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

By

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(With 13 figures and 2 tables)

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ABSTRACT

Seventy-seven species of azooxantellate Scleractinia are reported from collections made by R.V. Anton Bruun, Metring Naude, and Vityaz from deep-water (to 1720 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, Rhizosomella robusta, Sphenotrochus (S.) evexciostatus, S. (S.) imbricaticostatus, Truncatofabellum gardineri, T. zuluense and T. multispinum) and one subspecies (Flabellum (Uloocyathus) japonicum byhios) 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, 300–1300 m, and 1300–2000 m. The potential for using skeletal morphology as an indicator of environmental conditions (i.e. nutrient level) is discussed.

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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.

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<th>Year</th>
<th>Author</th>
<th>Remarks</th>
</tr>
</thead>
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<td>1848</td>
<td>Milne Edwards &amp; Haime</td>
<td>Two species of Tubastrea from off Seychelles.</td>
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<td>Duncan</td>
<td>Culicia natalensis from off Natal, South Africa.</td>
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<td>1902</td>
<td>Gardiner</td>
<td>Two species of Flabellum from South Africa.</td>
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<td>Von Marenzeller</td>
<td>Six deep-water species from Valdivia stations 243–247 off Kenya and Tanzania and other records to north in the Indian Ocean.</td>
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<td>1939</td>
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<td>Javana insignis from off north-west Madagascar.</td>
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<td>1975</td>
<td>Zibrowius, Southward &amp; Day</td>
<td>Polychaete symbionts from three species of Flabellum collected off Natal and Mozambique.</td>
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<td>1976</td>
<td>Keller</td>
<td>Fungiacyathus pseudostephanus from off Seychelles and mid-Indian Ridge.</td>
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<td>1978</td>
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<td>Discussion of two species of Tabauleraea, including records from off Comores and Madagascar.</td>
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<td>1985</td>
<td>Zibrowius</td>
<td>Additional records of Balanophyllia stimpsonii from off Mozambique and Natal, South Africa.</td>
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<tr>
<td>1989a</td>
<td>Cairns</td>
<td>Several records of Flabellum pavoninum off Kenya and Durban, South Africa.</td>
</tr>
<tr>
<td>1989b</td>
<td>Cairns</td>
<td>Eight species of azooxanthellates discussed incidental to review of Philippine fauna, from off Natal, Mozambique, Tanzania, Kenya, and Reunion.</td>
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seen at the Station Marine d’Endoume, Marseille (specimens from Marion Dufresne, Meiring Naude, Galathea, Cruise BENTHEDI on Le Suroît, 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 (1848b) would appear to have reported the first azooxanthellate scleractinians from the tropical south-west Indian Ocean, Coenosamnia ehrenbergiana (= Tubastraea coccinea) and Coenosamnia 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. Mabithiss 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 (1891a, 1891b); Alcock (1893, 1898, 1902c); Bourne (1905); Von Marenzeller (1907a, 1907b); 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
<table>
<thead>
<tr>
<th>Family</th>
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<th>Pacific Ocean</th>
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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 = Equatorial Pacific; 15 = Subantarctic.)
<table>
<thead>
<tr>
<th>Species</th>
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<th>Authors</th>
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<td>(Von Marenzeller, 1888)</td>
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<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Stephanocystus</td>
<td>(Von Marenzeller, 1904)</td>
<td>X X X</td>
<td>155-1000</td>
</tr>
<tr>
<td>Delocystus delicatus</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Delocystus</td>
<td>Marenzeller, 1904</td>
<td>X X X</td>
<td>240-1463</td>
</tr>
<tr>
<td>Delocystus andamanicus</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Delocystus</td>
<td>Alcock, 1898</td>
<td>X X X</td>
<td>510-1986</td>
</tr>
<tr>
<td>Delocystus rutilus</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Delocystus</td>
<td>Alcock, 1898</td>
<td>X X X</td>
<td>207-315</td>
</tr>
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<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Delocystus</td>
<td>81-2000</td>
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<td>Desmophyllum cristagalli</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Desmophyllum</td>
<td>Milne Edwards &amp; Haime, 1848</td>
<td>X X X X X</td>
<td>475-695</td>
</tr>
<tr>
<td>*Conotrochus brunneus</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Conotrochus</td>
<td>Moseley, 1881</td>
<td>X X X X</td>
<td>302-463</td>
</tr>
<tr>
<td>**Aulocystus rectidens</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Aulocystus</td>
<td>Dennant, 1906</td>
<td>X X X</td>
<td>330-335</td>
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<td>Aulocystus juvenescens</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Aulocystus</td>
<td>von Marenzeller, 1904</td>
<td>X X X</td>
<td>57-229</td>
</tr>
<tr>
<td>**Dasmosmilia variegata</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Dasmosmilia</td>
<td>Poutalès, 1871</td>
<td>X X X</td>
<td>366-1079</td>
</tr>
<tr>
<td>Asteroximilla marchadi</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Asteroximilla</td>
<td>Chevalier, 1966</td>
<td>X X X X X</td>
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<td>Solenosmilia variabilis</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Solenosmilia</td>
<td>Duncan, 1873</td>
<td>X X X</td>
<td>450</td>
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<tr>
<td>**Goniocorella dawsoni</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Goniocorella</td>
<td>Alcock, 1902</td>
<td>X X X</td>
<td>66-150</td>
</tr>
<tr>
<td>*Lophotheca pertusa</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Lophotheca</td>
<td>Linnaeus, 1758</td>
<td>X X X</td>
<td>183-366</td>
</tr>
<tr>
<td>*Rhizosmilia robusta</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Rhizosmilia</td>
<td>sp. nov.</td>
<td>X X X</td>
