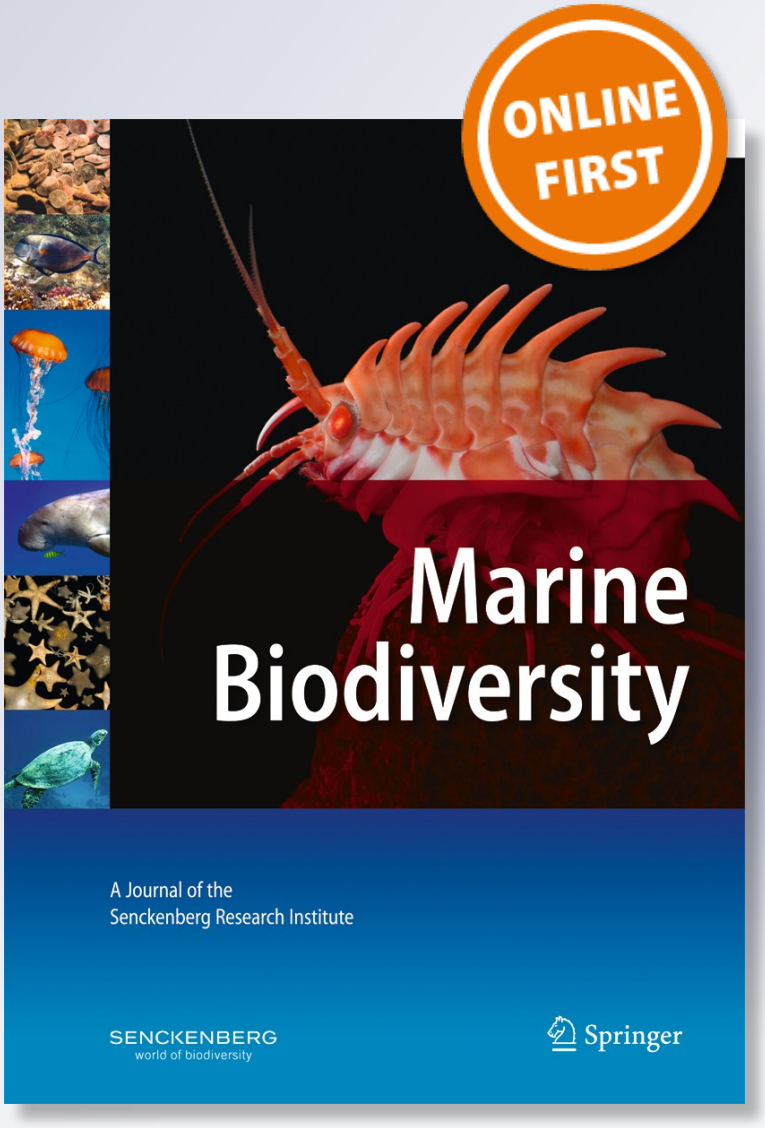

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SHORT COMMUNICATION

The soft coral fauna (Octocorallia: Alcyonacea) of Mayotte

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Abstract Soft corals collected around Mayotte in 2011 comprised 24 genera and 57 identifiable species of Alcyonacea; two genera and three species were added to the list from a 1997 collection made for a natural products study. When compared with other western Indian Ocean (WIO) data, Mayotte's alcyonacean fauna is the richest, and the island potentially comprises a regional biodiversity hotspot for this group. Mayotte has the largest barrier reef in the WIO and, considering the oceanography of the Mozambique Channel, this alcyonacean biodiversity may feed into the system and merits conservation.

Keywords Coral reefs · Biodiversity · Comoros · Mozambique Channel · Western Indian Ocean

Introduction

Mayotte forms part of the Comoros Archipelago, which lies between the coast of northern Mozambique and the northern tip of Madagascar. The most comprehensive account of its little-studied coral reefs is provided by IUCN/UNEP (1988), information, which is again briefly summarised by Spalding et al. (2001). The latter authors also include more recent information on e.g. crown-of-thorns starfish outbreaks and the 1998 ENSO bleaching event. While some work has been undertaken on the hard corals (Scleractinia) of the Comoros (IUCN/UNEP 1988, Spalding et al. 2001), there are no records of its soft corals. This fauna was thus collected during an expedition to the reefs in 2011, yielding the following information.

