Zootaxa 3963 (2): 160–200
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3963.2.2
http://zoobank.org/urn:lsid:zoobank.org:pub:86A305B7-2B9C-403E-8FC0-3420EFB13F52

Digitate and capitate soft corals (Cnidaria: Octocorallia: Alcyoniidae) from Western Australia with reports on new species and new Australian geographical records

MONIKA BRYCE[1, 4,5], ANGELO POLISENO[2], PHILIP ALDERSLADE[3] & SERGIO VARGAS[2]

[1]*Western Australian Museum, Locked Bag 49, Welshpool DC, Perth, Western Australia 6986, Australia. E-mail: Monika.bryce@museum.wa.gov.au*
[2]*Department of Earth & Environmental Sciences, Paleontology & Geobiology Ludwig-Maximilians-University Munich, Richard-Wagner Strasse 10, 80333 Munich,Germany.*
[3]*CSIRO Marine and Atmospheric Research, GPO Box 1538, Hobart, Tasmania 7001. E-mail: phil.alderslade@csiro.au*
[4]*Queensland Museum, PO Box 3300, South Brisbane BC, Queensland 4101, Australia.*
[5]*Corresponding author*

Table of contents

Abstract

We report on digitate and capitate Octocorallia within the genera *Parasphaerasclera* McFadden & Ofwegen, 2013, *Eleutherobia* Pütter, 1900, *Sphaerasclera* McFadden & Ofwegen, 2013, and *Paraminabea* Williams & Alderslade, 1999 from tropical Western Australian waters. Three new species (*Parasphaerasclera kimberleyensis*, *Eleutherobia australiensis*, *Eleutherobia imaharai*) are described, with a discussion of their taxonomic placement in the light of a recent treatment of the genus *Eleutherobia* and related taxa by McFadden & Ofwegen (2013). In addition, range extensions for three species are reported, *Parasphaerasclera grayi* (Thomson & Dean, 1931) known from Indonesia and the Pacific Ocean, *Eleutherobia somaliensis* Verseveldt & Bayer, 1988 from Somalia, and *Eleutherobia splendens* (Thomson & Dean, 1931) recorded from Indonesia and the Philippines. Additionally, one new Australian geographical record *(Sphaerasclera flammicerebra)* (Williams, 2003) with a known distribution from Palau to Mauritius, has been included. We complement mor-

 Accepted by E. Pante: 2 Apr. 2015; published: 26 May 2015

phological taxonomy with molecular data (*mtMutS*, 28S rDNA) to analyse and clarify phylogenetic placement of these species. The mitochondrial *mtMutS* phylogeny supported *Eleutherobia*, *Paraminabea*, *Parasphaerasclera* and *Sphaerasclera* as distinct monophyletic genera. Phylogenetic analyses based on 28S rDNA lacked resolution and were largely unresolved. Additionally, the molecular data corroborated our proposed morphological hypothesis of the placement of the new species *P. kimberleyensis* **sp. nov.** with no anthocodial armature in the genus *Parasphaerasclera*, and the assignment of the new species, *E. australiensis* **sp. nov.** and *E. imaharai* **sp. nov.**, with distinct polyps sclerites in the genus *Eleutherobia*.

Key words: *Eleutherobia*, *Paraminabea,* Parasphaerascleridae, *Parasphaerasclera, Sphaerasclera*, Kimberley, Indian Ocean

Introduction

The tropical marine environment of Western Australia extends northwards from the Tropic of Capricorn at 23.44° S and encompasses several marine bioregions, which reflect the region's diverse macro-scale habitat structure. The soft coral fauna of this large area, while largely unknown, is represented in many of the region's habitats, including inlets, estuaries, coastal and off-shore reefs and islands. Deep water soft coral communities are even less well known having received little collecting effort. Since 2009 the Western Australian Museum has been undertaking comprehensive biodiversity surveys off the Kimberley coast, in the state's far north (Bryce & Sampey 2014). Examination of soft coral species from these recent collections, paired with historical material from the Western Australian Museum's collection, has provided a base-line dataset on soft coral species occurrence and community composition.

