NEW TAXA AND DISTRIBUTIONAL RECORDS OF AZOOXANTHELLATE SCLERACTINIA (CNIDARIA, ANTHOZOA) FROM THE TROPICAL SOUTH-WEST INDIAN OCEAN, WITH COMMENTS ON THEIR ZOOGEOGRAPHY AND ECOLOGY

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(With 13 figures and 2 tables)

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ABSTRACT

Seventy-seven species of azooxanthellate Scleractinia are reported from collections made by R.V. *Anton Bruun*, *Meiring Naude*, and *Vityaz* from deep-water (to 1 720 m) in the tropical south-west Indian Ocean. Thirty-six new distributional records are noted for this region, increasing the total number of azooxanthellates from 64 to 100—one of the most diverse regions in the world oceans for azooxanthellate Scleractinia. Among the 77 records, seven species (*Caryophyllia elongata*, *Rhizosmilia robusta*, *Sphenotrochus (S.) evexicostatus*, *S. (S.) imbricaticostatus*, *Truncatoflabellum gardineri*, *T. zuluense* and *T. multispinosum*) and one subspecies (*Flabellum (Ulocyathus) japonicum bythios*) are described as new, and four new combinations are proposed.

The distribution and bathymetric ranges of all 100 species are given and zoogeographic affinities discussed. Twelve per cent of the 100 tropical south-west Indian Ocean species are cosmopolitan or widespread in distribution and six per cent were uncategorized. Of the remaining 82 species, the largest distributional pattern is that of Indo-West Pacific (43%), followed by those species known only from the Indian Ocean (36,5%); however, it is believed that, because of the relatively homogeneous nature of the deep-water fauna, there will be a tendency to find an increase of the Indo-West Pacific component at the expense of the Indian Ocean 'endemics' as the deep-water corals become better known. Ten species (12%) co-occur in tropical and southern temperate regions and seven species (8,5%) have a shared distribution with the Atlantic Ocean, five of which are found in the western Atlantic. Three significant bathymetric zones are defined, based on south-west Indian Ocean azooxanthellates: 0–300 m, 300–1 300 m, and 1 300–2 000 m. The potential for using skeletal morphology as an indicator of environmental conditions (i.e. nutrient level) is discussed.

CONTENTS

INTRODUCTION

Our knowledge of the azooxanthellate scleractinian fauna of the tropical south-west Indian Ocean is based on approximately 31 papers (Table 1), most of which include only one or several incidentally collected species or constitute reports on expeditions that briefly entered this region (e.g. *Valdivia*, *John Murray* Expedition, Percy Sladen Trust Expedition). The newly reported specimens presented herein are also based on expeditionary collecting, namely by R.V. *Anton Bruun*, *Vityaz* and the *Meiring Naude*; however, this paper also includes a re-analysis of previously reported specimens and a compilation of all previous records for the region (Table 2). This paper should not be considered as a faunistic revision, but rather as an annotated checklist of those species for which additional specimens were collected.

Sixty-four azooxanthellate Scleractinia have been reported previously from the tropical south-west Indian Ocean (Tables 1, 2). An additional 36 new records (Table 2) for the region are reported herein, resulting in a total of 100 azooxanthellate species for this region. Of the 36 new south-west Indian Ocean records, 11 species are also new records for the Indian Ocean, seven are described as new species, one as a new subspecies, and four new combinations are proposed. Additional records of 77 of the 100 species (77% of the fauna) are presented in the 'Systematic Account'. Examination of an unpublished collection (Zibrowius in prep.) from the same region

TABLE 1

Annotated, chronological list of publications on azooxanthellate Scleractinia from the tropical south-west Indian Ocean (* denotes significant papers).

Year	Author	Remarks
1848*b*	Milne Edwards & Haime	Two species of *Tubastraea* from off Seychelles.
1876	Duncan	*Culicia natalensis* from off Natal, South Africa.
1902	Gardiner	Two species of *Flabellum* from South Africa.
*1904	Gardiner	Fifteen azooxanthellate species from off South Africa.
1904	Von Marenzeller	Six deep-water species from *Valdivia* stations 243–247 off Kenya and Tanzania and other records to north in the Indian Ocean.
1926	Van der Horst	Eight shallow-water, mostly dendrophylliid species collected on Percy Sladen Trust Expedition of 1905 off Zanzibar, Seychelles, Mauritius, and Saya de Malha.
*1927	Van der Horst	Eight shallow-water species, primarily dendrophylliids from off South Africa.
1931	Van der Horst	Seven azooxanthellate species from off Seychelles, Mauritius, and Saya de Malha.
*1938	Gardiner & Waugh	Seventeen deep-water flabellids and caryophylliids collected on the *John Murray* Expedition (1933-1934) stations 102–133 off Kenya, Tanzania, and Seychelles.

TABLE 1 (*cont.*)

Year	Author	Remarks
*1939	Gardiner & Waugh	Eleven deep-water dendrophylliids and oculinids collected from the *John Murray* Expedition (1933–1934) stations 102–133 off Kenya, Tanzania, and Seychelles.
1958	Macnae & Kalk	Uncritical listing of eleven shallow-water azooxanthellates from Inhaca, Mozambique.
1964	Pichon	List of four shallow-water azooxanthellates from Tuléar, Madagascar.
1974*a*	Zibrowius	Record of *Deltocyathus* north-west of Madagascar.
1974*b*	Zibrowius	*Javania insignis* from off north-west Madagascar.
1974	Pichon	*Sphenotrochus* sp. from reefs off Madagascar.
1975	Zibrowius, Southward & Day	Polychaete symbionts from three species of *Flabellum* collected off Natal and Mozambique.
1976	Keller	*Fungiacyathus pseudostephanus* from off Seychelles and mid-Indian Ridge.
1978	Pichon	Uncritical list of eleven shallow-water azooxanthellates from Tuléar, Madagascar.
1979	Rosen	List of four shallow-water azooxanthellates from off Aldabra.
1979	Cairns	*Labyrinthocyathus delicatus* from off Natal.
1980	Best, Faure & Pichon	List of six shallow-water azooxanthellates off Seychelles.
1980	Zibrowius	*Lophelia pertusa* from north-west of Madagascar.
1981	Keller	*Caryophyllia scobinosa* from off Tanzania.
*1981	Boshoff	Forty-two azooxanthellates reported from off South Africa.
1982	Zibrowius	Two azooxanthellates from off Natal and Madagascar, both hosting crab galls.
1984	Schuhmacher	Discussion of two species of *Tubastraea*, including records from off Comores and Madagascar.
1985	Zibrowius & Grygier	Nine species of azooxanthellates, all hosting ascothoracid parasites, off Natal, Mozambique, Kenya, Comores, and Seychelles.
1985	Zibrowius	Additional records of *Balanophyllia stimpsonii* from off Mozambique and Natal, South Africa.
1985	Grygier	Two shallow-water azooxanthellates hosting ascothoracid parasites, from off Kenya, Reunion, and Comores Islands.
1989*a*	Cairns	Several records of *Flabellum pavoninum* off Kenya and Durban, South Africa.
1989*b*	Cairns	Eight species of azooxanthellates discussed incidental to review of Philippine fauna, from off Natal, Mozambique, Tanzania, Kenya, and Reunion.

seen at the Station Marine d'Endoume, Marseille (specimens from *Marion Dufresne*, *Meiring Naude*, *Galathea*, Cruise BENTHEDI on *Le Suroit*, Plante collection) revealed approximately 25 additional azooxanthellate species from this region, which would result in a fauna of about 125 species—one of the most diverse azooxanthellate scleractinian faunas in the world oceans.

Historical resumé. Milne Edwards & Haime (1848*b*) would appear to have reported the first azooxanthellate scleractinians from the tropical south-west Indian Ocean, *Coenopsammia ehrenbergiana* (= *Tubastraea coccinea*) and *Coenopsammia viridis* (= *Tubastraea micrantha*), from the 'Seychelles', two common, shallow-water species. Another shallow-water species, but less commonly collected, is *Culicia natalensis*, reported by Duncan (1876) from off Natal, South Africa. All of the remaining records of azooxanthellate corals from this region were made in the twentieth century and are summarized in Table 1; only the five most significant contributions are discussed in greater detail. Most of the other references listed in Table 1 are uncritical checklists or concentrate on other geographic areas or topics that only incidentally mention Scleractinia from the south-west Indian Ocean.

The first significant paper on south-west Indian Ocean azooxanthellates was that of Gardiner (1904), who examined over 2 000 specimens collected off South Africa and reported 15 species from this region, including five new species. Although some of his identifications subsequently have been changed, this paper remains the foundation for serious work on azooxanthellate corals from this region. As a counterpart to Gardiner's (1904) contribution, which dealt only with the caryophylliids and flabellids, Van der Horst (1927) reported eight species of dendrophylliids from the same region, based on the same collection sources.

In another pair of papers, Gardiner & Waugh published the results of the Scleractinia collected off Kenya, Tanzania and the Seychelles from the *John Murray* Expedition. Their first paper (Gardiner & Waugh 1938), like Gardiner's (1904), was restricted to the caryophylliids and flabellids; their second (Gardiner & Waugh 1939), like Van der Horst's (1927), reported the dendrophylliids and other minor families. Whereas Gardiner and Van der Horst reported primarily shallow-water azooxanthellates, the Gardiner & Waugh papers reported deeper-water species, their two contributions discussing 28 species collected from *H.E.M.S. Mabihiss* stations 102–133 within the south-west Indian Ocean (Sewell 1935).

Boshoff's (1981) annotated checklist of South African Scleractinia included 42 azooxanthellate species from the south-west Indian Ocean. Unfortunately, none of his specimens were illustrated, his localities are confused and obscure, and many of his identifications are incorrect (Zibrowius & Gili 1990). We are forced to agree with Zibrowius & Gili that Boshoff's contribution is misleading, and we look forward to Zibrowius' revision of the deep-water corals from this region, which will include a re-analysis of all the Boshoff specimens.

Other papers that include useful information on south-west Indian Ocean azooxanthellates, but do not report specimens from this region, include: Wood-Mason & Alcock (1891*a*, 1891*b*); Alcock (1893, 1898, 1902*c*); Bourne (1905); Von Marenzeller (1907*a*, 1907*b*); Van der Horst (1922); Gardiner (1929); Wells (1935); Scheer & Pillai (1974, 1983); Pillai & Scheer (1976); Zibrowius (1980); Fricke & Schuhmacher (1983); Zibrowius & Gili (1990); and Sheppard & Sheppard (1991).

ZOOGEOGRAPHY

Of the 100 species of azooxanthellate Scleractinia known from the tropical south-west Indian Ocean, 12 are cosmopolitan or widely distributed (Fig. 1; Table 2: distribution pattern 6) and six are not categorized because they are not identified to the species level or have a disjunct distribution (Table 2: pattern 7), e.g. *Fungiacyathus pseudostephanus*. Neither of these categories contributes to an understanding of zoogeographic affinities.

Of the remaining 82 species, the largest component is the Indo-West Pacific pattern (Table 2: pattern 3), shared by 35 species (43 %). Thirty species (36,5 %) are known only from the Indian Ocean: 20 species (24,5 %, Table 2: pattern 1) thus far

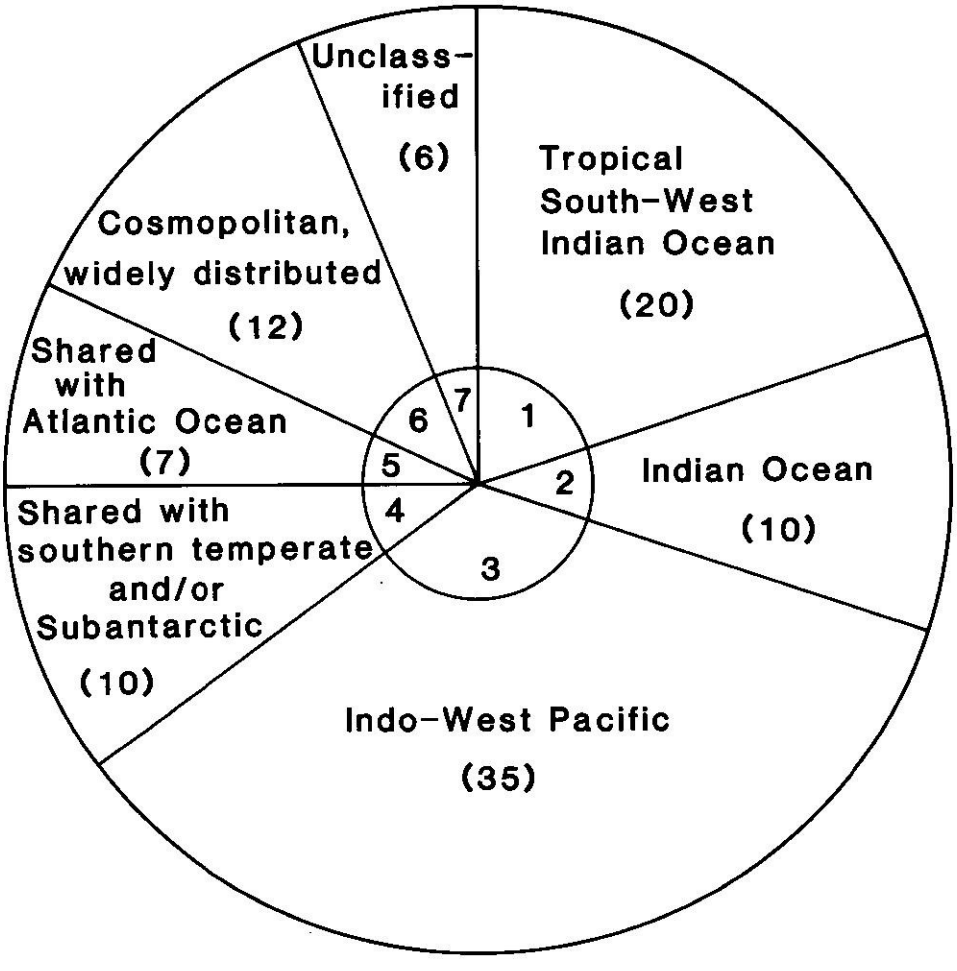

Fig. 1. Pie-diagram illustrating the seven zoogeographic patterns of the 100 species of south-west Indian Ocean azooxanthellate Scleractinia. Numbers in inner circle label the seven zoogeographic patterns discussed in the text and tabulated in Table 2. Numbers in parentheses are the numbers of species having that pattern.

TABLE 2

Checklist and distribution of the tropical south-west Indian Ocean azooxanthellate Scleractinia. (*—new record for South-West Indian Ocean; **—new record for Indian Ocean; ^—indicates that the species is not in study material and therefore not in Systematic Account. Key to areas: 1 = Western Atlantic; 2 = Eastern Atlantic; 3 = temperate S. Africa; 4 = tropical north-eastern S. Africa; 5 = off Mozambique; 6 = off Tanzania; 7 = off Kenya; 8 = off Madagascar; 9 = islands of South-West Indian Ocean; 10 = Madagascar Plateau; 11 = North-West Indian Ocean; 12 = Eastern Indian Ocean; 13 = Western Pacific; 14 = Western Pacific; 15 = Subantarctic.)