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Methods

Study area

As it is volcanic in origin, the island of Mayotte (12°30′S; 45°10′E) has relatively steep slopes and a rugged coastline. While it is 374 km^2 in area, its reefs are 570 km^2 in extent and it has the largest barrier reef in the western Indian Ocean (196 km), with the unusual feature of a second, inner barrier reef that is 18 km long (Fig. 1; Petit and Prudent 2010). The outer barrier reef is up to 2 km wide and encircles much of the island, creating one of the largest lagoons in the world (1100 km^2; Petit and Prudent 2010); it is ≥30 m deep. The outer slopes of the outer barrier reef fall steeply to ≥500 m depth. The island itself has fringing reef around much of its shores and numerous patch reefs of significant size in the lagoon.

Biological collection and analysis

Alcyonacean octocorals were collected during 17 dives undertaken to a maximum depth of 25 m on 12 Mayotte reefs during 24 June – 3 July 2011 (Table 1). The colonies were photographed underwater where possible before sampling. The samples were fixed in 4% formal-saline overnight and then transferred to 70% ethanol for identification in the laboratory.

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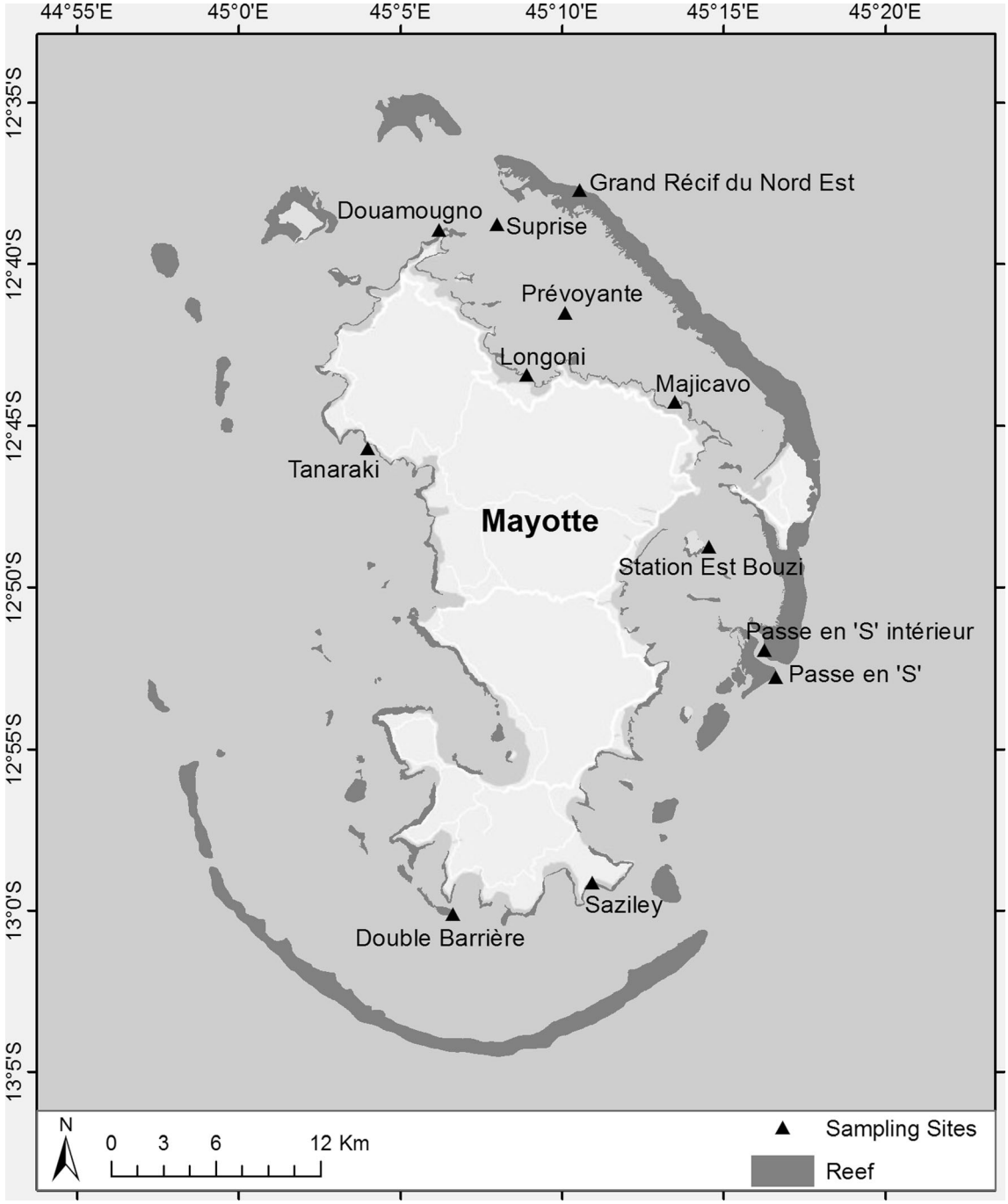