In this account we focus on small, digitate and capitate species of the genera *Eleutherobia, Parasphaerasclera, Sphaerasclera* and *Paraminabea*; genera that are often represented by one or few species (*Eleutherobia* 11, *Parasphaerasclera* 6, *Sphaerasclera* 1, *Paraminabea* 10), and often have very narrow geographic distributions (Table 1; McFadden & Ofwegen 2013). To date only three relevant species have been recorded from Australian waters; *Eleutherobia rubra* (Brundin, 1896) was described from the north west coast of the continent (Verseveldt & Bayer 1988), *Parasphaerasclera zanahoria* (Williams, 2000) was more recently recorded from the north east coast on the Great Barrier Reef by one of us (Alderslade, unpublished) and *Paraminabea aldersladei* Williams, 1992 from the north east and north west coasts of Australia (Williams 1992; Williams & Alderslade 1999). More than half of the described species of these genera were collected during two expeditions, the *Siboga* Indonesia Expedition in 1899 (Thomson & Dean 1931); and the German deep-sea expedition in 1906 (Kükenthal 1906a). Considering the limited survey effort in remote areas in comparison to more readily accessible areas it is hypothesized that the number of recorded deep-water species will increase with further collecting effort. The same holds true for the small species found in shallower habitats, which have adapted to a cryptic lifestyle preferring low light areas, such as overhangs and caves (Williams & Alderslade 1999; Williams 2000, 2001, 2003). Sampling in these rather inaccessible, high energy areas, in combination with the small colony size and apparent low abundance, makes them difficult to find. This present contribution describes three new species of soft coral within the genera *Parasphaerasclera* and *Eleutherobia*. The species, *P. kimberleyensis* **sp. nov.** was collected under an overhang at Long Reef, north Kimberley. *E. australiensis* **sp. nov.** was collected from deep-water off the Dampier Archipelago and *E. imaharai* **sp. nov.** off North West Cape, which is in the Pilbara region of Western Australia. Further, we report on range extensions of a number of species of *Eleutherobia, Parasphaerasclera, Sphaerasclera* and *Paraminabea*, and discuss the taxonomic placement of all included species which we establish using an integrative taxonomic approach (see Dayrat, 2005; Will *et al.* 2005; McFadden *et al.* 2014), combining morphological examinations with molecular phylogenetic analyses derived from two independent markers (i.e. *mtMutS* and 28S rDNA).

Abbreviations

WAM	Western Australian Museum, Locked Bag 49, Welshpool DC, WA 6986, Australia.
QM	Queensland Museum.
AIMS	The Australian Institute of Marine Science.

CSIRO The Commonwealth Scientific and Industrial Research Organization.
ZMB Museum für Naturkunde, Berlin.

Material and methods

Material was collected by SCUBA off the Kimberley region in Western Australia (Fig. 1). Upon collection, specimens were photographed and preserved in 70 % ethanol prior to further examination. Historical trawled material from the WAM collection was also examined. Sclerites were prepared for both light and scanning electron microscopy (SEM) by cutting small pieces of the specimen from five different regions (polyps, surface of the polyp region, surface of the base, interior of the polyp region, interior of the base) and dissolving them in sodium hypochlorite (13 % available chlorine). After the organic material had dissolved, the loose sclerites were rinsed with water and dried on a glass slide for further investigation. Durcupan ACM was used as mounting media for permanent slides (Fabricius & Alderslade 2001: 40). Twenty-five sclerites were measured per sclerite type. SEM images were taken using a Hitachi TM-1000. Images of the specimens were made using an Olympus SZ-CTV dissecting microscope with TSview software (TUCSEN) and a NIKON D 300 camera. Type material has been registered and deposited in the Western Australian Museum, Perth.