	Atlantic Ocean		South-West Indian Ocean								Indian Ocean		Pacific Ocean		Subantarctic	Distribution pattern[1]	Depth (m) (Indian Ocean)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Family **Pocilloporidae**																	
Madracis sp. A					x	?		?		x	?					7	42-160
Family **Fungiacyathidae**																	
^*Fungiacyathus (B.) pseudostephanus* Keller, 1976									x					x		7	3 880-5 120
Fungiacyathus (B.) sibogae (Alcock, 1902)				x	x	x	x	x			x		x			3	463-1 948
Fungiacyathus (F.) stephanus (Alcock, 1893)				x	x						x	x	x			3	880-2 000
Fungiacyathus (F.) paliferus (Alcock, 1902)				?					x	x			x			3	99-720
Family **Micrabaciidae**																	
Letepsammia formosissima (Moseley, 1876)			x	x	x	x		x					x			3	55-780
Stephanophyllia fungulus Alcock, 1902				x	x						x		x			3	98-236
Stephanophyllia complicata Moseley, 1876									x		x		x			3	229-236
Family **Rhizangiidae**																	
Culicia sp. cf. *C. natalensis* (Duncan, 1876)				x		?	x									1	34-366
Family **Oculinidae**																	
Madrepora oculata Linnaeus, 1758	x	x				x		x		x	x		x	x	x	6	732-1 270
^*Oulangia* sp.[2]									x							7	18
Family **Anthemiphylliidae**																	
**Anthemiphyllia dentata* (Alcock, 1902)									x		x		x			3	193-494

Family **Caryophylliidae**																
**Caryophyllia ambrosia ambrosia* Alcock, 1898	x	x				x			x	x	x		?			6	430–2 000
Caryophyllia grandis Gardiner & Waugh, 1938				x	x						x	?				2	183–595
Caryophyllia scobinosa Gardiner & Waugh, 1938						x		x		x			x			3	535–960
Caryophyllia sp. cf. *C. cornuformis* Pourtalès, 1868	?	?			x	x					?					5	91–320
^*Caryophyllia arcuata* Milne Edwards & Haime, 1848[3]									x							1	128–914
^*Caryophyllia ephyala* Alcock *in* Wood Mason & Alcock, 1891[4]				x							x	x	x			3	146–1 289
^*Caryophyllia epithecata* Gardiner, 1904[5]			x	x							x					4A	146–672
Caryophyllia profunda Moseley, 1881			x							x					x	4B	80–755
***Caryophyllia rugosa* Moseley, 1881				x	x		x				x		x			3	95–250
^?*Caryophyllia lamellifera* Moseley, 1881[6]									?			?	x			3	128–274
**Caryophyllia elongata* sp. nov.										x						1	630–680
Caryophyllia (P.) zanzibarensis Zou, 1984				x		x										1	238–302
**Trochocyathus rhombocolumna* Alcock, 1902					x						x		x			3	110–229
**Trochocyathus* sp. A			x		x			x	x							2	74–315
Trochocyathus rawsonii sensu Gardiner, 1904			x	x												4A	560–620
**Trochocyathus* sp. cf. *T. rawsonii* Pourtalès, 1874	?							x		x						5	750–780
^*'Caryophyllia' berteriana* Duchassaing, 1850[7]				x												1	165
^*Paracyathus* sp.[8]									x							7	0–146
^*Paracyathus pruinosus* Alcock, 1902[3]									x				x			3	274
^*Polycyathus* sp.[9]									x							7	?
Stephanocyathus (O.) nobilis (Moseley, 1873)	x	x			x	x	x	x	x		x					5	609–2 000
***Stephanocyathus (O.) campaniformis* (von Marenzeller, 1904)		x								x						5	1 600–1 610
Stephanocyathus (A.) spiniger (von Marenzeller, 1888)				x	x			x					x			3	210–695
Stephanocyathus (A.) explanans (von Marenzeller, 1904)				x		x						x				2	183–614
Labyrinthocyathus delicatus (von Marenzeller, 1904)			x	x	x											4A	155–1 000
Deltocyathus andamanicus Alcock, 1898						x				x	x					2	240–1 463
Deltocyathus rotulus (Alcock, 1898)				x	x	x				x	x	x				3	510–1 986
Deltocyathus sp. A				x		?		x								7	207–315
Desmophyllum cristagalli Milne Edwards & Haime, 1848	x	x	x			x			x	x	x	x	x	x	x	6	81–2 000
**Conotrochus brunneus* (Moseley, 1881)								x		x			x			3	475–695
***Aulocyathus recidivus* (Dennant, 1906)								x					x			3	?
Aulocyathus juvenescens von Marenzeller, 1904						x										1	302–463
***Dasmosmilia variegata* (Pourtalès, 1871)	x	x						x								5	330–335
**Asterosmilia marchadi* (Chevalier, 1966)	x	x	x	x	x	x					x					5	57–229
**Solenosmilia variabilis* Duncan, 1873	x	x	x	x							x		x		x	6	366–1 079
***Goniocorella dumosa* (Alcock, 1902)				x									x			3	760
^*Lophelia pertusa* (Linnaeus, 1758)[11]									x							6	450
**Rhizosmilia robusta* sp. nov.				x	x			x								1	66–150
^*Rhizosmilia gigas* (Van der Horst, 1931)[10]									x							1	183–366

TABLE 2 (*cont.*)

	Atlantic Ocean		South-West Indian Ocean								Indian Ocean		Pacific Ocean		Subantarctic	Distribution pattern[1]	Depth (m) (Indian Ocean)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Family **Turbinoliidae**																	
Tropidocyathus lessoni (Michelin, 1842)				X	X	X	X				X		X			3	62-421
ˆ*Tropidocyathus nascornatus* Gardiner & Waugh, 1938					X	X										1	183-457
***Thrypticotrochus multilobatus* Cairns, 1989						X		X					X			3	347-925
Sphenotrochus (S.) aurantiacus von Marenzeller, 1904			X	X	?											4A	155-366
**Sphenotrochus (S.) evexicostatus* sp. nov.				X	X			?								1	12-73
**Sphenotrochus (S.) imbricaticostatus* sp. nov.				X	X											1	37-347
**Sphenotrochus (E.) gilchristi* (Gardiner, 1904)			X	X												4A	24-165
Peponocyathus australiensis (Duncan, 1870)	X	X		X		X					X		X			6	101-366
Family **Flabellidae**																	
ˆ*Flabellum (U.) apertum* Moseley, 1876			X			X					X				X	4B	863-1 400
**Flabellum (U.) japonicum bythios* subsp. nov.								X	X		X	X				2	1 095-1 720
***Flabellum (U.) lowekeyesi* Squires & Ralph, 1965					X				X	X			X			3	835-1 030
***Flabellum (U.) messum* Alcock, 1902									X				X			3	430-835
ˆ*Flabellum (F.) sibogae* sensu Gardiner, 1904[12]				X												1	567
Flabellum (F.) pavoninum Lesson, 1831				X		X	X	X	X	X	X		X			3	98-665
ˆ*Truncatoflabellum inconstans* von Marenzeller, 1904			X	X												4A	100-155
**Truncatoflabellum* sp. cf. *T. stabile* (von Marenzeller, 1904)		X			X											5	1 250-1 520
***Truncatoflabellum formosum* Cairns, 1989				X	X								X			3	150-230
***Truncatoflabellum pusillum* Cairns, 1989					X								X			3	110-132
**Truncatoflabellum gardineri* sp. nov.				X												1	138
**Truncatoflabellum zuluense* sp. nov.				X												1	62-84
**Truncatoflabellum multispinosum* sp. nov.				X	X	X		X								1	62-183
Javania insignis Duncan, 1876				X	X			X			X		X			3	74-255
***Placotrochides scaphula* Alcock, 1902				X				X					X			3	695-1 360
Family **Guyniidae**																	
**Guynia annulata* Duncan, 1872	X	X		X	X						X		X			6	112-286
**Stenocyathus vermiformis* (Pourtalès, 1868)	X	X								X			X			6	80-672

Family **Dendrophylliidae**																
Balanophyllia stimpsonii (Verrill, 1865)			X	X	X			X		X	X	X			3	11-112
Balanophyllia ponderosa van der Horst, 1926				X				X			?	X			3	51-59
**Balanophyllia diffusa* Harrison & Poole, 1909				X	X	X	X				X				2	6-274
^*Balanophyllia diffusa* sensu Gardiner & Waugh, 1939						X				X					2	229-366
^*Balanophyllia gemmifera* Klunzinger, 1879[13]								X		X					2	81
^*Balanophyllia gemma* (Moseley, 1881)[13]						X									1	?
^*Balanophyllia diademata* van der Horst, 1927				X											1	165
Trochopsammia togata (van der Horst, 1927)			X	X											4A	155-775
Endopachys grayi Milne Edwards & Haime, 1848				X	X	X		X		X		X	X		6	57-274
^*Endopsammia philippinensis* Milne Edwards & Haime, 1848[14]						X		X		X	X	X			3	62
^?*Rhizopsammia minuta* van der Horst, 1922[15]					X	X						X			3	113
Rhizopsammia annae (van der Horst, 1933)			X	X											4A	0-80
**Rhizopsammia compacta* Sheppard & Sheppard, 1991				X	X					X					2	35-110
**Dendrophyllia* sp. cf. *D. horsti* Gardiner & Waugh, 1939				X	X	X									1	50-113
Dendrophyllia dilatata van der Horst, 1927				X	X										1	97-132
Dendrophyllia cladonia van der Horst, 1927				X	X										1	49-457
^*Dendrophyllia cornigera* (Lamarck, 1816)[13]			X	X				X		X					2	37-183
Dendrophyllia gaditana (Duncan 1873)	X	X			X	X		?	X		X	X			6	65-480
**Dendrophyllia ijimai* Yabe & Eguchi, 1934				X		X	X			X		?			3	62-223
Dendrophyllia fistula (Alcock, 1902)					X	X				X		X			3	210-900
Enallopsammia rostrata (Pourtalès, 1878)	X	X						X		X	X	X		X	6	229-805
Tubastraea micrantha (Ehrenberg, 1834)					X	X	X	X	X	X	X	X			3	0,5-55
Tubastraea coccinea (Lesson, 1829)	X				X			X	X	X	X	X	X		6	reef
**Tubastraea diaphana* (Dana, 1846)						X		X		X		X			3	reef
Totals	15	15	17	51	40	36	9	24	29	14	41	17	46	5	6	

[1] See text (Zoogeography Section)
[2] As reported by Rosen (1979)
[3] As reported by Van der Horst (1931)
[4] As reported by Gardiner (1904)
[5] Includes *Caryophyllia sewelli* Gardiner & Waugh (1938) and *Caryophyllia* sp. of Zibrowius (1974*a*)
[6] Based on *Caryophyllia cincticulatus* of Van der Horst (1931)
[7] As reported by Gardiner (1904); subsequently identified as a *Trochocyathus* by Zibrowius (1982)
[8] As reported by Van der Horst (1931) and Rosen (1979)
[9] As reported by Best, Faure & Pichon (1980)
[10] This species is clearly a parasmiliid, not a *Caryophyllia*
[11] As reported by Zibrowius (1980)
[12] Not a junior synonym of *Desmophyllum alabastrum* as suggested by Gardiner (1904); this species requires a new name.
[13] As reported by Van der Horst (1926)
[14] Based on *Balanophyllia regularis* as reported by Van der Horst (1926) (see Pillai & Scheer 1976)
[15] As reported by Gardiner & Waugh (1939)

known only from the tropical south-west Indian Ocean, and the other 10 species (12 %, Table 2: pattern 2) are more widely distributed in the Indian Ocean. Although Briggs (1974) divided the tropical Indo-Pacific region into the western Indian Ocean Province and the Indo-Polynesian Province, separated at the Persian Gulf, he also stated that there is no obvious physical barrier between east Africa and the Malay Peninsula and urged caution in interpreting endemic faunas for either province. We agree. To assume that the 20 species now known only from the tropical south-west Indian Ocean are endemic to that region would be misleading. The finding of 11 new records for the Indian Ocean, nine of which were heretofore known only from the western Pacific, reinforces the supposition that the south-west Indian Ocean fauna is an outpost of an essentially homogeneous Indo-West Pacific fauna and, as the deep-water corals are better understood, the Indo-West Pacific component will probably increase at the expense of the 'endemic' and 'exclusively' Indian Ocean species.

Ten species (12 % of the 82 species) have a shared distribution with temperate regions to the south: eight species being found also off temperate South Africa (Table 2: pattern 4A) and two species occurring in the temperate/circum-Subantarctic regions (Table 2: pattern 4B).

The final category (Table 2: pattern 5) is perhaps of greatest interest because of its unexpected nature: seven (8,5 %) of the tropical south-west Indian Ocean azooxanthellates have a shared distribution in the Atlantic Ocean. Six of the species occur in the eastern Atlantic and five occur in the western Atlantic.

As mentioned in the introduction, at least 125 species of azooxanthellate Scleractinia are believed to occur in the tropical south-west Indian Ocean, which represents one of the highest diversities of this type of coral in the world oceans. For comparative purposes, the number of azooxanthellates in some other well-studied regions, in descending order of diversity, are: 140 species (estimate), New Caledonia region (Zibrowius in prep.); 116, tropical western Atlantic (Cairns 1979); 110 (estimate), Philippine region (Cairns 1989*b*); 102, Japanese region (Yabe & Eguchi 1942; Eguchi 1968; Cairns in prep.); 85, north-east Atlantic (Zibrowius 1980); 54, Hawaiian Islands (Cairns 1984); 48, South Australia–Victoria–Tasmania region (Cairns & Parker 1992); 37, entire Antarctic and Subantarctic region (Cairns 1982); 25, temperate north-east Pacific (Cairns in prep.); and 14, temperate north-west Atlantic (Cairns 1981).

BATHYMETRIC DISTRIBUTION

The azooxanthellate corals of the south-west Indian Ocean can be divided into three bathymetric zones: 0–300 m, 300–1 300 m and 1 300–2 000 m. These zones were established by tabulating the number of species occurring in each 100 m interval and then looking for depths at which major gains or losses of species occurred.

Sixty-eight species occur in the subtidal zone (0–300 m), slightly over half of which (35) occur only in this zone. Species of the Dendrophylliidae (21 species) and Caryophylliidae (22 species) predominate, as well as representatives of the Flabellidae (eight species), Turbinoliidae (seven species), Micrabaciidae (three species), Guyniidae (two species), Pocilloporidae, Oculinidae, Fungiacyathidae, Rhizangiidae and Anthemiphylliidae—the last five families each being represented by only one species.

The number of species in the subtidal zone reaches a maximum (49) in the 100–200 m interval, and then decreases abruptly to only 41 species in the 200–300 m

interval. Only 35 species occur at a depth range of 300–400 m, most of them also known from shallower depths, five appearing for the first time, but another 35 species do not cross this border from shallower water. Thus, the subtidal zone appears to be well isolated and we consider 300 m to be its lower boundary, which is 100 m lower than the generally accepted model of marine zonation suggested by Belyaev *et al.* (1959).