Fig. 1 Mayotte and its reefs with the study sites at which alcyonacean octocorals were collected

Results

The collection comprised 211 samples that yielded 24 genera and 57 species; a natural products collection from 1997 added another two genera and three species (Table 2). Classification of the genera follows the guide published by Fabricius and Alderslade (2001). Not all of the samples (15) could be identified to species level and a few are still under examination.

Discussion

The alcyonacean biodiversity of Mayotte proved to be high (Table 2), totalling 26 genera and 60 identifiable species. If the results are compared with those obtained for the principal families targeted in other studies in the region, this biodiversity appears to be the highest in the southwestern Indian Ocean (Table 3). The Chagos Archipelago (6-11°S) lies upstream of Mayotte in the South Equatorial Current

Table 1 Mayotte reef sites at which alcyonacean octocorals were photographed and sampled

Locality	Station co-ordinates	
	Latitude S	Longitude E
Passe en "S"	12°52.786′	45°16.625′
Passe en "S" intérieur	12°51.934′	45°16.268′
Grand Récif du Nord Est	12°37.716	45°10.560′
Prévoyante	12°41.513′	45°10.114′
Surprise	12°38.762′	45°07.995′
Double Barrière	13°00.109′	45°06.629′
Saziley	12°59.138′	45°10.947′
Tanaraki	12°45.701′	45°03.994′
Longoni	12°43.414′	45°08.914′
Douamougno	12°38.940′	45°06.200′
Majicavo	12°44.256′	45°13.492′
Station Est Bouzi	12°48.739′	45°14.543′

Table 2 List of alcyonacean octocorals collected on the coral reefs of Mayotte. Genera and species marked with an asterisk did not form part of the present collection, but came from a study in 1997