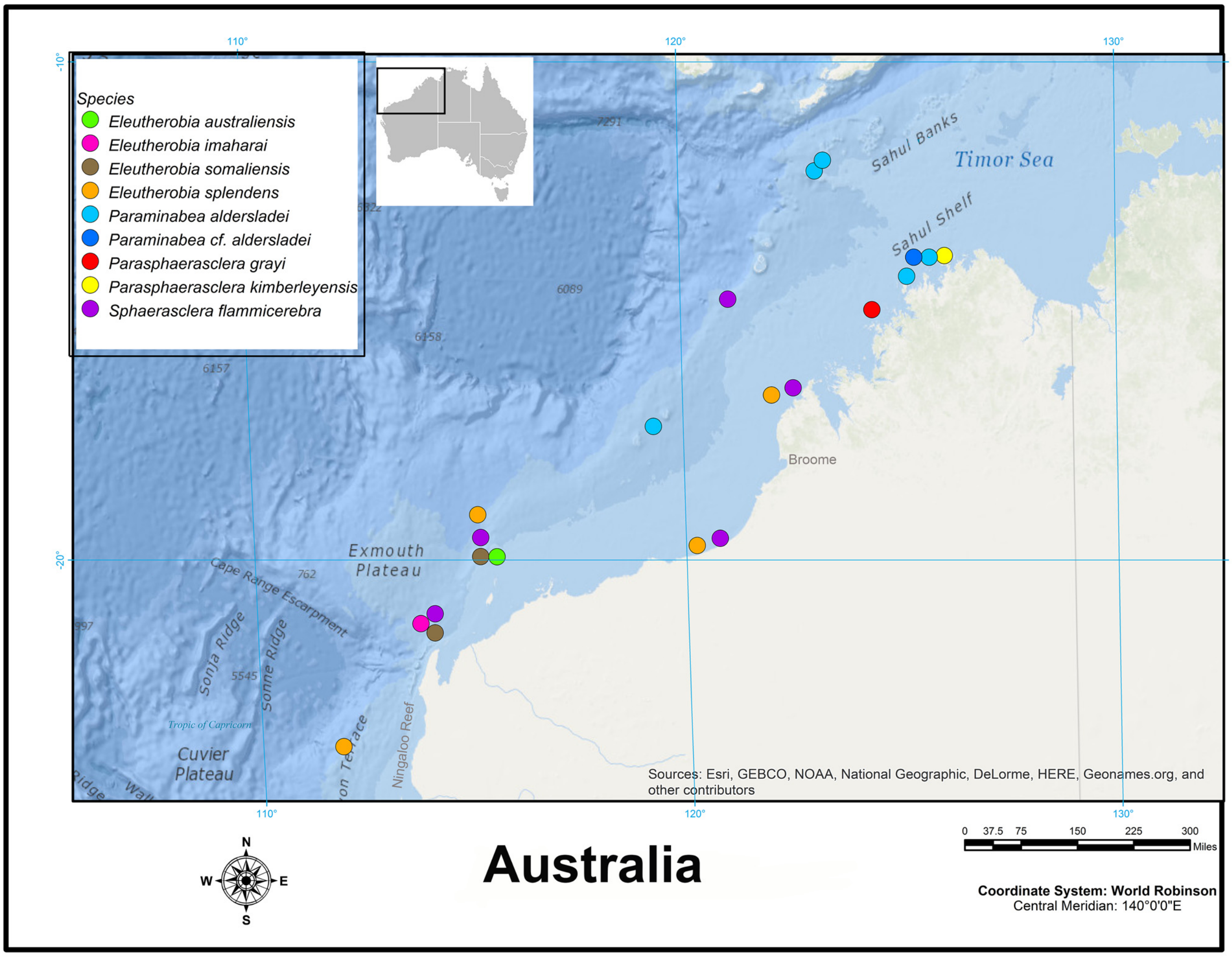

FIGURE 1. Location of the Kimberly region and collection sites.