<td>X X X X</td>
</tr>
<tr>
<td>*Rhizosmilia gigas</td>
<td>Caryophyllidae</td>
<td>Caryophylla</td>
<td>Rhizosmilia</td>
<td>Van der Horst, 1931</td>
<td>X X X X</td>
<td>X X X X</td>
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<tr>
<td>Family</td>
<td>Turbinolidae</td>
<td>Flabellidae</td>
<td>Flabellariidae</td>
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<tr>
<td></td>
<td>Atlantic Ocean</td>
<td>South-West Indian Ocean</td>
<td>Indian Ocean</td>
<td>Pacific Ocean</td>
<td>Subantarctic</td>
<td>Depth (m)</td>
</tr>
<tr>
<td>Tropidocyathus lessoni (Michelin, 1842)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropidocyathus nasocomatus Gardiner &amp; Waugh, 1938</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Thrypocoryophyllus miltiobatus Cairns, 1980</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Sphenotrochus (S.) aurantiacus von Marenzeller, 1904</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>*Sphenotrochus (S.) exquisitus sp. nov.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>*Sphenotrochus (S.) imbricaticostatus sp. nov.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>*Sphenotrochus (E.) gilchristi (Gardiner, 1904)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pemonocyathus australensis (Duncan, 1870)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flabellium (U.) apertum Mosley, 1876</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>*Flabellium (U.) japonicum bythos subsp. nov.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>**Flabellium (U.) lowebythos Squires &amp; Ralph, 1965</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**Flabellium (U.) mssum Alcock, 1902</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Flabellium (F.) sibogaense sensu Gardiner, 1904</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flabellium (F.) pavoninum Lessel, 1831</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Truncatoflabellum insinans von Marenzeller, 1904</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Truncatoflabellum sp. cf. T. stable (von Marenzeller, 1904)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>**Truncatoflabellum formosum Cairns, 1989</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>**Truncatoflabellum pusillum Cairns, 1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Truncatoflabellum gardineri sp. nov.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>*Truncatoflabellum zululense sp. nov.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>*Truncatoflabellum multispinosum sp. nov.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Javanica insignis Duncan, 1876</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>**Placotrochides scaphula Alcock, 1902</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guynia annulata Duncan, 1872</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Stenocyathus vermisiformis (Pourtalé, 1868)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Family Dendrophylliidae</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>-------------------------</td>
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<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Balanophyllia stimpsonii (Verrill, 1865)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Balanophyllia ponderosa van der Horst, 1926</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>?</td>
<td>x</td>
</tr>
<tr>
<td>*Balanophyllia diffusa Harrison &amp; Poole, 1909</td>
<td>x</td>
<td>x</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>*Balanophyllia diffusa sensu Gaddert &amp; Waugh, 1939</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>*Balanophyllia gemmula Klunzinger, 1879</td>
<td>x</td>
<td>?</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>2</td>
</tr>
<tr>
<td>*Balanophyllia gemma (Moseley, 1881)</td>
<td>x</td>
<td>1</td>
<td>1</td>
<td>165</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Balanophyllia diademata van der Horst, 1927</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Trochosammia tozoga (van der Horst, 1927)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Endopachs grata Milne Edwards &amp; Haime, 1848</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>*Endopachs philippinensis Milne Edwards &amp; Haime, 1848</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Rhizopsammia minuta** van der Horst, 1922 |
| x | x | x | x | x | x | 3 | 113 |
| Rhizopsammia annae (van der Horst, 1933) | x | x | x | x | x | x | 4A | 0-80 |
| *Rhizopsammia compacta* Sheppard & Sheppard, 1991 | x | x | x | x | x | x | 2 | 35-110 |
| *Dendrophylla sp. cf. D. horstii* Gardiner & Waugh, 1939 | x | x | x | x | x | x | 1 | 50-113 |
| Dendrophylla dilatata van der Horst, 1927 | x | x | x | x | x | x | 1 | 97-132 |
| Dendrophylla clavata van der Horst, 1927 | x | x | x | x | x | x | 1 | 49-457 |
| *Dendrophylla cornigera* (Lamarck, 1816) | x | x | x | x | x | x | 2 | 37-183 |
| Dendrophylla gadiata (Duncan 1873) | x | x | x | x | x | x | 6 | 65-480 |
| *Dendrophylla jemai* Yabe & Eguchi, 1934 | x | x | x | x | x | x | 3 | 62-223 |
| Dendrophylla fissa (Alcock, 1902) | x | x | x | x | x | x | 4 | 210-900 |
| Enalopsammia rostra (Pouwells, 1878) | x | x | x | x | x | x | 6 | 229-805 |
| Tubastraea micrantha (Ehrenberg, 1834) | x | x | x | x | x | x | 3 | 0-55 |
| Tubastraea coccinea (Lesson, 1829) | x | x | x | x | x | x | 6 | reef |
| *Tubastraea diaphana* (Dana, 1846) | x | x | 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 Lof (1979)
3 As reported by van der Horst (1931)
4 As reported by Gardiner (1940)
5 Includes Caryophyllia sepolica Gardiner & Waugh (1938) and Caryophyllia sp. of Zibrowius (1940)
6 Based on Caryophyllia cincta (van der Horst, 1931)
7 As reported by Gardiner (1940); subsequently identified as a Trochosammia species by Zibrowius (1982)
8 As reported by van der Horst (1931) and Rosen (1979)
9 As reported by Best, Faure & Pickering (1980)
10 This species is clearly a parasitic species, not a Caryophyllia
11 As reported by Zibrowius (1980)
12 Not a junior synonym of Desmophyllium alabstrum as suggested by Gardiner (1940); 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 & Sheer 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 1989b); 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, 300–1300 m and 1300–2000 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 Dendrophyllidae (21 species) and Caryophyllidae (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 Anthemiphyllidae—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 Anthemiphylidae 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, Damosmilia variegata, Rhizosmilia robusta sp. nov., Javania insignis, Flabellum pavoninum, Truncatoflabellum multispinosum sp. nov., T. inconstans, and numerous dendrophyllids.