Family Alcyoniidae
Cladiella australis (Macfadyen, 1936)
Cladiella kashmani Benayahu and Schleyer, 1996
Cladiella latissima (Tixier-Durivault, 1944)
Cladiella pachyclados (Klunzinger, 1877)
Cladiella sp.
Klyxum flaccidum (Tixier-Durivault, 1966)
Klyxum utinomii (Verseveldt, 1971)
Lobophytum crassum Von Marenzeller, 1886
Lobophytum denticulatum Tixier-Durivault 1956
Lobophytum depressum Tixier-Durivault, 1966
Lobophytum latilobatum Verseveldt, 1971
Lobophytum patulum Tixier-Durivault, 1956
Lobophytum pauciflorum (Ehrenberg, 1834)
Lobophytum sarcophytoides Moser, 1919*
Lobophytum venustum Tixier-Durivault, 1957
Lobophytum sp.
Protodendron repens (Thomson and Henderson, 1906)
Rhytisma fulvum fulvum (Forskål, 1775)
Sarcophyton cherbonnnieri Tixier-Durivault, 1958
Sarcophyton cinereum Tixier-Durivault, 1946
Sarcophyton ehrenbergi von Marenzeller, 1886*
Sarcophyton flexuosum Tixier-Durivault, 1966
Sarcophyton glaucum (Quoy and Gaimard, 1833)
Sarcophyton infundibuliforme Tixier-Durivault, 1958
Sarcophyton roseum Pratt, 1903
Sarcophyton subviride (Tixier-Durivault, 1958)
Sarcophyton trocheliophorum von Marenzeller, 1886*
Sarcophyton sp.
Sinularia abhishiktae Van Ofwegen and Vennam, 1991
Sinularia brassica May, 1898
Sinularia erecta Tixier-Durivault, 1945
Sinularia fungoides Thomson and Henderson, 1906
Sinularia gibberosa Tixier-Durivault, 1970
Sinularia grandilobata Verseveldt, 1980
Sinularia hirta (Pratt, 1903)
Sinularia humesi Verseveldt, 1968
Sinularia leptoclados (Ehrenberg, 1834)
Sinularia lochmodes Kolonko, 1926
Sinularia macrodactyla Kolonko, 1926
Sinularia maxima Verseveldt, 1971
Sinularia minima Verseveldt, 1971
Sinularia molesta Tixier-Durivault, 1970
Sinularia nanolobata Verseveldt, 1977
Sinularia notanda Tixier-Durivault, 1966
Sinularia numerosa Tixier-Durivault, 1970
Sinularia peculiaris Tixier-Durivault, 1970
Sinularia polydactyla (Ehrenberg, 1834)
Sinularia querciformis (Pratt, 1903)
Sinularia ramosa Tixier-Durivault, 1945
Sinularia terspilli Verseveldt, 1971
Sinularia vrijmoethi Verseveldt, 1971
Family Clavulariidae
Carijoa riisei (Duchassaing and Michelotti, 1860)
Clavularia sp.
Family Coelogorgidae
Coelogorgia palmosa Milne Edwards and Haime, 1857
Family Gorgoniidae
Rumphella sp.
Family Ifalukellidae
Plumigorgia sp.*
Family Nephtheidae
Capnella parva Light, 1913
Dendronephthya sp.
Lemnalia sp.
Litophyton sp.*
Paralemnalia thyrsoides (Ehrenberg, 1834)
Stereonephthya sp.
Family Nidaliidae
Chironephthya sp.
Family Subergorgiidae
Annella sp.
Family Tubiporidae
Tubipora musica Linnaeus, 1758
Family Xeniidae
Anthelia glauca (Lamarck, 1816)
Cespitularia sp.
Heteroxenia elizabethae Kölliker, 1874
Ovabunda faraunensis (Verseveldt and Cohen, 1971)
Ovabunda impulsatilla (Verseveldt and Cohen, 1971)
Ovabunda verseveldti (Benayahu, 1990)
Xenia hicksoni Ashworth, 1899
Xenia lepida Verseveldt, 1971

(SEC), and Tanzania and northern Mozambique lie north and south of where this current impinges on the East African coast (10-12°S). Mayotte (12° 30′S) lies in between, after the SEC is partially deflected by the northern tip of Madagascar. One might thus expect a biodiversity gradient from the Chagos Archipelago to East Africa, with

Table 3 The comparative alcyonacean biodiversity between the Chagos Archipelago (Reinicke and Van Ofwegen 1999; Schleyer and Benayahu 2010), Mayotte (present study), northern Mozambique (Benayahu et al. 2002), and Tanzania (Van Ofwegen and Benayahu 1992)