DNA extraction of ethanol-preserved specimens was done using Macherey-Nagel NucleoSpin® Tissue kit (M&N, Duren, Germany). DNA quality was examined on a 1.5 % agarose gel and the quantity (ng/µL) was measured on a Nanodrop 1000. The 5' end of the mitochondrial gene *mtMutS* and a partial fragment of the 28S nuclear ribosomal gene were amplified according to McFadden *et al.* (2011) and McFadden & Ofwegen (2012) or internal primers were used to amplify smaller, overlapping fragments spanning the region of interest in both genes. For *mtMutS*, we used the following internal primers: MSH-met1F (5'-ATGAGCCARATACCTATGC-3'), MSH3010F (5'-GGATAAAGGTTGGACTATTATAG-3'; (Thoma *et al.* 2009) and MSH3101R (5'-GATATCACATAAGATAATTCCG-3'; Sanchez *et al.* 2003). PCR programs used were adapted from previous protocols published elsewhere (Sanchez *et al.* 2003; McFadden *et al.* 2004; Brugler & France 2008; Vargas *et al.* 2014). PCR products were purified by precipitation, adding one volume of 20 % (w/v) polyethylene glycol 8000 in 2.5molL^{-1} NaCl and sequenced in both directions using the same primers used for PCR. Sequences were deposited at the European Nucleotide Archive under accession numbers HG970065-970091. DNA sequences were aligned against other octocoral sequences available in GenBank using MUSCLE (Edgar, 2004) with default options in GENEIOUS 6.0.5 (Drummond *et al*. 2012). The programs RAxML 7.2.8 (Stamatakis, 2006) and MrBayes 3.1.2 (Ronquist & Huelsenbeck 2003) were used to infer Maximum Likelihood (ML) and Bayesian phylogenetic trees, respectively. For ML analyses we use GTRGAMMA model with bootstrap analyses including 1000 pseudo-replicates, the support values were obtained with the rapid bootstrap algorithm (Stamatakis, 2008). Rate variation was modeled using a discrete gamma distribution with 4 categories (Yang, 1994). For the Bayesian, the best-fit model was selected using the Akaike Information Criterion (AIC) implemented in jModeltest 2.1.3 (Darriba *et al.* 2012). The analyses ran for 10,000,000 generations under the best fitted model (i.e. GTR + I + G) with a sample frequency of 500 and the first 25 % of sampled trees were discarded as burn-in. Convergence between the runs (stationarity of parameters) was assessed using the standard deviation of the split frequencies. We assumed convergence was achieved when this value reached 0.01. The 28S tree was re-rooted considering the stoloniferans *Cornularia pabloi* and *Cornularia cornucopiae* as outgroups. Due to the lack of *mtMutS* sequences for *C. cornucopiae,* the mitochondrial tree was re-rooted using *C. pabloi* as the only outgroup. All the nodes with bootstrap values < 70 % and a posterior probability < 0.95 were collapsed into polytomies using TreeGraph 2.3.0-425 beta (Stöwer & Müller 2010).

Results

Systematics

Family Parasphaerascleridae McFadden & Ofwegen, 2013

Diagnosis. Soft corals with a digitiform, digitate or lobate growth form. Usually with a bare stalk, which can be indistinct. Polyps monomorphic, retractile, producing small, coenenchymal mounds when retracted. Permanent calyces absent. Sclerites of colony surface and interior predominantly radiates and/or tuberculate spheroids, occasionally along with rodlets and crosses. Sclerites permanently coloured. Polyp sclerites absent. Azooxanthellate. (adapted from McFadden & Ofwegen 2013).

Genus *Parasphaerasclera* McFadden & Ofwegen, 2013

Type species. *Alcyonium rotiferum* Thomson, 1910 by original designation.

Diagnosis. As for the family.

Parasphaerasclera grayi (Thomson & Dean, 1931) new record

(Figs. 2A,B, 3, 4; Tabs. 1, 2)

Nidalia grayi Thomson & Dean, 1931: 37, Pl. 2, Fig. 2.
Eleutherobia grayi Verseveldt & Bayer 1988: 33–34, Figs. 24, 25; Williams 2001: 210–216, Figs. 1–10. Benayahu *et al.* 2004: 550 (recorded only); Dautova & Savinkin 2009: 4–10, Figs. 3–7.
Parasphaerasclera grayi McFadden & Ofwegen 2013: 70, 71, 78.