In the upper bathyal zone (300–1 300 m) the number of species steadily decreases from the lower boundary of the subtidal zone (41 species) to 1 300 m (only 12 species). This lower boundary is also 100 m deeper than that based on bivalve species investigated by Krylova (1989). We may thus conclude that the outer shelf margin and upper continental slope (0–1 300 m) are the most favourable zones for azooxanthellate corals. The upper region of the slope to 700 m is inhabited by the same families (with the exception of the Pocilloporidae) as occur in the subtidal zone. The families Guyniidae, Rhizangiidae and Anthemiphylliidae do not occur deeper than 700 m. Furthermore, six species of caryophylliids do not occur deeper than 700 m, and two are endemic to the 500–700 m interval. The families Fungiacyathidae, Guyniidae and Flabellidae each lose a species at depths below 700 m. Thus, it appears that the 300–700 m interval is populated by a transitional coral fauna, the lower boundary of this transitional region (700 m) lying 300 m shallower than was suggested in the general model of Belyaev *et al.* (1959) of 1 000 m.

The fauna of the lower bathyal zone (1 300–2 000 m) is the most isolated, consisting of 12 species, 10 of which have a broad bathymetric range. Three of the 12 lower bathyal species also range into the subtidal zone, seven occur as shallow as the upper bathyal zone, and two occur in the lower interval of the upper bathyal. No species makes a first appearance in this zone. Only three families are represented: Caryophylliidae (six species), Flabellidae (four species) and Fungiacyathidae (two species). Only six of the 12 species reach the depth of 2 000 m, the lower boundary of this zone. The position of the lower boundary of the bathyal zone is shallower by 1 000 m than the model of Belyaev *et al.* (1959), but this difference may be explainable due to a paucity of deep-water collections in the south-west Indian Ocean.

All boundaries established for the subtidal and bathyal zones, based on the azooxanthellate corals, coincide with those found for Brachiopoda and Bivalvia by Zezina (1976) and Krylova (1989), respectively. This is not surprising, since all three taxa belong to the same trophic feeding group: the sestonfeeders.

ECOLOGY

It is sometimes possible to predict the environment in which a deep-water coral lives by an analysis of the morphology of the coral, which is essentially an immobile organism with finely-tuned adaptations to variations in the environment. For this purpose, it is better to use the solitary (non-colonial) species because the more complex construction of colonial species may obscure the interpretation (Keller 1981). Analysis of this kind may also serve as a model for palaeoecological reconstructions.

In the subtidal zone of the tropical south-west Indian Ocean, in conditions of high water productivity (Bogorov *et al.* 1968; Koblenz-Mishke 1977), there are many kinds

of azooxanthellate Scleractinia of various sizes and shapes. The largest specimens and most diverse taxa settle on hard substrates, i.e. muddy sand, pebbles, rubble, or rocky bottoms covered with loose sediment. Species common to this environment are *Stephanophyllia complicata*, *S. fungulus*, *Dasmosmilia variegata*, *Rhizosmilia robusta* sp. nov., *Javania insignis*, *Flabellum pavoninum*, *Truncatoflabellum multispinosum* sp. nov., *T. inconstans*, and numerous dendrophylliids.

Another homogeneous coral association occurs on loose sandy bottoms. Most of the species of this association are part of the interstitial fauna, e.g. *Caryophyllia rugosa*, *C. cornuformis*, *Sphenotrochus evexicostatus* sp. nov., *S. gilchristi*, *S. aurantiacus*, *S. imbricaticostatus* sp. nov., *Peponocyathus australiensis*, *Aulocyathus juvenescens* and *Guynia annulata*. These species belong to three families—Caryophylliidae, Turbinoliidae and Guyniidae—but have many similar features: small, unattached coralla with a GCD usually less than 10 mm; low number of septa, usually 48 or fewer; dense skeletal elements; narrow, conical coralla; and smooth calicular margins. Species of *Truncatoflabellum* dwell on the sand in the same locations, but differ in having larger coralla (GCD often over 10 mm) and a trapezoid corallum shape resulting from asexual transverse division. However, their skeletal elements are dense and their calicular margins are smooth.

There may be many reasons for a small-sized coral association. Thiel (1975) believed that invertebrate groups that are faced with constant food restrictions consist, on average, of small individuals. My investigations (Keller 1978, 1989) on the coral associations of the abyssal region and mid-oceanic, bathyal submarine ridges, which both have low nutrient levels, confirm this assertion. However, in addition to their small size, corals in oligotrophic regions also adapt by having a deep fossa, a scalloped calicular margin—the exsert septa forming tall thecal extensions, and a delicate, fragile skeleton. These characteristics allow the coral to accomplish the function of support in the most economical way, which is important in low nutrient level regions. On the contrary, species forming the sandy-bottom associations have dense, robust coralla and their fossae are shallow, with smooth calicular margins due to little or non-exsert septa. This morphology is indicative of normal trophic conditions. Maps of the primary production and zooplankton distribution (Bogorov *et al.* 1968; Koblenz-Mishke 1977) confirm this hypothesis. We suppose that the small size of subtidal corals is related to their location on a shifting sand substrate, not favourable to their existence or normal development. The corals occurring on loose, mobile sand often possess fewer septa than average, possibly as a result of neotenic development, which is common in unfavourable conditions (Keller 1978).

As noted previously, species of three families (Fungiacyathidae, Micrabaciidae and Caryophylliidae) are widely distributed in the upper bathyal and transitional regions. These families have the greatest bathymetric ranges among the Scleractinia, because each includes one genus that occurs at abyssal depths. Fungiacyathidae is represented by three species of *Fungiacyathus*: *F. paliferus*, *F. stephanus* and *F. sibogae*; Caryophylliidae by two species of *Deltocyathus*: *D. andamanicus* and *D. rotulus*; and Micrabaciidae by *Letepsammia formosissima*. As noted before (Keller 1978), there are definite peculiarities in construction of scleractinian skeletons that make it possible for them to adapt to unfavourable environmental conditions, in particular, life in low nutrient levels associated with environments at great depths. This distinctive morpho-

logy consists of a flattened discoidal growth form, a widely open calice with a deep fossa, highly exsert septa, and a light fragile skeleton. Corals with such a morphology maximize the area for food capture and for respiration, and can live in conditions of high nutrient levels as well as being pre-adapted to survive in low nutrient levels.

Species of *Flabellum* (Flabellidae) also occur in the upper bathyal and transitional regions. In the nearshore areas and in other highly productive areas, such as over seamounts (e.g. Saya de Malha Bank), most species of this genus have a serrate calicular edge, a shallow fossa, a narrow elliptical calice with a smooth calicular margin, and numerous septa. The widely distributed *F. pavoninum* is a good example. Lower in the transitional region, but still in the upper bathyal zone where the productivity is not very high (Bogorov *et al.* 1968), two different types of *Flabellum* construction exist. Typical of the first type are *F. messum* and *F. lowekeyesi*, the latter being very common in the south-west Indian Ocean at depths of 800–1 000 m. Its adaptive characteristics are a deep fossa and large calice, a scalloped calicular edge, the septa of which are quite exsert, and a rather fragile skeleton. The shallower-water *F. messum* (430–835 m) has a similar morphology and both species are very similar to *F. marcus* Keller, 1981, which occurs on the oligotrophic mid-oceanic Marcus-Necker submarine ridge. The construction of these three species is well adapted to catching and digesting food in oligotrophic waters, since it requires less calcium carbonate and energy compared with a similarly-sized dense skeleton with a smooth calicular margin. A second, deeper-water group of *Flabellum* species typifies a second kind of skeletal construction, including the species *F. apertum* (863–1 400 m) and *F. japonicum bythios* subsp. nov. (1 095–1 720 m). These species, like the first type, have a deep fossa, an open calice, and a fragile skeleton, but are distinguished from the first group by having a flattened corallum, somewhat similar to that of *Stephanocyathus*.

Three species of *Caryophyllia*, two of which dwell in the upper bathyal and transitional zones, are also characterized by an open calice and highly exsert septa producing a scalloped calicular margin: *C. grandis* (183–490 m), *C. scobinosa* (535–960 m) and *C. ambrosia* (430–2 000 m). The morphology of *C. ambrosia* is most similar to *C. grandis*, the former replacing the latter at greater depth. The main difference between the two species is that the number of septa of the shallower species, *C. grandis*, is greater than that of the deeper *C. ambrosia*, which supports the correlation suggested by Keller (1978) of a decreasing septal number with increase in depth.

The upper bathyal species *C. profunda* (80–755 m) has a somewhat different morphology: a shallow fossa with only a slightly scalloped calicular margin. However, its shallow depth range is reflected in a relatively large number of septa (up to 96 septa and 24 pali). It is advantageous for this species to exist in unfavourable trophic conditions, because its numerous septa (and corresponding mesenteries) provide an increased area for food capture and absorption.

The four species of *Stephanocyathus* live in relatively deep water, two of them occurring in the upper bathyal zone—*S. explanans* (183–614 m) and *S. spiniger* (210–695 m), and two others in the lower bathyal—*S. campaniformis* (1 600–1 610 m) in the south-west Indian Ocean and the better known *S. nobilis* (609–2 000 m). All species in this genus are characterized by having a flattened corallum, an open calice, and highly exsert septa, which produce a scalloped calicular margin. As

mentioned above, corals with such a morphology are best adapted for living in waters having a poor nutrient level.

We conclude, therefore, that a certain kind of environment, i.e. low nutrient level, leads to a certain type of skeletal morphology that occurs in parallel in different families, in agreement with the law of homology series of variations (Vavilov 1967). However, for an accurate reconstruction of environmental conditions, either in the Recent or in the geologic past, it is necessary to analyse the entire coral assemblage at a particular depth. If in a community there exist species with exsert septa and scalloped margins and also flattened forms, it is not significant. However, if most or all of the species have highly exsert septa, a deep fossa, and a fragile skeleton, as is typical of those species in the bathyal of the south-west Indian Ocean, we may conclude that they lived in a region of low nutrient levels. This conclusion is in agreement with maps of primary production and zooplankton distribution published by Koblenz-Mishke (1977) and Bogorov *et al.* (1968).

MATERIAL AND METHODS

Material. The specimens that form the basis of this study derive primarily from three sources (see Station List). Many were obtained from 38 stations of cruises 7 and 8 of the Indian Ocean International Expedition, the specimens collected from waters of a wide range of depths (34–1 360 m) off Mozambique and Kenya using R.V. *Anton Bruun* in 1964 (see Anonymous 1965). Secondly, deeper-water (to 1 720 m) specimens were examined from the Madagascar and Mascarene plateaus, off south-eastern Mozambique and off Madagascar from 33 stations of the Russian research vessel *Vityaz* (cruise 17) in 1988–1989. Third, a collection of relatively shallow-water azooxanthellates (primarily 50–100 m) was studied, comprising specimens from 52 stations made by the R.V. *Meiring Naude* off Zululand, South Africa. The geographic and bathymetric data for all of these stations are listed in the Station List. The R.V. *Anton Bruun*, *Meiring Naude*, and some of the *Vityaz* specimens are deposited at the National Museum of Natural History, Washington, D.C. (NMNH), but most of the *Vityaz* specimens are deposited at the Institute of Oceanology, Moscow (IOM).

In addition to the newly reported material, previously reported specimens of historical interest were examined by the first author from the following institutions: BM (Gardiner 1904; Van der Horst 1926, 1931; Gardiner & Waugh 1938, 1939); ORI (part of Boshoff 1981); ZMA (Alcock 1902*a*, 1902*b*); and ZMB (Von Marenzeller 1904). Finally, a reference collection of Indian Ocean deep-water corals was examined in 1991 by the first author at the Station Marine d'Endoume, Marseille, but is not cited in this publication.

Methods. The geographic region considered in this report is the tropical south-west Indian Ocean (Fig. 2). The south-western border between the tropical and temperate regions has been variously defined from Algoa Bay to just south of Durban, but we have chosen to follow Briggs (1974) in setting this boundary at the mouth of the Kei River (28°22′E 32°41′S). The southern boundary of the region is somewhat arbitrarily taken to be 40°S; the eastern boundary, 70°E; the northern boundary, 2°S (border between Kenya and Somalia); and the western boundary, the coast of eastern Africa and a N–S line from the mouth of the Kei River to 40°S. The region includes

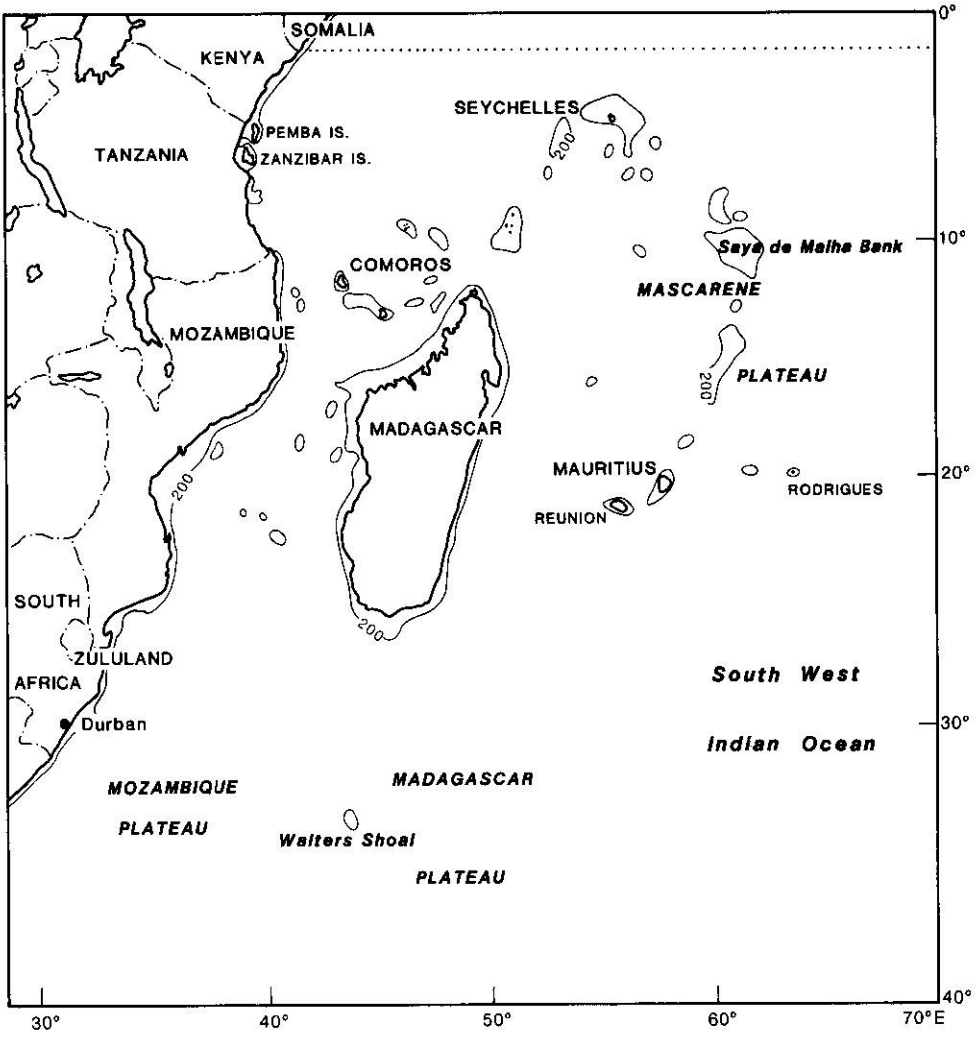

Fig. 2. Map of the region covered in this checklist.

the following countries: north-eastern South Africa, Mozambique, Tanzania (including Pemba and Zanzibar), Kenya and Madagascar; the following islands: Comores, Seychelles, Mauritius, Reunion and Rodriques; and the following submarine features: Madagascar and Mascarene plateaus, Walters Shoal and Saya de Malha Bank.