	Chagos Archipelago	Mayotte	Northern Mozambique	Tanzania
Family Alcyoniidae				
Cladiella australis (Macfadyen, 1936)		+	+	+
Cladiella brachyclados Ehrenberg, 1834			+	
Cladiella daphnae Van Ofwegen and Benayahu, 1992				+
Cladiella kashmani Benayahu and Schleyer, 1996		+	+	
Cladiella digitulata (Klunzinger, 1877)				+
Cladiella krempfi (Hickson, 1919)	+		+	+
Cladiella laciniosa (Tixier-Durivault, 1944)			+	+
Cladiella latissima (Tixier-Durivault, 1944)		+	+	
Cladiella pachyclados (Klunzinger, 1877)	+	+	+	
Cladiella tulearensis (Tixier-Durivault, 1944)			+	
Cladiella sp.		+		
Klyxum flaccidum (Tixier-Durivault, 1966)	+	+		+
Klyxum simplex (Thomson and Dean, 1931)	+			
Klyxum utinomii (Verseveldt, 1971)	+	+		
Lobophytum crassum Von Marenzeller, 1886	+	+	+	+
Lobophytum denticulatum Tixier-Durivault 1956		+		
Lobophytum depressum Tixier-Durivault, 1966	+	+	+	
Lobophytum latilobatum Verseveldt, 1971		+		
Lobophytum patulum Tixier-Durivault, 1956		+	+	
Lobophytum pauciflorum (Ehrenberg, 1834)		+		+
Lobophytum rotundum Tixier-Durivault, 1957)				+
Lobophytum sarcophytoides Moser, 1919*		+		
Lobophytum variatum Tixier-Durivault, 1957	+			
Lobophytum venustum Tixier-Durivault, 1957	+	+	+	+
Lobophytum sp.		+		
Protodendron repens (Thomson and Henderson, 1906)		+		
Rhytisma fulvum fulvum (Forskål, 1775)		+	+	
Sarcophyton cherbonnnieri Tixier-Durivault, 1958		+		+
Sarcophyton cinereum Tixier-Durivault, 1946		+		
Sarcophyton cornispiculatum Verseveldt, 1971				+
Sarcophyton crassocaule Moser, 1919	+			+
Sarcophyton crassum Tixier-Durivault, 1946	+			+
Sarcophyton ehrenbergi von Marenzeller, 1886*		+	+	
Sarcophyton elegans Moser, 1919				+
Sarcophyton flexuosum Tixier-Durivault, 1966	+	+		
Sarcophyton glaucum (Quoy and Gaimard, 1833)	+	+	+	+
Sarcophyton infundibuliforme Tixier-Durivault, 1958		+		+
Sarcophyton roseum Pratt, 1903		+		
Sarcophyton subviride (Tixier-Durivault, 1958)		+		+
Sarcophyton trocheliophorum von Marenzeller, 1886*	+	+	+	+
Sarcophyton sp.		+		
Sinularia abhishiktae Van Ofwegen and Vennam, 1991		+		+
Sinularia abrupta Tixier-Durivault, 1970	+		+	
Sinularia brassica May, 1898	+	+	+	
Sinularia compacta Tixier-Durivault, 1970				+
Sinularia conferta (Dana, 1846)	+			+
Sinularia densa (Whitelegge, 1897)	+			
Sinularia depressa Tixier-Durivault, 1970	+			
Sinularia erecta Tixier-Durivault, 1945	+	+	+	
Sinularia firma Tixier-Durivault, 1970	+		+	
Sinularia fishelsoni Verseveldt, 1970				+
Sinularia fungoides Thomson and Henderson, 1906		+	+	
Sinularia gardineri (Pratt, 1903)				+

Table 3 (continued)