Material examined. WAM Z54774, six whole specimens, Station 69/K11, unnamed outcrop NW Black Rocks, close to White Island, NW Australia, 14.9741° S, 124.3974° E, SCUBA, depth 12 m, coll. M. Bryce, 17 October 2011.

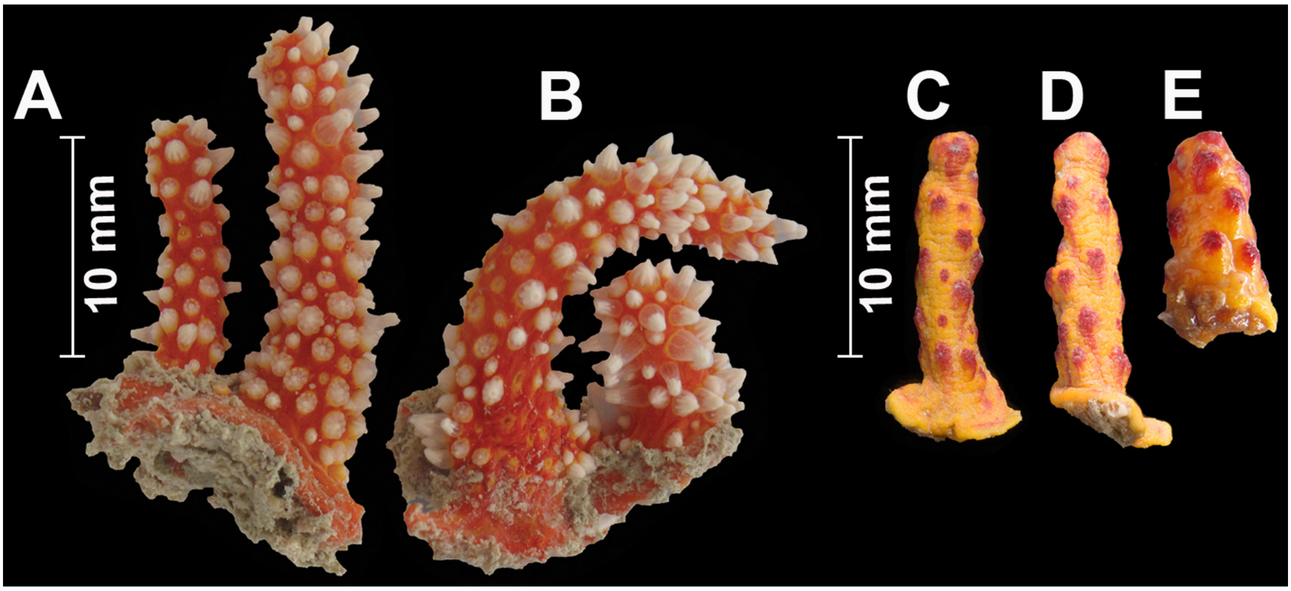

FIGURE 2. A, B, *Parasphaerasclera grayi* WAM Z54774*;* C–E *Parasphaerasclera kimberleyensis* **sp. nov.** C, D, holotype WAM Z59789; E, paratype WAM Z67195.