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. corniformis, Sphenotrochus evexicostatus sp. nov., S. gilchristi, S. aurantiacus, S. imbricaticostatus sp. nov., Peponocyathus australiensis, Aulocyathus juvenescens and Guyenia annulata. These species belong to three families—Caryophylliidae, Turbinoliidae and Guynidae—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 (Fungiacythidae, 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. Fungiacythidae is represented by three species of Fungiacythus: F. paliferus, F. stephanus and F. sibogae; Caryophylliidae by two species of Deltocythus: D. andamanicus and D. rotulus; and Micrabaciidae by Letespsammia 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 morphi-
logy consists of a flattened discoidal growth form, a widely open calice with a deep fossa, highly exert 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 exert, 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. apertura* (863–1 400 m) and *F. japonicum bythis* 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 exert 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 exert 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 exert septa and scalloped margins and also flattened forms, it is not significant. However, if most or all of the species have highly exert 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 Naudé 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 Naudé, and some of the Vityaz specimens are deposited at the National Museum of Natural History, Washington, D.C. (NMMNH), 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 1902a, 1902b); 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
the following countries: north-eastern South Africa, Mozambique, Tanzania (including Pemba and Zanzibar), Kenya and Madagascar; the following islands: Comores, Seychelles, Mauritius, Reunion and Rodrigues; and the following submarine features: Madagascar and Mascarene plateaus, Walters Shoal and Saya de Malha Bank.

Species synonymsies are complete for records within the Indian Ocean, although additional citations are often given that provide more complete synonymsies, 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., C., P. 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 Tubastrea), 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, 1907b, 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, 1902a)
Bathyactis sibogae Alcock, 1902a: 108; 1902c: 38 [part. — lectotype from Siboga—208].

Bathyactis stabilis Gardiner & Waugh, 1939: 231–232, text-figs 1–2 [syn. nov.].
Fungiacyathus (Bathyactis) sibogae: Cairns, 1989b: 10–11, pl. 3 (figs d–k), pl. 4 (figs a–c) [synonymy].