Species synonymies are complete for records within the Indian Ocean, although additional citations are often given that provide more complete synonymies, descriptions, and/or good illustrations. In the 'New Records' sections, the station number is followed by the number of specimens examined, and finally the catalogue number (if any) or museum of deposition. Station data are found in a separate Station List. Types are deposited primarily at the NMNH, but some are also at the IOM and SAM (see text). The new species were distinguished and described by Cairns and thus should be

cited as: Cairns *in* Cairns & Keller. The descriptive, historical and zoogeographic sections are also the work of the first author; the bathymetric and ecology sections are the work of the second author.

Only those species new to the south-west Indian Ocean and taxa not definitively identified to the species level are illustrated. The scanning electron microscopy was done by the first author on a Cambridge Stereoscan 100.

The following abbreviations are used in the text:

Museums

BM	British Museum (Natural History), London
IOM	Institute of Oceanology, Moscow
NM	Natal Museum, Pietermaritzburg
NMNH	National Museum of Natural History, Washington, D.C.
ORI	Oceanographic Research Institute, Durban
SAM	South African Museum, Cape Town
USNM	United States National Museum (now the NMNH, Smithsonian, Washington, D.C.)
ZMA	Zoological Museum, Amsterdam
ZMB	Zoologisches Museum, Berlin

Vessels

AB.	R.V. *Anton Bruun*
JM	John Murray Expedition (H.E.M.S. *Mabihiss*)
MN	R.V. *Meiring Naude*
V	R.V. *Vityaz*

Morphological terms

GCD	Greater Calicular Diameter
GCD : LCD	Ratio of Greater Calicular Diameter to Lesser Calicular Diameter
SEM	Scanning Electron Microscopy
S_x, C_x, P_x	Septa, Costae, or Pali (respectively) of cycle designated by numerical subscript

SYSTEMATIC ACCOUNT

A checklist of species recorded from the tropical south-west Indian Ocean and their distribution is provided in Table 2.

Suborder ASTROCOENIINA
Family **Pocilloporidae**
Genus *Madracis*

Madracis sp. A
Fig. 3A–B

New records

V–2697, 1 branch, IOM; AB–372B, 1 colony, USNM 91499; AB–400C, 1 branch, USNM 91498.

Remarks

A well-preserved branch tip from Walters Shoal (Fig. 3A–B) measures 14,5 mm long and 2,2–2,5 mm in diameter, supporting about 20 corallites. Costae are highly echinulate and faintly striate. Corallites are circular to slightly elongate, each with 10 primary septa and traces of 10 secondary septa. Very small paliform lobes occur on inner edges of primary septa. Styliform columella massive.

Like most other genera containing shallow-water azooxanthellate species (e.g. *Culicia*, *Polycyathus*, *Oculina*, *Balanophyllia*, *Dendrophyllia* and *Tubastraea*), many species have been described (about 15 in the case of *Madracis*) but none of these genera has been comprehensively revised. Until a worldwide revision is available for this genus, we opt to leave these specimens unidentified to species.

At least three species of *Madracis* have been reported from the western Indian Ocean: an unidentified species reported by Gardiner & Waugh (1939) from off Pemba, Tanzania (73–165 m); *Madracis* sp. cf. *M. decactis* from the reefs of Tuléar, Madagascar (Pichon 1978); and *M. interjecta* von Marenzeller, 1907*b*, from the Gulf of Aqaba, Red Sea (see also Scheer & Pillai 1983; Fricke & Schuhmacher 1983) at 122–350 m.

Distribution

Off Mozambique; off Walters Shoal; 42–160 m.

Suborder FUNGIINA
Family **Fungiacyathidae**
Genus *Fungiacyathus*

Fungiacyathus (Bathyactis) sibogae (Alcock, 1902*a*)

Bathyactis sibogae Alcock, 1902*a*: 108; 1902*c*: 38 [*part.*—lectotype from *Siboga*–208].
Bathyactis symmetrica: von Marenzeller, 1904: 312–313, pl. 18 (fig. 25). Gardiner & Waugh, 1939: 231.
Bathyactis stabilis Gardiner & Waugh, 1939: 231–232, text-figs 1–2 [syn. nov.].
Fungiacyathus (Bathyactis) sibogae: Cairns, 1989*b*: 10–11, pl. 3 (figs d–k), pl. 4 (figs a–c) [synonymy].

New records

AB–365D, 3, USNM 91487; AB–369J, 3, USNM 91486; AB–370D, 1, USNM 91489; AB–373H, 2, USNM 91488; AB–373J, 3, USNM 91485.

Remarks

The south-west Indian Ocean specimens collected by R.V. *Anton Bruun* are indistinguishable from the lectotype of the species and to those reported by Cairns (1989*b*) from Indonesia. Gardiner & Waugh's (1939) specimens of *Bathyactis stabilis* and *B. symmetrica* (BM 1939.7.13.92 and 1939.7.13.93, respectively) and Von Marenzeller's (1904) *B. symmetrica* from *Valdivia*–245 (ZMB 5066) were examined by SDC and also found to be conspecific, the latter being 20,8 mm in calicular diame er.

Distribution

Indian Ocean: off Zululand, South Africa; off south-eastern Mozambique; off Pemba, Tanzania (Von Marenzeller 1904); off Kenya (Gardiner & Waugh 1939); off

south-west Madagascar; Gulf of Oman (Gardiner & Waugh 1939); 463–1 948 m. Elsewhere: Indonesia; 522–1 914 m (Cairns 1989*b*). *Fungiacyathus sibogae* is a new record for the Indian Ocean in name only, being previously reported by Gardiner & Waugh (1939) and Von Marenzeller (1904) as *B. stabilis* and *B. symmetrica*.

Fungiacyathus (Fungiacyathus) stephanus (Alcock, 1893)

Bathyactis stephanus Alcock, 1893: 149, pl. 5 (fig. 12, 12a).
Bathyactis symmetrica: Gardiner & Waugh, 1939: 230–231 [*part.—John Murray*–185].
Bathyactis stephana: Gardiner & Waugh, 1939: 232.
Fungiacyathus (F.) stephanus: Cairns, 1989*b*: 7–9, pl. 1 (figs a–k), pl. 2 (figs a–n) [synonymy and distribution].

New records

AB–370D, 1, USNM 91500; AB–373H, 4, USNM 91501, 1, SAM–H4574; AB–374D, 1, USNM 81534; AB–399C, 13, USNM 80859.

Distribution

Indian Ocean: off Natal (Gardiner & Waugh 1939) and Zululand, South Africa; off Mozambique; Gulf of Aden (Gardiner & Waugh 1939); Bay of Bengal (Alcock 1893); 880–2 000 m. Elsewhere: Indonesia; Philippines; 245–1 977 m (see Cairns 1989*b*).

Fungiacyathus (Fungiacyathus) paliferus (Alcock, 1902*a*)

Bathyactis palifera Alcock, 1902*a*: 108; 1902*c*: 38, pl. 5 (fig. 34, 34a).
Fungiacyathus sp. Zibrowius & Grygier, 1985: 119–120 (figs 6–7).
?Fungiacyathus sp. Zibrowius & Grygier, 1985: 120 (figs 8–9).
Fungiacyathus (F.) paliferus: Cairns, 1989*b*: 9–10, pl. 2 (figs c–i), pl. 3 (figs a–c) [synonymy and distribution].

New record

V–2722, 1, IOM.

Distribution

Indian Ocean: ?off Natal, South Africa (Zibrowius & Grygier 1985); Reunion (Zibrowius & Grygier 1985); Walters Shoal; 99–720 m. Elsewhere: Philippines; Indonesia; Great Australian Bight; 75–522 m (Cairns 1989*b*).

Family **Micrabaciidae**
Genus *Letepsammia*

Letepsammia formosissima (Moseley, 1876)

Fig. 3D

Stephanophyllia formosissima Moseley, 1876: 561–562; 1881: 201–204, pl. 4 (fig. 11), pl. 13 (figs 6–7), pl. 16 (figs 8–9). Van der Horst, 1927: 7. Gardiner & Waugh, 1939: 234. Boshoff, 1981: 24. Zibrowius & Grygier, 1985: 120.
Letepsammia formosissima: Owens, 1986: 487. Cairns, 1989*b*: 15–18, pl. 6 (fig. j), pl. 7 (figs g–i), pl. 8 (figs a–d) [synonymy and distribution].
Stephanophyllia: Williams, 1986, upper left colour photo.

New records

V–2608, 1, IOM, 1, USNM 91506; V–2626, 33, IOM, 6, USNM 91507; AB–358A, 2, USNM 91508; AB–370G, 10, USNM 75642; AB–370H, 1, USNM 75641; AB–372G, 2, USNM 75643; AB–390R, 1, USNM 91509; AB–390S, 30, USNM 75640; *Vema*–14 SAT6, 6, USNM 75644; MN–ZL3, 1, USNM 91505.

Remarks

An undescribed species of *Letepsammia* from the south-west Indian Ocean was mentioned first by Squires (1967: 505), and later by Owens (1986: 487) and Cairns (1989*b*: 16). This 'species' differs from typical *L. formosissima* in having a denser and more robust corallum, coarser septal teeth, and a papillose columella. Because these differences are slight and may be interpreted as intraspecific variation, a new species is not described at this time.

Distribution

Indian Ocean: off Nieca River mouth, South Africa (Zibrowius & Grygier 1985); off Durban, South Africa (Van der Horst 1927; Boshoff 1981); off Zululand; off Mozambique; off Pemba, Tanzania (Gardiner & Waugh 1939); off north-west Madagascar; 320–780 m. Elsewhere: Japan; Philippines; Hawaiian Islands; New Zealand; Australia; Tasmania; 97–828 m (Cairns 1989*b*).

Genus *Stephanophyllia*

Stephanophyllia fungulus Alcock, 1902*b*

Stephanophyllia fungulus Alcock, 1902*b*: 122–123; 1902*c*: 40, pl. 5 (fig. 35a–b). Gardiner & Waugh, 1939: 234. Pillai & Scheer, 1976: 14. Cairns, 1989*b*: 21–23, pl. 10 (figs a–k), pl. 11 (figs a–b) [synonymy and distribution].

Non *Stephanophyllia fungulus* Alcock. Boshoff, 1981: 24.

New records

AB–373B, 1, USNM 91510; MN–ZCC1, 1, USNM 91511.

Remarks

The specimen from MN–ZCC1 is very similar to the specimen illustrated by Cairns (1989*b*, pl. 10h) from off Natal.

Distribution

Indian Ocean: off Natal, South Africa (Cairns 1989*b*); off south-eastern Mozambique; Chagos Archipelago (Gardiner & Waugh 1939); Maldive Islands (Pillai & Scheer 1976); 98–236 m. Elsewhere: western Pacific Ocean; 15–635 m (Cairns 1989*b*).

Stephanophyllia complicata Moseley, 1876

Stephanophyllia complicata Moseley, 1876: 558; 1881: 198–201, pl. 4 (fig. 12), pl. 13 (figs 3–5). Van der Horst, 1926: 51; 1931: 11. Gardiner & Waugh, 1939: 234. Pillai & Scheer, 1976: 14. Cairns, 1989*b*: 21, pl. 12 (figs a–b).

New record

V–2804, 1, IOM.

Remarks

Three of the specimens reported by Van der Horst (1926, 1931) from Saya de Malha Bank are deposited at the USNM (81875).

Distribution

Indian Ocean: Saya de Malha Bank (Van der Horst 1926, 1931); Chagos Archipelago (Gardiner & Waugh 1939); Maldive Islands (Pillai & Scheer 1976); 229–236 m. Elsewhere: Indonesia; 236 m (Moseley 1881).

Suborder FAVIINA
Family **Rhizangiidae**
Genus *Culicia*

Culicia sp. cf. *C. natalensis* (Duncan, 1876)

Fig. 3G

Cylicia tenella var. *natalensis* Duncan, 1876: 439–440, pl. 40 (fig. 3).
?Culicia tenella: Gardiner & Waugh, 1939: 230 (*John Murray*–123). Boshoff, 1981: 24.

New record

AB–421A, 2 colonies, USNM 91515.

Diagnosis

Larger colony (Fig. 3G) roughly spherical, about 4 cm in diameter, consisting of 50 closely spaced corallites. Corallites elongate and tubular, with circular calices up to 6,5 mm in diameter. Epitheca smooth and thin. Septal symmetry irregular: 10–12 primary septa, an equal number of secondary septa, and occasionally rudimentary tertiary septa in some sectors. Primary septa large, each having 4 or 5 prominent teeth, and joined to columella. Columella rudimentary and papillose.

Remarks

Specimens of *Culicia* have been reported at least four times from the south-west Indian Ocean: *C. excavata* (Milne Edwards & Haime, 1849) from the Cape of Good Hope; *C. tenella* var. *natalensis* (Duncan, 1876) from off Natal; *C. tenella* by Gardiner & Waugh (1939) from off Pemba, Tanzania; and *C. tenella* by Boshoff (1981) from off Mozambique and the Natal regions. In calicular size, septal number and arrangement, and distribution (i.e. tropical south-west Indian Ocean), the R.V. *Anton Bruun* specimens resemble *C. natalensis* (Duncan, 1876) more so than *C. excavata*, the latter having smaller corallites, fewer septa, and appearing to be restricted to temperate South Africa. The type of *C. natalensis* could not be found for comparison. *Culicia natalensis* is very similar to *C. hoffmeisteri* Squires, 1966, a species known only from South Australia at 0–29 m (Cairns & Parker 1992). When more specimens of the south-west Indian Ocean species are collected, detailed comparisons should be made to this Australian species.

Distribution

Off Natal, South Africa (Duncan 1876; Boshoff 1981); ?off Pemba, Tanzania (Gardiner & Waugh 1939); off Kenya; 34 m.