	Chagos Archipelago	Mayotte	Northern Mozambique	Tanzania
Sinularia gibberosa Tixier-Durivault, 1970	+	+		+
Sinularia grandilobata Verseveldt, 1980		+	+	
Sinularia gravis Tixier-Durivault, 1970	+		+	
Sinularia heterospiculata Verseveldt, 1970	+		+	
Sinularia hirta (Pratt, 1903)	+	+		
Sinularia humesi Verseveldt, 1968	+	+		
Sinularia inelegans Tixier-Durivault, 1970			+	
Sinularia leptoclados (Ehrenberg, 1834)	+	+	+	+
Sinularia lochmodes Kolonko, 1926		+	+	
Sinularia macrodactyla Kolonko, 1926		+	+	+
Sinularia macropodia (Hickson and Hiles, 1900)			+	
Sinularia marenzelleri (Wright and Studer, 1889)				+
Sinularia maxima Verseveldt, 1971		+		
Sinularia minima Verseveldt, 1971		+		
Sinularia molesta Tixier-Durivault, 1970	+	+		
Sinularia muralis (May, 1899)	+			
Sinularia nanolobata Verseveldt, 1977	+	+		
Sinularia notanda Tixier-Durivault, 1966	+	+		
Sinularia numerosa Tixier-Durivault, 1970	+	+	+	
Sinularia parva Tixier-Durivault, 1970	+			
Sinularia peculiaris Tixier-Durivault, 1970	+	+		+
Sinularia platylobata Van Ofwegen and Benayahu, 1992				+
Sinularia polydactyla (Ehrenberg, 1834)	+	+	+	+
Sinularia portiere Verseveldt, 1980				+
Sinularia querciformis (Pratt, 1903)	+	+		+
Sinularia ramosa Tixier-Durivault, 1945		+		
Sinularia rigida Dana, 1846	+			+
Sinularia rotundata Tixier-Durivault, 1970			+	+
Sinularia terspilli Verseveldt, 1971		+	+	+
Sinularia triangula Tixier-Durivault, 1970			+	
Sinularia variabilis Tixier-Durivault, 1945	+			
Sinularia vrijmoethi Verseveldt, 1971		+	+	
Sinularia whiteleggei Lüttschwager, 1914	+			
Family subtotals	39	51	35	36
Family Briareidae				
Briareum hamrum (Gohar, 1948)			+	
Family Clavulariidae				
Carijoa riisei (Duchassaing and Michelotti, 1860)	+	+		
Clavularia sp.	+	+		
Family Coelogorgidae				
Coelogorgia palmosa Milne Edwards and Haime, 1857		+		
Family Gorgoniidae				
Rumphella sp.		+		
Family Ifalukellidae*				
Plumigorgia sp.*		+		
Family Nephtheidae				
Capnella parva Light, 1913		+		
Capnella boullioni Verseveldt, 1976	+			
Capnella sp.	+			
Dendronephthya gracillima Kükenthal, 1905	+			
Dendronephthya sp.		+		
Lemnalia africana (May, 1898)	+		+	+
Lemnalia bantayensis Roxas, 1933	+			
Lemnalia cervicornis (May, 1898)				+
Lemnalia flava (May, 1898)	+		+	+
Lemnalia humesi Verseveldt, 1969	+		+	
Lemnalia tenuis Verseveldt, 1969				+
Lemnalia sp.		+		
Litophyton viridis (May, 1898)				+
Litophyton sp.	+	+		

Table 3 (continued)

	Chagos Archipelago	Mayotte	Northern Mozambique	Tanzania
Paralemnalia thyrsoides (Ehrenberg, 1834)		+		
Scleronephthya sp.	+			
Stereonephthya cordylophora Verseveldt, 1973	+			
Stereonephthya unicolor (Gray, 1862)	+			
Stereonephthya sp.		+		
Family Nidaliidae				
Chironephthya sp.	+	+		
Family Subergorgiidae				
Annella sp.		+		
Family Tubiporidae				
Tubipora musica Linnaeus, 1758	+	+	+	
Family Xeniidae				
Anthelia glauca (Lamarck, 1816)	+	+	+	
Cespitularia coerulea May, 1898			+	
Cespitularia densa Tixier-Durivault, 1966			+	
Cespitularia erecta Macfadyen, 1936			+	+
Cespitularia robusta Tixier-Durivault, 1966				
Cespitularia schlichteri Janes, 2008				
Cespitularia simplex Thomson and Dean, 1931				
Cespitularia sp.	+	+		
Heteroxenia fuscescens (Ehrenberg, 1834)			+	+
Heteroxenia pinnata Roxas, 1933	+			
Heteroxenia elizabethae Kölliker, 1874		+		
Heteroxenia ghardaquensis Gohar, 1940				+
Ovabunda faraunensis (Verseveldt and Cohen, 1971)		+		
Ovabunda hamsina (Reinicke, 1997)				
Ovabunda impulsatilla (Verseveldt and Cohen, 1971)		+		
Ovabunda verseveldti (Benayahu, 1990)		+		
Ovabunda sp.	+			
Sansibia flava (May, 1899)	+			
Xenia crassa Schenk, 1896	+		+	
Xenia garciae Bourne, 1894	+			
Xenia hicksoni Ashworth, 1899		+		
Xenia lepida Verseveldt, 1971		+		
Xenia lillieae Roxas, 1933	+			
Xenia novaebrittianiae Ashworth, 1900	+			
Totals	63	73	45	44