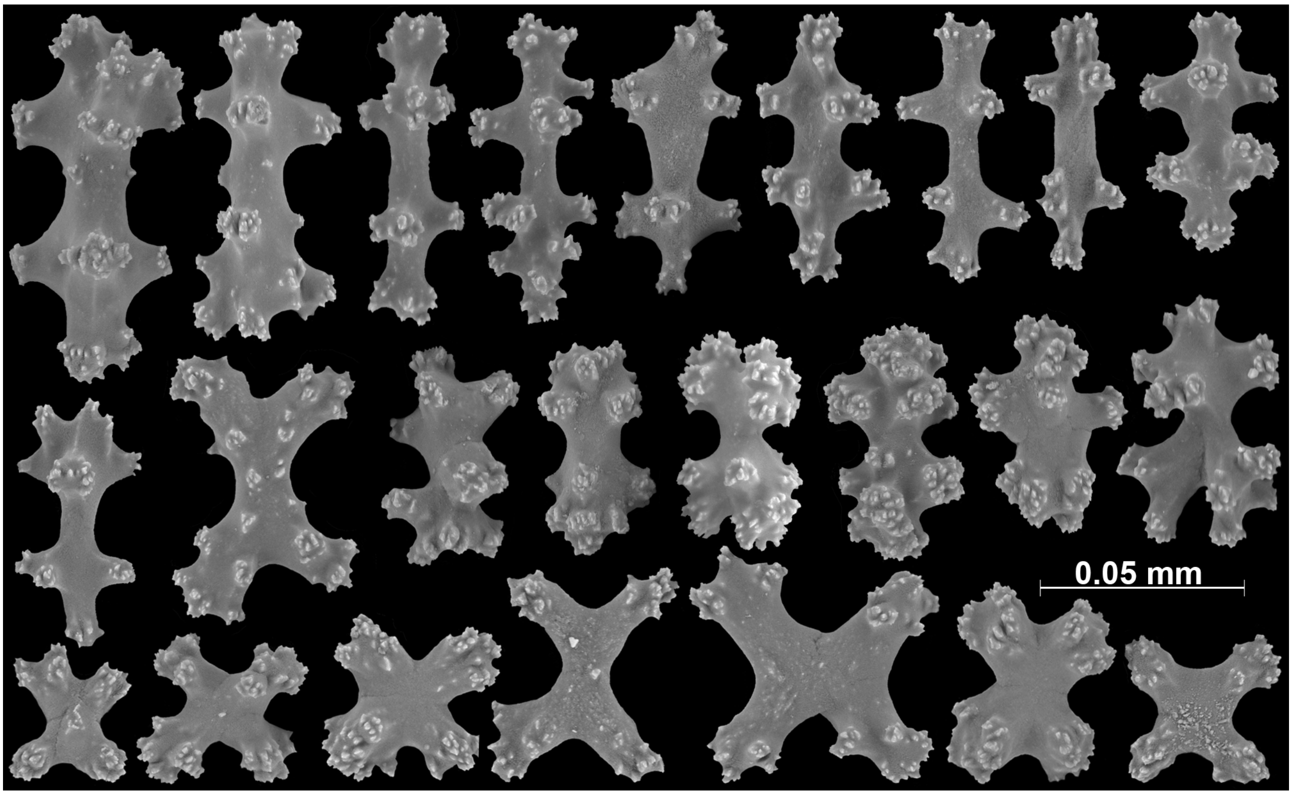

FIGURE 3. *Parasphaerasclera grayi,* WAM Z54774, sclerites from the surface of the polyparium.

Description. In total six upright, unbranched colonies were collected. They are digitiform, symmetrical with a wide base tapering distally towards the rounded apex of the polyparium (Fig. 2A,B) and were always growing in pairs, arising from a common, polyp-free, one mm thick, encrusting holdfast. The colonies vary in size, but are in general very similar in shape, colour, arrangement of polyps and sclerite composition. The polyp-free basal portion of each colony is very short and occupies only 10 % of the total colony length. Polyps are monomorphic, large, retractile, quite numerous, evenly distributed over the colony and are translucent when fully extended and the coenenchymal mounds associated with the polyps are narrow. Pair one consists of one colony that is 31 mm in total length, with an apex 4 mm in diameter and a base 10 mm in diameter, together with a smaller colony that is 5 mm in total length with an apex 4 mm in diameter and a base 9 mm in diameter. Pair two consists of one colony that is 25 mm in total length, with an apex 5 mm in diameter and a base 10 mm in diameter, together with a smaller colony that is 13 mm in total length with an apex 3 mm in diameter and a base 6 mm in diameter. Pair three consists of one colony that is 19 mm in total length, with an apex 5 mm in diameter and a base 8 mm in diameter, together with a smaller colony that is 9 mm in total length with an apex 5 mm in diameter and a base 7 mm in diameter.