Family **Oculinidae**
Genus *Madrepora*

Madrepora oculata Linnaeus, 1758

Madrepora oculata Linnaeus, 1758: 798. Zibrowius, 1974*a*: 762–766, pl. 2 (figs 3–5); 1980: 36–40, pl. 13 (figs A–P) [synonymy]. Cairns, 1979: 39–42, pl. 3 (fig. 2), pl. 4 (fig. 5), pl. 5 (figs 1–3) [synonymy].
Lophohelia investigatoris Alcock, 1898: 24–25.
Amphihelia (Diplohelia) moresbyi Alcock, 1898: 25–26 [*fide* Zibrowius, 1974*a*].
Amphihelia oculata: von Marenzeller, 1904: 308–310, pl. 14 (fig. 1).
Madrepora kauaiensis: Gardiner & Waugh, 1939: 227.
Non *Madrepora oculata* Linnaeus. Boshoff, 1981: 27 [= a dendrophylliid, H. Zibrowius, pers. comm.].
Lophelia exigua: Boshoff, 1981: 37.

New records

V–2699, 7 branches, IOM; AB–365D, 2 branches, USNM 77210.

Distribution

Indian Ocean: Off Pemba, Tanzania (Gardiner & Waugh 1939); off south-west Madagascar; Madagascar Plateau; off Somalia (Von Marenzeller 1904); Red Sea (Von Marenzeller 1904); Arabian Sea (Alcock 1898); Laccadive Islands (Alcock 1898); St Paul and Amsterdam Islands (Zibrowius 1974*a*); 732–1 270 m. Elsewhere: cosmopolitan; 80–1 500 m (Cairns 1979).

Family **Anthemiphylliidae**
Genus *Anthemiphyllia*

Anthemiphyllia dentata (Alcock, 1902*a*)

Fig. 3E

?Discotrochus investigatoris Alcock, 1893: 142, pl. 5 (fig. 5, 5a).
Discotrochus dentatus Alcock, 1902*a*: 104; 1902*c*: 27, pl. 4 (fig. 26). Gardiner & Waugh, 1938: 194. Pillai & Scheer, 1976: 16.
Anthemiphyllia dentata: Cairns & Parker, 1992: 16–17, pl. 4 (figs e–f) [synonymy].

New record

V–2804, 1, IOM.

Distribution

Indian Ocean: Saya de Malha Bank; Arabian Sea (Alcock 1893; Gardiner & Waugh 1938); Maldive Islands (Gardiner & Waugh 1938; Pillai & Scheer 1976); 193–494 m. Elsewhere: off Japan; Indonesia; South Australia; 75–522 m (see Cairns & Parker 1992).

Suborder CARYOPHYLLIINA
Family **Caryophylliidae**
Genus *Caryophyllia*

Caryophyllia ambrosia ambrosia Alcock, 1898

Fig. 3H

Caryophyllia communis: Wood-Mason & Alcock, 1891*a*: 6. Alcock, 1898: 11–12.
Caryophyllia ambrosia Alcock, 1898: 12, pl. 1 (fig. 1, 1a). Zibrowius, 1980: 63–65, pl. 25 (figs A–K) [synonymy].
Caryophyllia clavus: van der Horst, 1931: 3 [*part.*—specimens from Laccadive Sea]. Gardiner & Waugh, 1938: 176.
Caryophyllia ambrosia ambrosia: Cairns, 1979: 59.

New records

V–2668, 12, IOM; V–2671, 1, IOM; V–2816, 4, IOM. Reference specimens: Gardiner & Waugh's (1938) *Caryophyllia clavus*: JM–119, 3, BM 1950.1.9.159–183; JM–122, 2, BM 1950.1.9.75–80; JM–185, 3, BM 1950.1.9.134–158.

Distribution

Indian Ocean: off Pemba and Zanzibar, Tanzania (Gardiner & Waugh 1938); Saya de Malha Bank; Madagascar Plateau; Gulf of Aden (Gardiner & Waugh 1938); Maldive Islands (Van der Horst 1931); Laccadive Islands (Alcock 1898); 430–2 000 m. Elsewhere: western and eastern Atlantic; 1 600–2 670 m (Zibrowius 1980).

Caryophyllia grandis Gardiner & Waugh, 1938

Caryophyllia clavus: von Marenzeller, 1904: 281 [*part.*—*Valdivia*–186, pl. 16 (fig. 9, 9I)].
Caryophyllia grandis Gardiner & Waugh, 1938: 177, pl. 1 (fig. 2). Pillai & Scheer, 1976: 16. Zibrowius & Gili, 1990: 32.

New records

V–2631, 12, IOM, 1, USNM 91521; 12 miles (19 km) north of Durban, 183–220 m, 4, USNM 62497. Reference specimens: 4 syntypes of *C. grandis* from JM–145, BM 1950.1.9.211–225.

Remarks

Caryophyllia grandis is similar to *C. ambrosia*, both having unattached coralla of approximately the same size. To reiterate and add to Gardiner & Waugh's (1938) distinctions, *C. grandis* has a brownish theca; more crowded septa (and more septa than *C. ambrosia* at a corresponding size, sometimes up to a full fifth cycle); narrower pali; less exsert septa; and a shallower depth range (183–595 m vs 430–2 670 m). Comparisons to another unattached, cornute species, *C. valdiviae*, known only from the Walvis Ridge and off north-west Africa (882–1 230 m), are made by its authors Zibrowius & Gili (1990).

Distribution

Off Natal, South Africa (Zibrowius & Gili 1990); off south-eastern Mozambique; Maldive Islands (Gardiner & Waugh 1938); ?off western Sumatra (Von Marenzeller 1904); 183–595 m.

Caryophyllia scobinosa Alcock, 1902*a*

Caryophyllia scobinosa Alcock, 1902*a*: 90; 1902*c*: 8, pl. 1 (fig. 2, 2a). Gardiner & Waugh, 1938: 177–178. Keller, 1976: 17–18.
Caryophyllia clavus: von Marenzeller, 1904: 281 [*part.*—*Valdivia*–246, pl. 16 (fig. 9c–g, but not 9h)].

New records

V–2650, 1, IOM; V–2699, 2, IOM; AB–365D, 11, USNM 91519.

Distribution

Indian Ocean: off Pemba and Dar es Salaam, Tanzania (Von Marenzeller 1904; Gardiner & Waugh 1938; Keller 1976); south-west of Madagascar; off Walters Shoal, Madagascar Plateau; 535–960 m. Elsewhere: Celebes and Sulu Seas; 786–805 m.

Caryophyllia sp. cf. *C. cornuformis* Pourtalès, 1868

Fig. 3C, F

?*Caryophyllia cornuformis*: Gardiner & Waugh, 1938: 179, text-fig. 2.

New records

V–2626, 1, IOM; AB–370G, 32, USNM 91525, 1, SAM–H4585; AB–370H, 1, USNM 91526.

Remarks

Both Cairns (1979) and Zibrowius (1980) stated that Gardiner & Waugh's (1938) south-west Indian Ocean specimens of *C. cornuformis* were not that species, but did not state which species the *John Murray* specimens are. Comparisons of our new records to typical western Atlantic *C. cornuformis* show them to be very similar in size, shape, and septal and palar arrangement. The south-west Indian Ocean specimens differ only in having a thinner, sometimes ridged, non-porcellaneous theca, and some specimens have an intact base. It is suggested that two similar species may be involved: one very similar, if not identical, to *C. cornuformis*, which always has a broken base and irregular septal symmetry, and another as yet unnamed species (illustrated by Gardiner & Waugh 1938) that has an intact base and hexameral (three cycles) symmetry.

Distribution

Indian Ocean: off south-western Mozambique; ?off Pemba and Zanzibar, Tanzania (Gardiner & Waugh 1938); ?Gulf of Aden (Gardiner & Waugh 1938); 91–347 m. Distribution of *C. cornuformis*: western Atlantic from Brazil to 63°N at 37–931 m (Cairns 1979) and eastern Atlantic in area bounded by Celtic Sea, Azores, and Morocco at 1 300–2 200 m (Zibrowius 1980).

Caryophyllia profunda Moseley, 1881

Caryophyllia profunda Moseley, 1881: 138–139, pl. 1 (fig. 6) [*part.*—not specimen from Cape Verde Islands]. Von Marenzeller, 1904: 298. Zibrowius, 1974*a*: 751–755, pl. 1 (figs 1–10) [synonymy]. Cairns, 1982: 17–19, pl. 5 (figs 1–5) [synonymy]. Zibrowius & Gili, 1990: 25–26, pl. 4 (figs L–R).
Caryophyllia cyathus: von Marenzeller, 1904: 295, pl. 16 (fig. 6).

New records

V–2686, 12, IOM, 1, USNM 91527; V–2722, 3, IOM; V–2731, 11, IOM; V–2733, 9, IOM.

Distribution

Indian Ocean: Agulhas Bank and Cape Agulhas (Von Marenzeller 1904); Madagascar Plateau; St Paul and Amsterdam Islands (Zibrowius 1974*a*); 80–755 m. Elsewhere: circum-Subantarctic; 35–1 116 m (Cairns 1982).

Caryophyllia rugosa Moseley, 1881

Fig. 3I

Caryophyllia rugosa Moseley, 1881: 141–143, pl. 1 (fig. 8). Cairns, 1984: 11–13, pl. 2 (figs A–B), pl. 4 (fig. I) [synonymy].

New records

AB–371E, 6, USNM 77212; AB–371F, 5, USNM 77213; *Manihine* 381–1, 2, USNM 91528; MN–ZD4, 2, USNM 91529; MN–ZQ8a, 1, USNM; JM–157 (attached to a colony of *Balanophyllia diffusa*), 1, BM 1950.1.6.35.

Distribution

Indian Ocean: off Zululand; off south-eastern Mozambique; off Mombasa, Kenya; off Maldive Islands; 95–250 m. Elsewhere: Hawaiian Islands; Philippines; Ceram Sea; Japan; Bikini; 71–230 m (Cairns 1984).

Caryophyllia elongata sp. nov.

Fig. 4A–B

Records

Holotype: V–2716, 1, IOM.

Description

Corallum attached, subcylindrical, straight, and elongate: 25,6 mm in height, 9,3 × 7,9 mm in calicular diameter, and 5,7 mm in pedicel diameter. Costae poorly developed, only slightly ridged C_1 and C_2 present near calice. Theca otherwise porcellaneous, covered by low, rounded granules. Corallum primarily white, but theca light brown near calice.

Septa hexamerally arranged in four complete cycles (48 septa) according to the formula: $S_1 > S_2 > S_4 > S_3$. S_1 moderately exsert (2–2,5 mm), with slightly sinuous inner edges that reach about three-quarters distance to columella. S_2 slightly less exsert and equally sinuous, extending about two-thirds distance to columella. S_3 least exsert and smallest septa, extending only about half distance to columella. S_4 twice as exsert and slightly wider than S_3, both cycles having sinuous inner edges. Septal granules prominent, usually rectangular in profile, sometimes extending as short ridges paralleling inner septal edge. Twelve P_3 form a deeply recessed palar crown, each palus about 1,2 mm wide, highly sinuous, and separated from its respective S_3 by a deep and

narrow notch. Each couple of P_3 within a system are slightly closer to each other than to those of adjacent systems, giving the impression of paired pali. Fossa quite deep, containing the palar crown and even deeper columella, consisting of two narrow fascicular elements.

Remarks

Among the 56 Recent species of *Caryophyllia* listed by Cairns (1991), 18 have attached coralla with septa hexamerally arranged in four cycles, and in only five of these species are the S_4 larger than the S_3, the set of characters found in *Caryophyllia elongata* sp. nov.: *C. polygona* Pourtalès, 1878; *C. calveri* Duncan, 1873; *C. alberti* Zibrowius, 1980; *C. atlantica* (Duncan, 1873); and *C. panda* Alcock, 1902*a*. *Caryophyllia elongata* is distinguished from these species by having S_1 larger than S_2 (S_1 and S_2 are equal in size in most species), a very deep fossa, and deeply recessed, 'paired' pali.

Etymology

The species name *elongata* (from the Latin *elongatus*, prolonged) is an allusion to the elongate corallum of this species.

Distribution

Known only from the type locality of 33°17'S 44°55'E (Madagascar Plateau, off Walters Shoal), 630–680 m.

Subgenus *Caryophyllia (Premocyathus)*

Caryophyllia (Premocyathus) zanzibarensis Zou, 1984 [comb. nov.].

Caryophyllia compressa Gardiner & Waugh, 1938: 180, pl. 2 (fig. 4) [junior secondary homonym of *Caryophyllia (Premocyathus) compressus* Yabe & Eguchi, 1942].
?Trochocyathus pileus: Gardiner & Waugh, 1938: 187.
Caryophyllia zanzibarensis Zou, 1984: 52, 53 [replacement name for *C. compressa* Gardiner & Waugh, 1938].

New record

Manihine 381–3, 4, USNM 91542.

Remarks

This species is transferred to the subgenus *Premocyathus* based on its highly compressed corallum and carinate thecal edges. Other Recent species in this subgenus include: *C. (P.) compressus* Yabe & Eguchi, 1942; *C. (P.) spinacarens* (Moseley, 1881), comb. nov.; *C. (P.) burchae* Cairns, 1984; and *?C. (P.) dentiformis* (Alcock, 1902*b*). *Caryophyllia (Premocyathus) zanzibarensis* is most similar to *C. (P.) spinacarens*, differing primarily in having fewer septa and in being more compressed.

Distribution

Off north-eastern Tanzania, Maziwi Island (Gardiner & Waugh 1938); 238–302 m.