Mayotte having an intermediate value. This was not the case, particularly if only the family Alcyoniidae are considered (Table 3), these being identified to the same high level in all the surveys. In this family, 12 species were exclusively found at Mayotte; 14 were common to all the localities; eight to the Chagos and Mayotte; 17 to Mayotte and East Africa; and nine to the Chagos and East Africa.

A comparison with the Alcyonacea of northern Madagascar would be useful, but the findings of an early study (Tixier-Durivault 1966) used in even recent work (Evans 2011) needs radical updating. Later studies (Verseveldt 1969, 1971, 1973a, b, c) listed numerous species for NW Madagascar, but cannot be used reliably as certain taxa require re-examination and revision of their identification; the aforementioned works were published before Verseveldt's (1980, 1982, 1983) extensive revisions of the genera *Sinularia, Sarcophyton*, and *Lobophytum*. Verseveldt's (1969, 1971, 1973a, b, c) Madagascan studies nevertheless list over 60 reef-dwelling species in the families considered here, but at least 12 have been synonymised (e.g., Verseveldt 1982: *Sarcophyton acutangulum* and *S. ehrenbergi*; Verseveldt 1983: *Lobophytum cristagalli* and *L. crassum*; Van Ofwegen et al. 2016: *Sinularia compressa* and *S. polydactyla*), leaving a total of approximately 50 valid species. Consequently, Mayotte potentially has the richest alcyonacean fauna within the confines of the SEC circulation in the southwestern Indian Ocean (SWIO).

Further north in the monsoon region, Tanzania and the Seychelles similarly appear to have fewer alcyonacean species; Van Ofwegen and Benayahu (1992) recorded 44 in the former (Table 3) and Verseveldt (1976) found 32 in the latter, to which Janes (2008) added another eleven. Within the depth range of this study, Malyutin (1992) listed 54 species

(including 37 Alcyoniidae) for the Seychelles. Again these figures are lower than those for Mayotte.

Obura (2012) noted that, in the western Indian Ocean (WIO), scleractinian biodiversity was highest within a core region in the northern Mozambique Channel; Mayotte was important amongst the sites sampled and had the highest scleractinian biodiversity amongst the small scattered islands. McClanahan (2015) similarly detected a biodiversity hotspot for coral reef fish between northern Madagascar and the African coast (without specifically naming Mayotte), but with a low variance. Mayotte's high alcyonacean biodiversity is thus not surprising and must be at least partially attributable to the extensive environmental variability of its outer and inner barrier reefs, as well as its expansive lagoon with patch and fringing reefs.

Since Mayotte lies in the northern entrance of the Mozambique Channel, the richness of its alcyonacean biodiversity must have had some influence on the distribution of this fauna further south. The channel is characterised by cyclonic and anticyclonic mesoscale eddies that would both entrap and transport the reproductive products of Mayotte corals down the channel (Halo et al. 2014; Hancke et al. 2014; Ternon et al. 2014). The East African and west Madagascan coasts would provide dispersal corridors for such recruits, but the connectivity facilitated by such processes is proving lower than anticipated (see e.g. Jones et al. 2009; McCook et al. 2009). The richness of the alcyonacean fauna at Mayotte nevertheless represents valuable biodiversity that would feed into these corridors and merits conservation.

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