New records


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 (1989b) 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 diameter.

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 1989b). *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).

*Fungiacyathus (F.) stephanus*: Cairns, 1989b: 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 1989b).

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

*Bathyactis palifera* Alcock, 1902a: 108; 1902c: 38, pl. 5 (fig. 34, 34a).
*Fungiacyathus* sp. Zibrowius & Grygier, 1985: 120 (figs 8–9).

*Fungiacyathus (F.) paliferus*: Cairns, 1989b: 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 1989b).

**Family Micrabacidae**

**Genus Letepsammia**

**Letepsammia formosissima** (Moseley, 1876)

*Fig. 3D*


*Letepsammia formosissima*: Owens, 1986: 487. Cairns, 1989b: 15–18, pl. 6 (fig. j), pl. 7 (figs g–i), pl. 8 (figs a–d) [synonymy and distribution].

*Stephanophylla*: Williams, 1966, upper left colour photo.
New records


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 (1989b: 16). This 'species' differs from typical L. formosisima 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 infraspecific 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 1989b).

Genus Stephanophyllia

Stephanophyllia fungulus Alcock, 1902b


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 (1989b, pl. 10h) from off Natal.

Distribution

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

Stephanophyllia complicata Moseley, 1876

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

Culicia tenella var. natalensis Duncan, 1876: 439–440, pl. 40 (fig. 3).

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, 1974a: 762–766, pl. 2 (figs 3–5); 1980: 36–40, pl. 13 (figs A–P) [synonym]. Cairns, 1979: 39–42, pl. 3 (fig. 2), pl. 4 (fig. 5), pl. 5 (figs 1–3) [synonym].

Amphithelia (Diplohelia) moresbyi Alcock, 1898: 25–26 [fide Zibrowius, 1974a].
Amphithelia oculata: von Marenzeller, 1904: 308–310, pl. 14 (fig. 1).


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 1974a); 732–1 270 m. Elsewhere: cosmopolitan; 80–1 500 m (Cairns 1979).

Family Anthemiphylliidae
Genus Anthemiphyllia

Anthemiphyllia dentata (Alcock, 1902a)

Fig. 3E

?Discotrechus investigatoris Alcock, 1893: 142, pl. 5 (fig. 5, 5a).
Anthemiphyllia dentata: Cairns & Parker, 1992: 16–17, pl. 4 (figs e–f) [synonym].

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 Caryophyllina

Family Caryophylliidae

Genus Caryophyllia

Caryophyllia ambrosia ambrosia Alcock, 1898

Fig. 3H

Caryophyllia ambrosia Alcock, 1898: 12, pl. 1 (fig. 1, 1a). Zibrowius, 1980: 63–65, pl. 25 (figs A–K) [synonomy].
Caryophyllia ambrosia ambrosia: Cairns, 1979: 59.

New records


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, 9f)].

New records


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, 1902a


**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

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 1974a); 80–755 m. Elsewhere: circum-Subantarctic; 35–1 116 m (Cairns 1982).

*Caryophyllia rugosa* Moseley, 1881

Fig. 31

*Caryophyllia rugosa* Moseley, 1881: 141–143, pl. 1 (fig. 1). Cairns, 1984: 11–13, pl. 2 (figs A–B), pl. 4 (fig. 1) [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 Maldives 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\textsubscript{1} and C\textsubscript{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\textsubscript{1} > S\textsubscript{2} > S\textsubscript{3} > S\textsubscript{4}. S\textsubscript{1} moderately exsert (2–2.5 mm), with slightly sinuous inner edges that reach about three-quarters distance to columella. S\textsubscript{2} slightly less exsert and equally sinuous, extending about two-thirds distance to columella. S\textsubscript{3} least exsert and smallest septa, extending only about half distance to columella. S\textsubscript{4} twice as exsert and slightly wider than S\textsubscript{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\textsubscript{3} form a deeply recessed palar crown, each palus about 1.2 mm wide, highly sinuous, and separated from its respective S\textsubscript{3} by a deep and
narrow notch. Each couple of P₃ 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 S₄ larger than the S₃, 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, 1902a. Caryophyllia elongata is distinguished from these species by having S₁ larger than S₂ (S₁ and S₂ 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].


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, 1902b). 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.
Genus *Trochocyathus*

*Trochocyathus rhombocolumna* Alcock, 1902c

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

**New records**


**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 S₄ slightly wider that the S₃, but those S₄ adjacent to S₁ are wider than those adjacent to S₂ (about equal in width as an S₂).