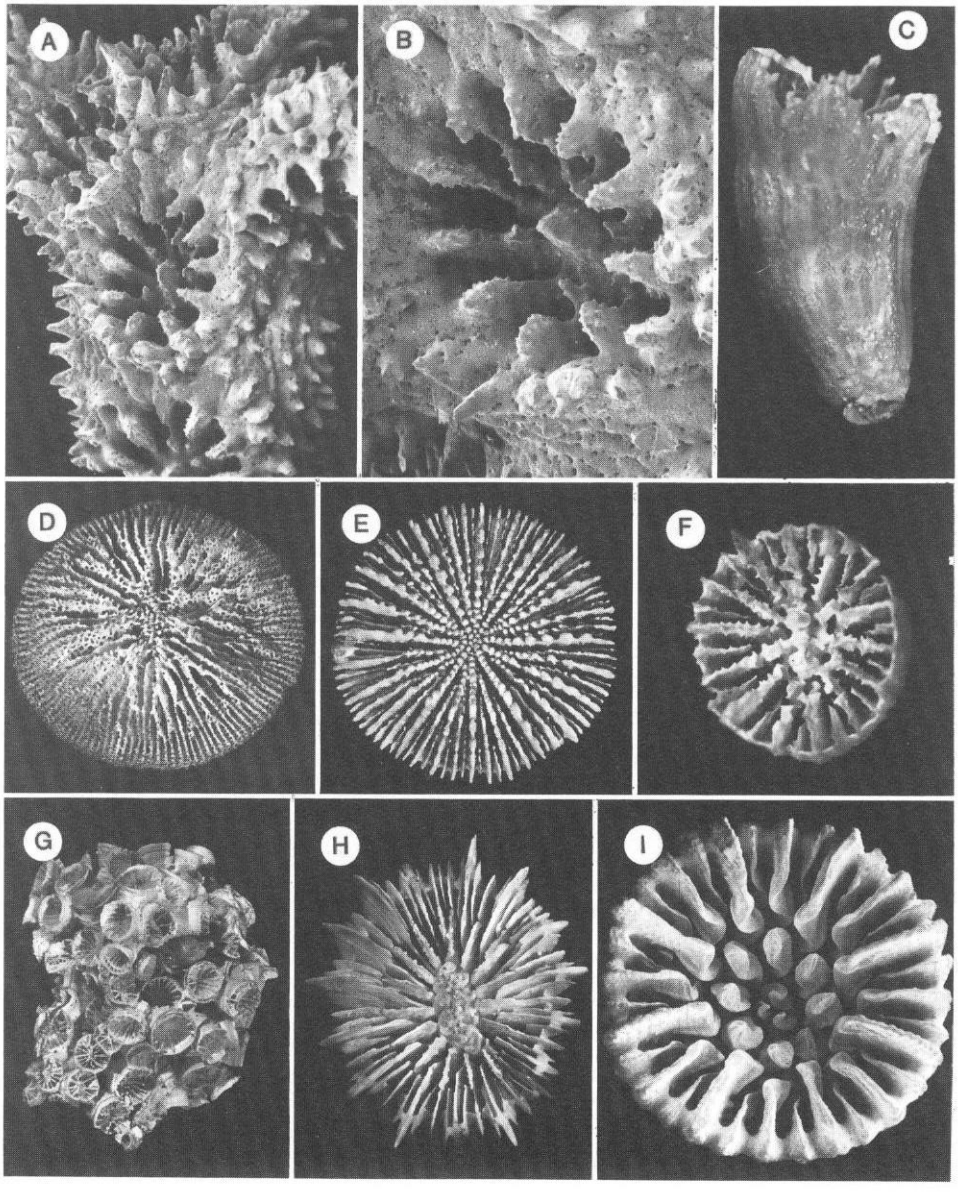

Fig. 3. A–B. *Madracis* sp. A, V–2697, IOM, branch and calicular views. A × 10, B × 20. C, F. *Caryophyllia* sp. cf. *C. cornuformis*, V–2626, IOM, lateral and calicular views. C × 5,8, F × 6,7. D. *Letepsammia formosissima*, V–2608, USNM 91506, calice. × 1,3. E. *Anthemiphyllia dentata*, V–2804, IOM, calice. × 1,4. G. *Culicia* sp. cf. *C. natalensis*, AB–421A, USNM 91515, colony. × 0,9. H. *Caryophyllia ambrosia ambrosia*, V–2668, IOM, calice. × 1,3. I. *Caryophyllia rugosa*, AB–371E, USNM 77212, calice. × 9,4.

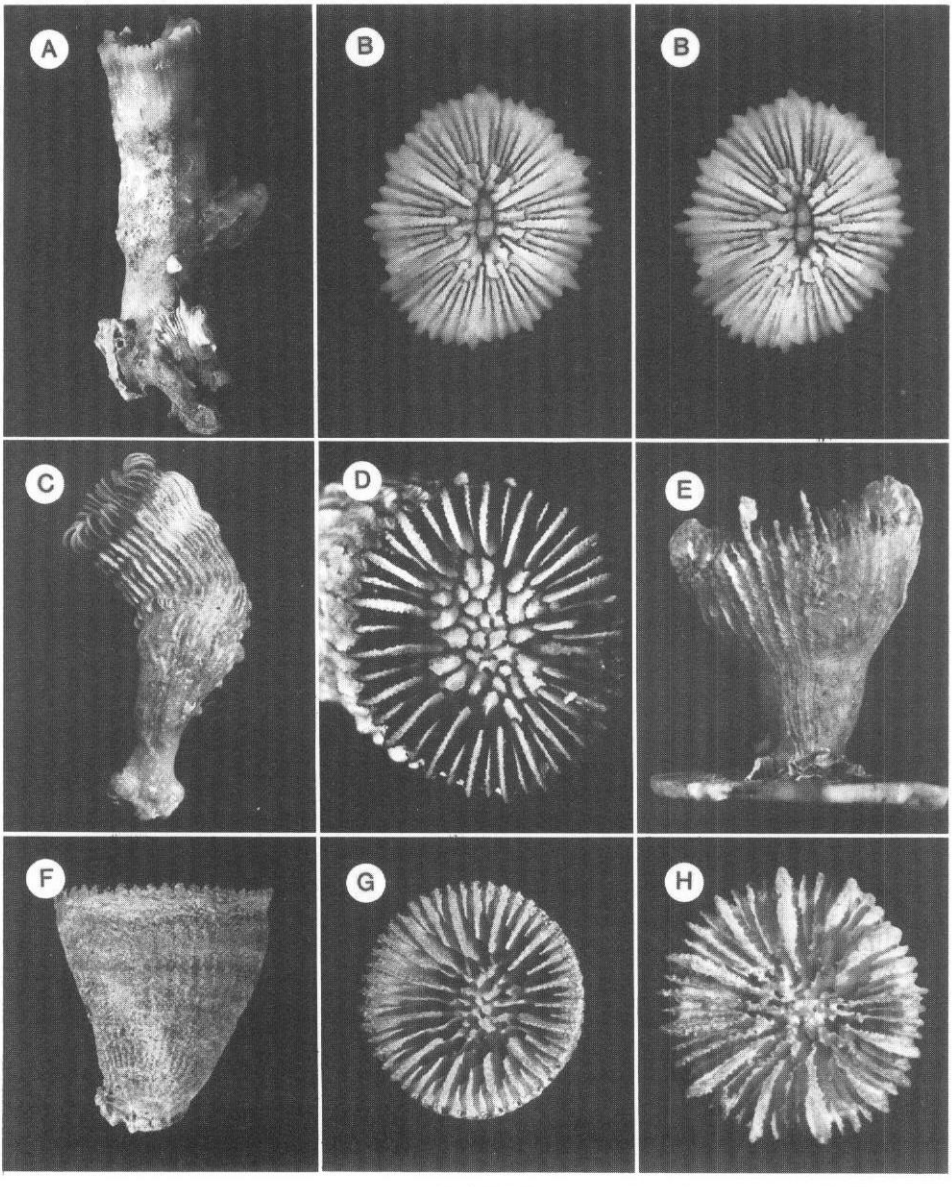

Fig. 4. A–B. *Caryophyllia elongata* sp. nov., V–2716 (holotype), lateral and stereo calicular views. A × 1,6, B × 3,9. C–D. *Trochocyathus* sp. A, V–2662, IOM, lateral and calicular views. C × 1,7, D × 4,5. E, H. *Trochocyathus* sp. cf. *T. rawsonii*, V–2733, USNM 91568, lateral and calicular views. E × 3,6, H × 3,3. F–G. *Conotrochus brunneus*, AB–365D, USNM 91556, lateral and calicular views. F × 3,5, G × 3,9.

Genus *Trochocyathus*

Trochocyathus rhombocolumna Alcock, 1902*c*

Trochocyathus rhombocolumna Alcock, 1902*c*: 16, pl. 2 (fig. 12).
Paracyathus gardineri: Gardiner & Waugh, 1938: 183–184 (*part.*—JM–157, pl. 3 (fig. 5)).

New records

AB–371E, 5, USNM 91563; AB–371F, 2, USNM 91564. Reference material: Gardiner & Waugh's (1938) *P. gardineri*: JM–157, 4, BM 1950.1.9.724–826; JM–106, 1, BM 1950.1.9.718.

Remarks

Specimens herein reported from off Mozambique were compared to those identified by Gardiner & Waugh (1938) as *Paracyathus gardineri* from the Maldive Islands (JM–157) and found to be conspecific; however, the *John Murray* specimen from off Tanzania (JM–106) was too damaged to identify. Several specimens from the Maldive Islands are extremely similar to the figured holotype of *T. rhombocolumna*. A peculiarity of this species is that not only are the S_4 slightly wider that the S_3, but those S_4 adjacent to S_1 are wider than those adjacent to S_2 (about equal in width as an S_2).

As noted by Cairns (1984), the Indian Ocean specimens reported by Gardiner & Waugh (1938) as *P. gardineri* Vaughan, 1907, are not conspecific with that Hawaiian species, the former differing in having a basal attachment, more crowded septa, and transverse costae.

Distribution

Off south-western Mozambique; Maldive Islands (Gardiner & Waugh 1938); 110–229 m. Elsewhere: Sulu Archipelago (Alcock 1902*c*); 522 m.

Trochocyathus sp. A

Fig. 4C–D

Records

V–2662, 1, IOM; V–2803, 1, USNM 91567; AB–371F, 2, USNM 91565; MN–ZDD3, 1, USNM 91566.

Diagnosis

Corallum ceratoid and firmly attached either basally or laterally by epithecal bands. Coralla up to 10,3 × 9,1 mm in calicular diameter and 15 mm in height. Costae granular and well developed; transverse sculpturing not present. Corallum light brown, especially near calice. Septa hexamerally arranged in four cycles according to the formula: S_1 and $S_2 > S_3$ and S_4. All septa have straight, vertical inner edges, except the S_3, which are sinuous. Pali occur before the highest three cycles, the P_2 and P_3 about the same size, the P_3 about twice that width. All pali extend to columella. Columella papillose, consisting of 5–12 elements in an elliptical field.

Remarks

Trochocyathus sp. A is similar to *T. rhombocolumna* in having robust palar and columellar elements and having 48 septa, but differs in having: P_3 recessed from the columella, forming chevrons with the P_2; longitudinal (not transverse) costae; less crowded septa; brown theca; and equally wide S_1 and S_2.

Distribution

Off Zululand, South Africa; off south-eastern Mozambique; south-west of Madagascar; Saya de Malha Bank; 74–315 m.

Trochocyathus rawsonii sensu Gardiner, 1904

Non *Trochocyathus rawsonii* Pourtalès, 1874: 35.
Trochocyathus rawsonii: Gardiner, 1904: 100–103, pl. 1 (fig. 2a–b), pl. 2 (figs A–K).

New record

MN–SM232, 3, USNM 77220. Reference specimen: *T. rawsonii* of Gardiner (1904, pl. 1 (fig. 2)), 1, BM 1950.1.10.112.

Remarks

As noted by Cairns (1979) and Zibrowius & Gili (1990), the South African specimens reported by Gardiner (1904) as *T. rawsonii* are incorrectly identified and probably represent an undescribed species. The South African specimens differ in having elongate, often curved coralla attached by a slender pedicel; better developed costae; and a paucity of S_5. But, as stated above, until this genus is better known, we prefer not to introduce a new name for this species at this time, but await Zibrowius' anticipated faunistic revision, which will include many more specimens of this taxon.

Distribution

Off South Africa from Cape of Good Hope to Buffalo River (Gardiner 1904); 560–620 m (depths of Gardiner's specimens unknown).

Trochocyathus sp. cf. *T. rawsonii* Pourtalès, 1874

Fig. 4E, H

?Trochocyathus rawsonii Pourtalès, 1874: 35, pl. 6 (figs 7–10). Cairns, 1979: 77–79, pl. 13 (figs 5–7), pl. 14 (figs 1–6) [synonymy].
Non *Trochocyathus rawsonii* Pourtalès. Gardiner, 1904: 100–103.

New records

V–2608, 4, IOM; V–2731, 1, IOM; V–2733, 1, USNM 91568.

Remarks

Although Gardiner's (1904) records of *T. rawsonii* are thought to be misidentified, three specimens collected off Madagascar and the Madagascar Plateau are indistinguishable from small specimens of the attached, trochoid form of *T. rawsonii* described and figured by Cairns (1979: 77, pl. 13 (fig. 6)). The largest of the three

specimens (V–2608) is 11,6 mm in calicular diameter and 13,4 mm in height, having 48 septa arranged in four complete cycles.

Distribution

Indian Ocean: off north-western Madagascar and off Walters Shoal, Madagascar Plateau; 750–780 m. Distribution of *T. rawsonii*: Georgia to Brazil; 82–622 m (Cairns 1979).

Genus *Stephanocyathus*

Stephanocyathus (Odontocyathus) nobilis (Moseley, 1873)

Fig. 5D–E

Ceratotrochus nobilis Moseley, 1873: 402, text-fig. 3.
Stephanotrochus nobilis: Moseley, 1881: 155, pl. 3 (fig. 3a–b).
Stephanotrochus nitens Alcock *in* Wood-Mason & Alcock, 1891*a*: 7–8. Alcock, 1898: 18–19, pl. 2 (fig. 6, 6a); 1902*d*, text-fig. 92.
Stephanotrochus oldhami Alcock, 1894: 187–188; 1898: 19–20.
Stephanocyathus nobilis: Gardiner & Waugh, 1938: 189–192, pl. 6 (figs 13, 15). Pillai & Scheer, 1976: 16. Zibrowius, 1980: 101–103, pl. 51 (figs A–K) [synonymy].
Non *Stephanocyathus nobilis*: Boshoff, 1981: 39–40 (= *S. explanans*). Zou, 1988: 74–75 (= *S. weberianus*).
Stephanocyathus (Odontocyathus) nobilis: Cairns, 1979: 110–111, pl. 20 (figs 7, 10).

New records

V–2629, 6, IOM, 1, USNM 91543; V–2653, 3, IOM; V–2814, 2, IOM; AB–399B, 1, USNM 91544; AB–399C, 28, USNM 91545, 2, SAM–H4576.

Remarks

Although Zibrowius (1980) expressed reservation about the authenticity of Indian Ocean records of *S. nobilis* (type locality, Azores), comparison of Indian Ocean specimens with those from the eastern Atlantic, including the holotype, convince us that they are the same species, a conclusion also reached by Zou (1988); however, we do not include western Pacific specimens as *S. nobilis*. Although not examined (types presumably deposited in the Indian Museum, Calcutta), we concur with Gardiner & Waugh (1938) that *S. nitens* Alcock, 1891*a* (*in* Wood-Mason & Alcock), and *S. oldhami* Alcock, 1894, are undoubtedly junior synonyms of *S. nobilis*, but agree with Zibrowius (1980) that *S. weberianus* Alcock, 1902*a*, and *S. campaniformis* von Marenzeller, 1904, are distinct species.

Distribution

Indian Ocean: off south-eastern Mozambique; off Zanzibar, Tanzania (Gardiner & Waugh 1938); off Mombasa, Kenya (Gardiner & Waugh 1938); off south-western Madagascar; off Saya de Malha Bank; Gulf of Aden (Gardiner & Waugh 1938); Arabian Sea off India (Wood-Mason & Alcock 1891*a*; Alcock 1894); Maldive Islands (Gardiner & Waugh 1938; Pillai & Scheer 1976); 609–2 000 m. Elsewhere: off England; Azores; and Gulf of Guinea (Zibrowius 1980); off Brazil (Cairns 1979); 763–2 200 m.

Stephanocyathus (Odontocyathus) campaniformis (von Marenzeller, 1904)

Fig. 5A–B

Stephanotrochus campaniformis von Marenzeller, 1904: 302–304, pl. 18 (fig. 20, 20a).
Stephanocyathus campaniformis: Zibrowius & Gili, 1990: 32–35, pl. 4 (figs A–K), pl. 5 (figs E–J) [synonymy].

New record

V–2674, 1, IOM.

Remarks

Stephanocyathus campaniformis is very similar to *S. nobilis*, the major differences being its smaller adult size (distance from centre of base to edge break = 7,5–11,5 mm vs 10–15 mm for adult *S. nobilis*), and its characteristic bell shape, usually with a much higher H : W ratio than *S. nobilis* (i.e. 0,65–1,3 mm vs 0,42–0,61 mm for *S. nobilis*). The south-west Indian Ocean specimen, 29,5 mm in calicular diameter and 19,2 mm in height (H : W = 0,65), was compared to topotypic specimens of *S. campaniformis* reported by Zibrowius & Gili (1990) from the Walvis Ridge (USNM 86873–86876), the Indian Ocean specimen being very similar to a specimen figured by Zibrowius & Gili (1990, pl. 4 (figs F–G)).

Distribution

Indian Ocean: south-west Indian Ridge south of Madagascar Plateau; 1 600–1 610 m. Elsewhere: Walvis Ridge, off Namibia; 882–1 230 m (Zibrowius & Gili 1990).

Stephanocyathus (Acinocyathus) spiniger (von Marenzeller, 1888)

Stephanotrochus spiniger von Marenzeller, 1888: 20–21.
Odontocyathus spiniger: Eguchi, 1968: C39–C40, pl. C20 (figs 12–14), pl. C23 (figs 1–2) [synonymy].
Stephanocyathus spiniger: Boshoff, 1981: 39.
Stephanocyathus (Acinocyathus) spiniger: Wells, 1984: 209, figs 2.10–13 [synonymy]. Cairns & Parker, 1992: 26–27, pl. 7 (figs g–i) [synonymy].

New records

V–2635, 4, IOM; AB–365D, 14, USNM 77215, 1, SAM–H4595.

Distribution

Indian Ocean: off Durban, South Africa (Boshoff 1981); off south-eastern Mozambique; off south-western and northern Madagascar; 210–695 m. Elsewhere: Japan; Philippines; Indonesia; Great Australian Bight; 120–560 m (Cairns & Parker 1992).

Stephanocyathus (Acinocyathus) explanans (von Marenzeller, 1904)

Stephanotrochus explanans von Marenzeller, 1904: 304–307, pl. 18 (fig. 19a–b).
Stephanocyathus explanans: Gardiner & Waugh, 1938: 192.
Stephanocyathus nobilis: Boshoff, 1981: 39.

New records

19 km north of Durban, South Africa, 183–220 m, 4, USNM 62500.

Remarks

Although having the same size range, *S. explanans* differs from *S. spiniger* in having shorter, thinner costal spines; having much less exsert septa ($S_1 = S_2$, whereas S_1 of *S. spiniger* are much larger than S_2); and in lacking corallum pigmentation.

Distribution

Off Durban, South Africa (Boshoff 1981); off Pemba and Zanzibar, Tanzania (Von Marenzeller 1904); west of Sumatra (Von Marenzeller 1904); 183–614 m.

Genus *Labyrinthocyathus*

Labyrinthocyathus delicatus (von Marenzeller, 1904)

Ceratotrochus delicatus von Marenzeller, 1904: 302, pl. 18 (fig. 18).
Cyathoceras cornu: Gardiner, 1904: 121–122.
Labyrinthocyathus sp. Cairns, 1979: 70, pl. 11 (figs 10–11).
Labyrinthocyathus delicatus: Zibrowius & Gili, 1990: 44.

New records

V–2637, 2, IOM; AB–357E, 1, USNM 77219; MN–SM162, 1, USNM 91546.

Distribution

Known only from the Indian Ocean off South Africa, from Cape Town to Durban (Von Marenzeller 1904; Gardiner 1904; Cairns 1979), and off south-eastern Mozambique; 155–1 000 m.

Genus *Deltocyathus*

Deltocyathus andamanicus Alcock, 1898

Fig. 5F

Deltocyathus andamanicus Alcock, 1898: 16–17, pl. 1 (fig. 5, 5a). Gardiner & Waugh, 1938: 196. Pillai & Scheer, 1976: 16.
Non *Deltocyathus* sp. cf. *D. andamanicus*: Cairns, 1984: 15, pl. 3 (figs A–B).

New record

Manihine 381–63, 1, USNM 91548.

Remarks

At least eight species of *Deltocyathus* have been reported from the Indian Ocean: *D. andamanicus* Alcock, 1898; *D. rotulus* (Alcock, 1898); *D. murrayi* Gardiner & Waugh, 1938; *D. varians* Gardiner & Waugh, 1938; *D. sarsi* (Gardiner & Waugh, 1938); *D. nascornatus* (Gardiner & Waugh, 1938); *Deltocyathus* sp. sensu von Marenzeller, 1904; and *D. italicus* sensu Zibrowius, 1974*a*. The species *D. minutus* Gardiner & Waugh, 1938, and *D. lens* Alcock, 1902, pertain to the genus *Feponocyathus* (see Cairns 1989*b*: 30). The specimen reported herein, 15,5 mm in calicular diameter, corresponds to the original description and illustrations of Alcock's *D. andamanicus*.

Distribution

Off Zanzibar, Tanzania (Gardiner & Waugh 1938); Gulf of Aden (Gardiner & Waugh 1938); Maldive Islands (Gardiner & Waugh 1938; Pillai & Scheer 1976); Andaman Sea (Alcock 1898); 240–1 463 m.

Deltocyathus rotulus (Alcock, 1898)

Fig. 5I

Trochocyathus rotulus Alcock, 1898: 16, pl. 2 (fig. 1, 1a).
Deltocyathus fragilis Alcock, 1902*a*: 99–100; 1902*c*: 21, pl. 2 (fig. 15, 15a).
Deltocyathus rotulus: van der Horst, 1931: 6. Gardiner & Waugh, 1938: 196.

New records

AB–365C, 9, USNM 91549; AB–389C, 1, USNM 91550. Reference material: Gardiner & Waugh's (1938) *D. rotulus* from JM–119, 2, BM 1950.1.9.1159–1162.

Remarks

We concur with Gardiner & Waugh's (1938) evaluation that *D. fragilis* is a junior synonym of *D. rotulus*, even though the type specimens of each species have a different number of septa: 96 and 72, respectively. Of the approximately 15 valid Recent species in the genus, only one other, *D. magnificus* Moseley, 1876, has five cycles of septa. *Deltocyathus rotulus* is distinguished from *D. magnificus* by having a scalloped calicular edge and in lacking the V-shaped deltoid septal fusions characteristic of the genus.

Distribution

Indian Ocean: off Durban, South Africa; off south-eastern Mozambique; off Zanzibar, Tanzania (Gardiner & Waugh 1938); Gulf of Aden (Gardiner & Waugh 1938); Maldive Islands (Alcock 1898; Gardiner & Waugh 1938); off Sri Lanka (Van der Horst 1931); 510–1 986 m. Elsewhere: Flores Sea; 794 m (Alcock 1902*a*, 1902*c*).

Deltocyathus sp. A

Fig. 5G–H

?Deltocyathus italicus: Zibrowius, 1974*a*: 757.
Deltocyathus lens: Gardiner & Waugh, 1938: 198.

Records

V–2662, 9, IOM; MN–ZV5, 1, USNM 91551.

Remarks

This species is similar to the Miocene *D. italicus* (Michelotti, 1838) and Recent Atlantic specimens described by Cairns (1979) as *Deltocyathus* sp. cf. *D. italicus* [cited by Zibrowius (1980) and Zibrowius & Gili (1990) as *D. conicus* Zibrowius, 1980]. *Deltocyathus italicus* and the south-west Indian Ocean specimens are similar in size and shape, having a highly conical corallum with a pointed base; however, *Deltocyathus* sp. A differs in having granular, rounded costae (not dentate, ridged costae as in *D. italicus*); relatively small P_3 not fused to their corresponding S_3 (in *D. italicus*, P_3

are quite large and solidly fuse to their S_3); and a fossa moderate in depth (the central calice of *D. italicus* is usually elevated, having no fossa). Although not described or illustrated, it is likely that Zibrowius' (1974*a*) 'conical species' from north-west of Madagascar is the same. No other Indian Ocean species of *Deltocyathus* is known to have a conical corallum.

Distribution

Known only from the Indian Ocean off Durban, South Africa; off Zanzibar (Gardiner & Waugh 1938); ?off south-western and north-western Madagascar (Zibrowius 1974*a*); 207–315 m.

Genus *Desmophyllum*

Desmophyllum cristagalli Milne Edwards & Haime, 1848*a*

Desmophyllum cristagalli Milne Edwards & Haime, 1848*a*: 253, pl. 7 (fig. 10, 10a). Zibrowius, 1974*a*: 758–761, pl. 3 (figs 1–10); 1980: 117–121, pl. 61 (figs A–O). Cairns, 1979: 117–119, pl. 21 (figs 7–8), pl. 22 (fig. 8) [synonymy]. Zibrowius & Gili, 1990: 35–36.
Desmophyllum capense Gardiner, 1904: 96–97.
?Desmophyllum sp. Gardiner & Waugh, 1938: 176.
Non *Desmophyllum cristagalli* Milne Edwards & Haime. Boshoff, 1981: 37.

New records

V–2699, 1 IOM; V–2716, 6, IOM; V–2722, 1, IOM.

Distribution

Indian Ocean: off Cape of Good Hope (Gardiner 1904); off Pemba, Tanzania (Gardiner & Waugh 1938); off Walters Shoal, Madagascar Plateau; Gulf of Aden (Gardiner & Waugh 1938); Maldive Islands (Gardiner & Waugh 1938); 81–2 000 m. Elsewhere: cosmopolitan; 60–2 460 m (Cairns 1979).

Genus *Conotrochus*

Conotrochus brunneus (Moseley, 1881)

Fig. 4F–G

Pleurocyathus brunneus Moseley, 1881: 159–160, pl. 2 (fig. 1a–c).
Phloeocyathus hospes: Alcock, 1902*b*: 116–117.
Ceratotrochus (Phloeocyathus) hospes: Alcock, 1902*c*: 12, pl. 2 (fig. 8, 8a).
Conotrochus brunneus: Gardiner & Waugh, 1938: 175–176, pl. 5 (figs 11–12). Zibrowius, 1980: 79. Cairns & Parker, 1992: 22.

New record

AB–365D, 2, USNM 91556.

Distribution

Indian Ocean: off south-west Madagascar; Maldive Islands (Gardiner & Waugh 1938); 475–695 m. Elsewhere: Indonesia (Moseley 1881; Alcock 1902*b*, 1902*c*); 110–1 089 m.

Genus *Aulocyathus*

Aulocyathus recidivus (Dennant, 1906)

Fig. 5C

Ceratotrochus recidivus Dennant, 1906: 159–160, pl. 6 (figs 1a–b, 2a–c). Zibrowius, 1980: 107.
Aulocyathus recidivus: Cairns, 1982: 25–26, pl. 7 (figs 7–9), pl. 8 (fig. 1). Cairns & Parker, 1992: 22–24, pl. 6 (figs d, h) [synonymy].

New record

Unspecified R.V. *Anton Bruun* station 'off Madagascar', depth unknown, 1, USNM 91555.

Remarks

Aulocyathus recidivus is distinguished from *A. juvenescens* by its much larger and stouter corallum and by having a greater number of septa. Three additional species are known in this genus from the eastern Atlantic and western Pacific (see Zibrowius 1980).

Distribution

Indian Ocean: 'off Madagascar'; depth unknown. Elsewhere: off South Australia and Tasmania (Dennant 1906; Cairns & Parker 1992); Macquarie Ridge (Cairns 1982); 128–1 000 m.

Aulocyathus juvenescens von Marenzeller, 1904

Aulocyathus juvenescens von Marenzeller, 1904: 301–302, pl. 18 (fig. 17). Zibrowius, 1980: 107.

New record

Manihine 381–3, 2, USNM 91554. Reference material: syntypes of *A. juvenescens* from *Valdivia*–243 and 245 (ZMB 5064, 7032).

Remarks

The *Manihine* specimens, collected only several kilometres from the type locality (*Valdivia* station 245), are the only specimens to have been reported subsequent to its description in 1904.

Distribution

Known only from the Indian Ocean off Pemba and Zanzibar, Tanzania (Von Marenzeller 1904); 302–463 m.

Genus *Dasmosmilia*

Dasmosmilia variegata (Pourtalès, 1871)

Fig. 6C

Parasmilia variegata Pourtalès, 1871: 21, pl. 1 (fig. 13).
Non *Dasmosmilia variegata*: Gardiner & Waugh, 1938: 172–173.
Dasmosmilia variegata: Cairns, 1979: 134–135, pl. 25 (figs 4–7, 10), pl. 26 (fig. 1) [synonymy]. Zibrowius, 1980: 71–72, pl. 30 (figs A–K) [synonymy].