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 1902c); 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 ceroidal 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: S₁ and S₄ > S₂ and S₃. All septa have straight, vertical inner edges, except the S₃, which are sinuous. Pali occur before the highest three cycles, the P₂ and P₃ about the same size, the P₁ 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 columnellar elements and having 48 septa, but differs in having: P₁ recessed from the columnella, forming chevrons with the P₂; longitudinal (not transverse) costae; less crowded septa; brown theca; and equally wide S₁ and S₂.

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 S₃. 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].

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 (figs 3a–b).
*Stephanotrochus nitens* Alcock in Wood-Mason & Alcock, 1891a: 7–8. Alcock, 1898: 18–19, pl. 2 (fig. 6a); 1902d, text-fig. 92.
*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, 1891a (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, 1902a, 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 1891a; Alcock 1894); Maldive Islands (Gardiner & Waugh 1938; Pillai & Sheer 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

*Stephanocyathus campaniformis* von Marenzeller, 1904: 302–304, pl. 18 (fig. 20, 20a).

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)

*Odontocyathus spiniger*: Eguchi, 1968: C39–C40, pl. C20 (figs 12–14), pl. C23 (figs 1–2) [synonymy].


*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).


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 (S₁ = S₂, whereas S₁ of *S. spiniger* are much larger than S₂); 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)
*Ceratoirochus 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 & Gill, 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
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, 1974a. The species *D. minutus* Gardiner & Waugh, 1938, and *D. lens* Alcock, 1902, pertain to the genus *Peponocyathus* (see Cairns 1989b: 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. 51

Trochocyathus rotulus Alcock, 1898: 16, pl. 2 (fig. 1, 1a).
Deltocyathus fragilis Alcock, 1902a: 99–100; 1902c: 21, pl. 2 (fig. 15, 15a).

New records


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 1902a, 1902c).

Deltocyathus sp. A

Fig. 5G–H


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 P₃ not fused to their corresponding S₃ (in D. italicus, P₃
are quite large and solidly fuse to their Ss); 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' (1974a) '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 1974a); 207–315 m.

**Genus Desmophyllum**

*Desmophyllum cristagalli* Milne Edwards & Haime, 1848a

*Desmophyllum cristagalli* Milne Edwards & Haime, 1848a: 253, pl. 7 (fig. 10, 10a), Zibrowius, 1974a: 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* sp. Gardiner & Waugh, 1938: 176.


**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).


*Ceratotrechus (Phloeocyathus) hospes* Alcock, 1902c: 12, pl. 2 (fig. 8, 8a).


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 1902b, 1902c); 110–1 089 m.
Genus *Aulocyathus*

*Aulocyathus recidivus* (Dennant, 1906)

Fig. 5C


*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


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* (Pourelas, 1871)

Fig. 6C

*Parasmilia variegata* Pourelas, 1871: 21, pl. 1 (fig. 13).


*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.
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.


New records


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 Zulu-land; 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 Jeffreyi* Alcock, 1898: 27–28, pl. 3 (fig. 3, 3a–b).


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, 1902c)

Fig. 6E

*Pourotosmilia dumosa* Alcock, 1902c: 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-ZD3, 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 disseipements 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: S₁ > S₂ > S₃ > S₄ > S₅, the fourth cycle complete at a GCD of 8–9 mm and the fifth cycle complete at a GCD of 19–21 mm; S₅ not observed even in largest calice of 31 mm diameter. S₁ 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 S₃ adjacent to S₁, which are more exsert than their adjacent S₁. Inner edges of S₂ also straight; inner edges of S₃ and S₄ slightly sinuous; S₅ 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 (P₄, if S₅ present; P₃, if only S₄ present in a half-system) and in such a manner of insertion as described by Cairns (1978) for R. gerdæ. 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. Vescicular endothecal disseipements 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 (Pourtales, 1874) and R. gerdæ 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 S₅ 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 x 1.5, B x 2.1.
C. Dasmosmilia variegata, V-2644, IOM, calice. x 4.7. D. Solenosmilia variabilis, MN-SM162,
USNM 91690, partial colony. x 0.7. E. Goniocorella dumosa, MN-SM174, USNM 77221. x 1.6.
F-I. Rhizosmilia robusta sp. nov. F, I. AB-373B (holotype), lateral and calicular views. F x 0.9,
I x 1.5. G. MN-ZD7, USNM 91686, paratype illustrating exothecal roots. x 2.5. H. MN-ZD5,
USNM 91685, calice of a paratype. x 2.2.