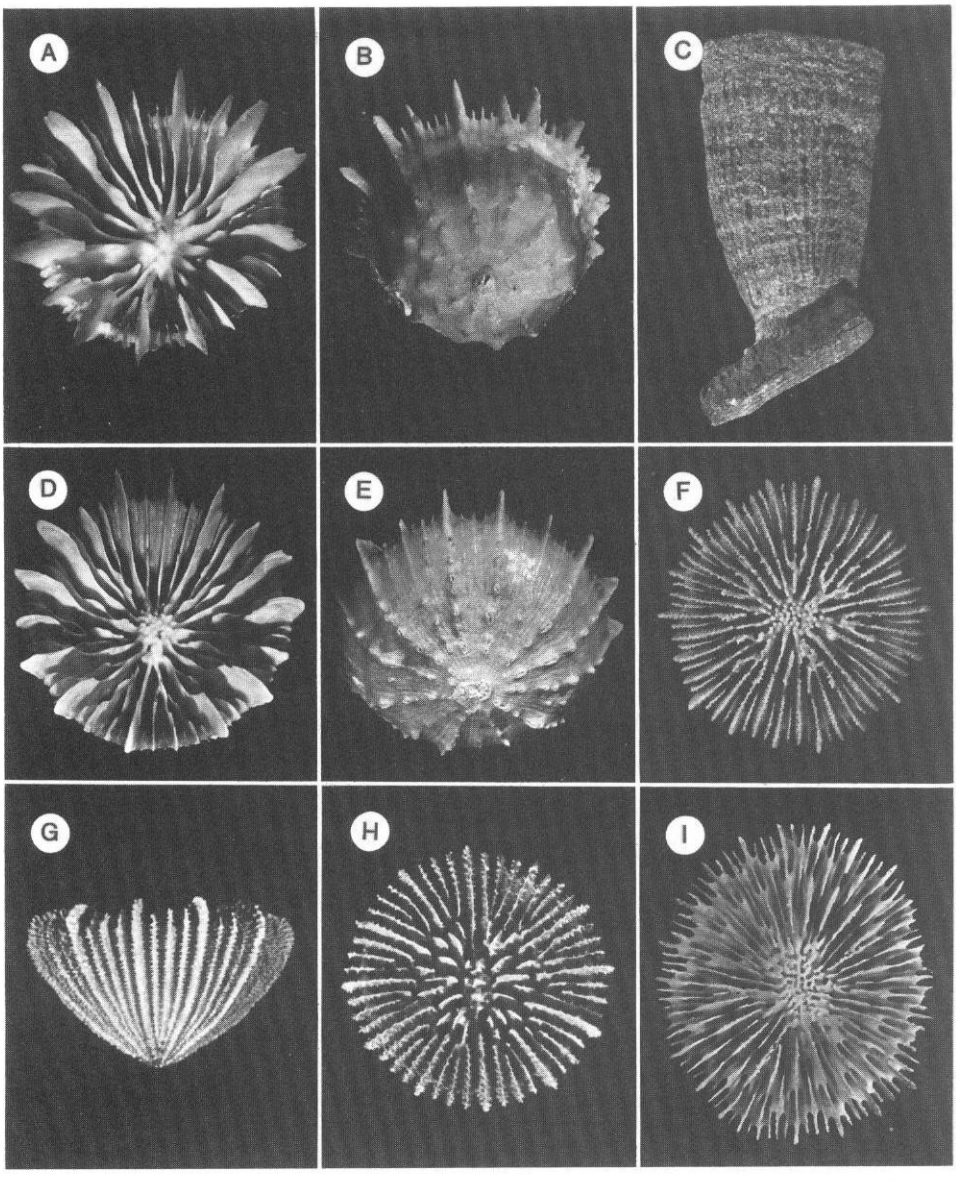

Fig. 5. A–B. *Stephanocyathus campaniformis*, V–2673, IOM, calicular and basal views. Both × 1,7. C. *Aulocyathus recidivus*, *Anton Bruun* station 'off Madagascar', USNM 91555, lateral view. × 2,9. D–E. *Stephanocyathus nobilis*, AB–399C, USNM 91545, calicular and lateral views. Both × 1,5. F. *Deltocyathus andamanicus*, *Manihine* 381–63, USNM 91548, calice. × 2,2. G–H. *Deltocyathus* sp. A, MN–ZV5, USNM 91551, calicular and lateral views. Both × 3,8. I. *Deltocyathus rotulus*, AB–389C, USNM 91550, calice. × 1,5.

New record

V–2644, 1, IOM.

Remarks

The figured specimen, measuring 10,1 × 8,3 mm in calicular diameter and 14,8 mm in height, was compared to specimens from both the western and eastern Atlantic and found to be indistinguishable in most characters, except that the Indian Ocean specimen is firmly attached to a substrate (a cylindrical bryozoan), not asexually regenerated from a parent corallum fragment, as is typical for most other known specimens.

Distribution

Indian Ocean: off south-western Madagascar; 330–335 m. Elsewhere: off Florida, Venezuela, Brazil, Cape Verde Islands, and the Azores; 110–600 m (Cairns 1979; Zibrowius 1980).

Genus *Asterosmilia*

Asterosmilia marchadi (Chevalier, 1966)

Fig. 6A–B

Ceratotrochus johnsoni: Gardiner, 1904: 118–119, pl. 1 (fig. 5a–c), pl. 2 (fig. M). Gardiner & Waugh, 1938: 188.
Dasmosmilia marchadi Chevalier, 1966: 944–949, pl. 5 (figs 3–4).
Asterosmilia marchadi: Cairns, 1979: 140–142, pl. 26 (figs 7, 9–10). Zibrowius, 1980: 141–142, pl. 74 (figs A–K) [synonymy].

New records

V–2634, 1, IOM; AB–372J, 2, USNM 91557; AB–372L, 26, USNM 91559, 1, SAM–H4594; AB–373B, 1, USNM 91560; MN–ZD8, 1, USNM 91561; MN–ZH27, 1, USNM 91562. Reference specimens: *C. johnsoni* of Gardiner & Waugh (1938): JM–106, 2, BM 1950.1.9.1065–1069; JM107, 1, BM 1950.1.9.1284; *C. johnsoni* of Gardiner (1904) from Cape Natal, 1, BM 1950.1.10.118.

Remarks

Zibrowius (1980: 141, 142) noted the extreme resemblance of the Indian Ocean specimens reported by Gardiner (1904) and Gardiner & Waugh (1938) to Atlantic *A. marchadi*, but did not commit to that identification. Comparisons of the south-west Indian Ocean specimens reported herein and Gardiner (1904) and Gardiner & Waugh's (1938) specimens, with typical eastern and western Atlantic specimens of *A. marchadi*, show no significant differences. Therefore, *A. marchadi* is considered to have a disjunct distribution in both the Atlantic and western Indian oceans.

Distribution

Indian Ocean: South Africa off Bisho, Cape Natal (Gardiner 1904), and Zululand; off south-eastern Mozambique; off Pemba, Tanzania (Gardiner & Waugh 1938); off the Maldive Islands (Gardiner & Waugh 1938); 57–229 m. Elsewhere: eastern

Atlantic from Spanish Sahara to Gabon (Zibrowius 1980); western Atlantic from off Florida and the northern coast of South America (Cairns 1979); 79–229 m.

Genus *Solenosmilia*

Solenosmilia variabilis Duncan, 1873

Fig. 6D

Solenosmilia variabilis Duncan, 1873: 328, pl. 42 (figs 11–18). Von Marenzeller, 1904: 310–311, pl. 15 (fig. 4, 4a). Zibrowius, 1974*a*: 768–769; 1980: 143–145, pl. 75 (figs A–N) [synonymy]. Cairns, 1979: 136–138, pl. 26 (figs 2–4) [synonymy]. Scheer & Pillai, 1983: 160. Cairns & Parker, 1992: 29–30, pl. 8 (figs d–e).
Solenosmilia Jeffreyi Alcock, 1898: 27–28, pl. 3 (fig. 3, 3a–b).
Non *Solenosmilia variabilis* Duncan. Gardiner & Waugh, 1939: 229–230.

New records

MN–SM129, 1 branch, USNM 77211; MN–SM162, 2 colonies, USNM 91690; MN–SM226, branch fragments, USNM 91691.

Distribution

Indian Ocean: off South Africa from Agulhas Bank (Von Marenzeller 1904) to off Durban; off Somalia (Von Marenzeller 1904); Laccadive Sea (Alcock 1898); 366–1 079 m. Elsewhere: amphi-Atlantic; South Australia; circum-Subantarctic; 220–2 165 m (Cairns & Parker 1992).

Genus *Goniocorella*

Goniocorella dumosa (Alcock, 1902*c*)

Fig. 6E

Pourtalosmilia dumosa Alcock, 1902*c*: 36–37, pl. 5 (fig. 33, 33a).
Goniocorella dumosa: Cairns, 1982: 31–34, pl. 9 (figs 7–9), pl. 10 (figs 1–2) [synonymy].

New record

MN–SM174, 4 branches, USNM 77221.

Distribution

Indian Ocean: off Bisho, South Africa; 760 m. Elsewhere: off Japan, Banda Sea, and New Zealand region; 100–638 m (Cairns 1982).

Genus *Rhizosmilia*

Rhizosmilia robusta sp. nov.

Fig. 6F–I

Records

Holotype: AB–373B, 1, USNM 91681. Paratypes: AB–371F, 1, USNM 91682; AB–408D, 2 corallites, USNM 91683; MN–ZB23, 1, SAM–H4572; MN–ZC10, 1,

USNM 91684; MN–ZD5, 1, USNM 91685; MN–ZDD3, 3, USNM 91689; MN–ZD7, 2, USNM 91686, 1, SAM–H4573; MN–ZK20, 1, USNM 91687; MN–ZK21, 1, USNM 91688.

Description

Corallites trochoid in shape, firmly attached through a massive pedicel and thin expansive base. Largest corallite of holotypic colony 31,0 × 26,2 mm in calicular diameter, 25,0 mm in height, and 16,8 mm in pedicel diameter. Lower pedicel and base reinforced with concentric rings of hollow chambers formed by adding exothecal dissepiments over raised costae (Fig. 6G), as is characteristic of the genus (Cairns 1978). Calice elliptical in outline, even in small specimens. Costae equal (0,4–0,5 mm wide) and quite low, separated by very narrow (0,10–0,12 mm), shallow intercostal striae. Costae covered with low, rounded granules. Corallum white.

Septa arranged in five cycles according to the formula: $S_1>S_2>S_3>S_4>S_5$, the fourth cycle complete at a GCD of 8–9 mm and the fifth cycle complete at a GCD of 19–21 mm; S_6 not observed even in largest calice of 31 mm diameter. S_1 moderately exsert (up to 2,7 mm above calicular edge), their inner edges vertical and straight, extending to the columella. Septa of higher cycles progressively less exsert and smaller, except for those S_5 adjacent to S_1, which are more exsert than their adjacent S_4. Inner edges of S_2 also straight; inner edges of S_3 and S_4 slightly sinuous; S_5 rudimentary, with irregularly shaped inner edges. Septal faces relatively smooth, bearing very low and sparsely placed granules. Septa well spaced, each separated from one another by approximately twice the septal thickness. Small paliform lobes present deep in fossa before septa of penultimate cycle (P_4, if S_5 present; P_3, if only S_4 present in a half-system) and in such a manner of insertion as described by Cairns (1978) for *R. gerdae*. Paliform lobes sometimes dissected into three or four thin, elongate ribbons, similar in shape to columellar elements, but occurring higher in fossa.

Fossa deep, containing a trabecular columella. Vesicular endothecal dissepiments present, giving corallum a low density.

Remarks

Although the holotype is a phaceloid colony of four corallites, all paratypes are represented as individual corallites, either broken from a larger colony or not yet having formed a colony.

Only two other species of *Rhizosmilia* are known: *R. maculata* (Pourtalès, 1874) and *R. gerdae* Cairns, 1978, both species known only from relatively shallow water (3–287 m) in the western Atlantic. *Rhizosmilia robusta* sp. nov. is most similar to *R. maculata*, especially in corallum size and shape and septal, palar, and costal morphology, but differs in having an entirely white corallum (that of *R. maculata* is speckled brown), and in having fewer septa at a corresponding calicular diameter. *Rhizosmilia robusta* attains its fifth cycle at a GCD of 19–21 mm, whereas *R. maculata* attains its at a GCD of only 11 mm (Cairns 1977) and often has additional S_6 in larger corallites.

A probable fourth species of *Rhizosmilia* was reported as *Caryophyllia gigas* by Van der Horst (1931) from off Mauritius—*Rhizosmilia gigas* comb. nov. Because only

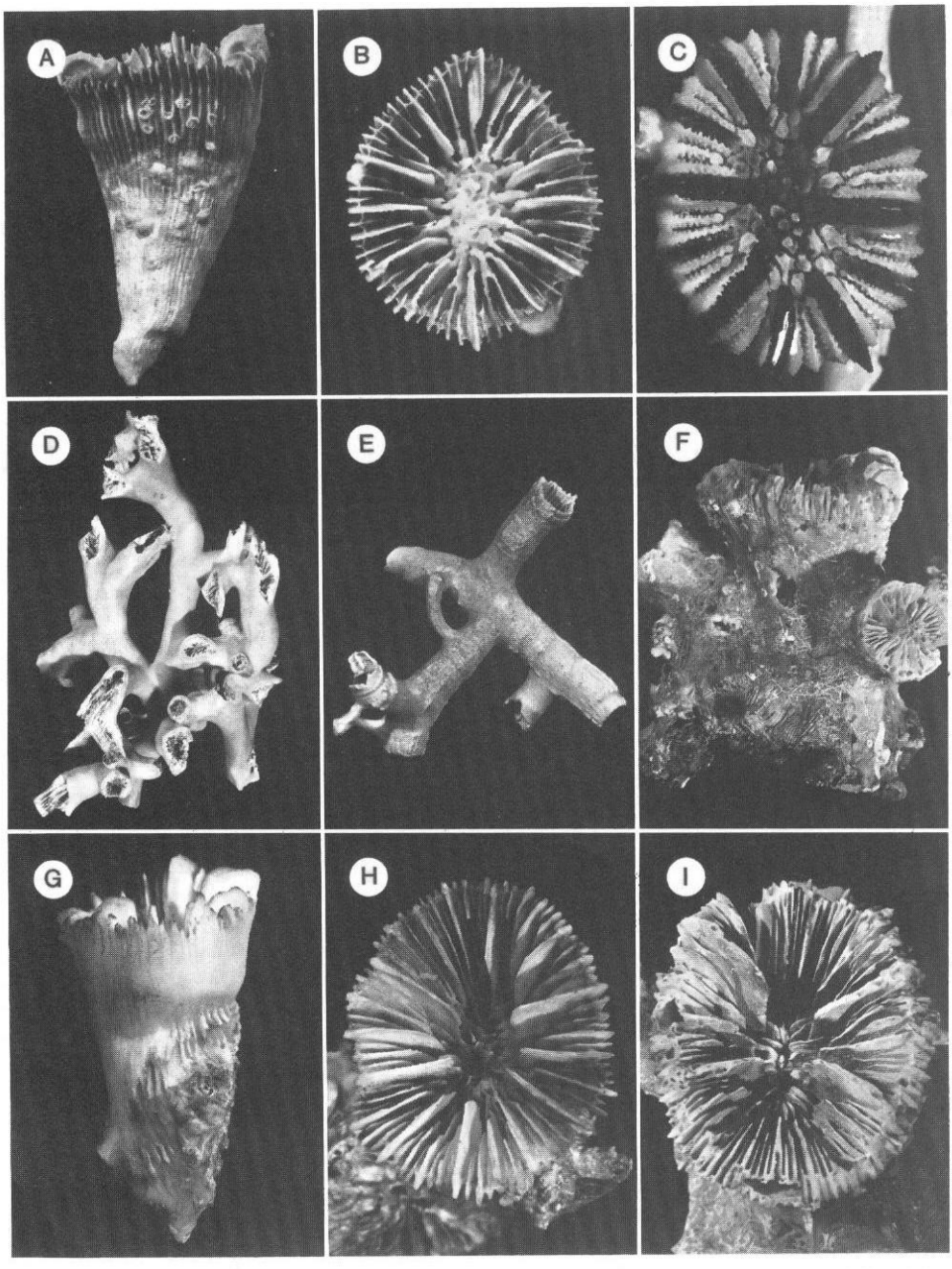

Fig. 6. A–B. *Asterosmilia marchadi*, V–2634, IOM, lateral and calicular views. A × 1,5, B × 2,1. C. *Dasmosmilia variegata*, V–2644, IOM, calice. × 4,7. D. *Solenosmilia variabilis*, MN–SM162, USNM 91690, partial colony. × 0,7. E. *Goniocorella dumosa*, MN–SM174, USNM 77221. × 1,6. F–I. *Rhizosmilia robusta* sp. nov. F, I. AB–373B (holotype), lateral and calicular views. F × 0,9, I × 1,5. G. MN–ZD7, USNM 91686, paratype illustrating exothecal roots. × 2,5. H. MN–ZD5, USNM 91685, calice of a paratype. × 2,2.