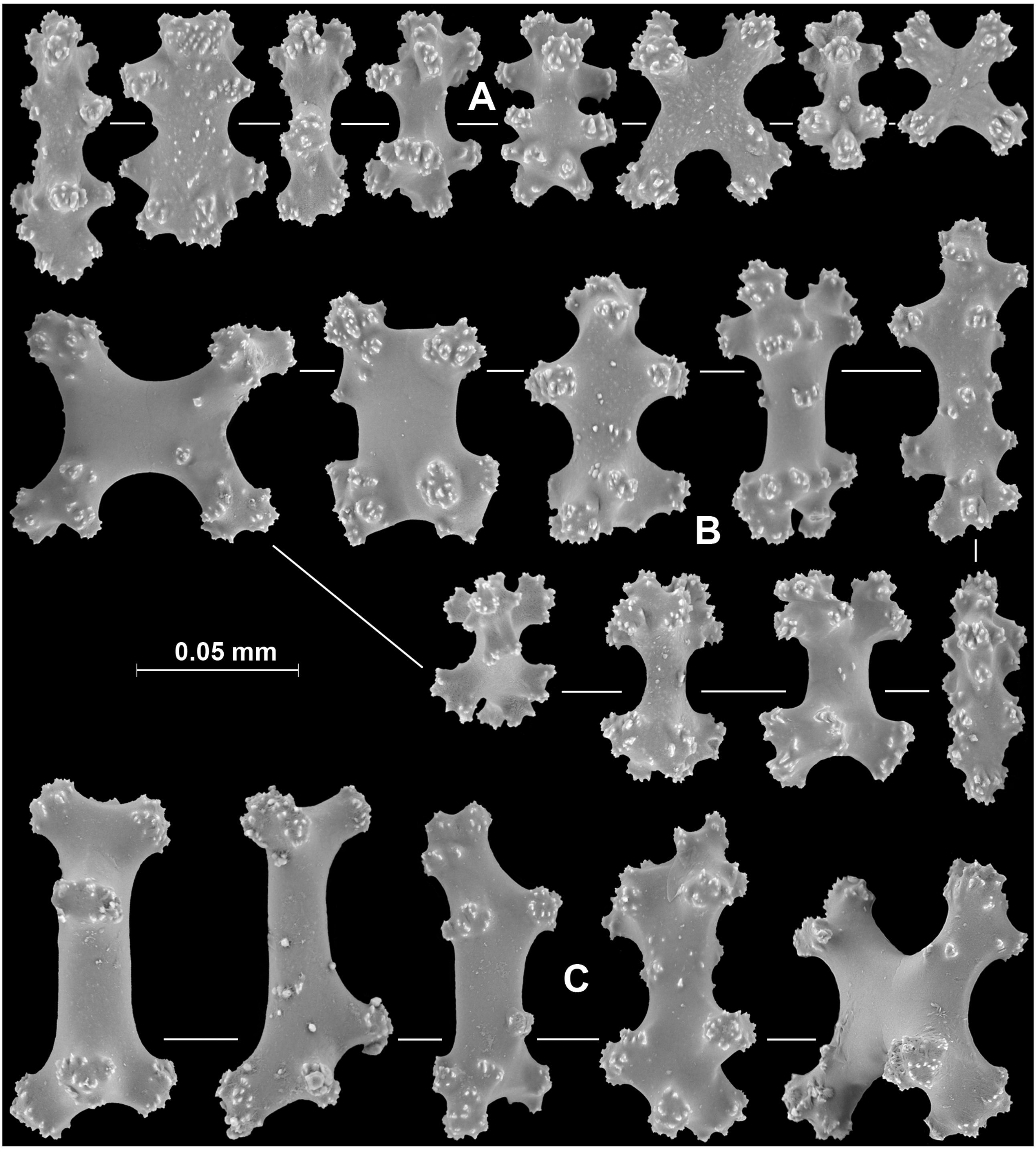

FIGURE 4. *Parasphaerasclera grayi,* WAM Z54774, sclerites: A, surface of the stalk; B, interior of the polyparium; C, interior of the stalk.

In the surface of the polyparium, including the coenenchymal mounds, the majority of sclerites are 6, 7- and 8-radiates and rodlets 0.04–0.08 mm long and crosses 0.03–0.07 mm in diameter (Fig. 3). The smaller radiates are tuberculate capstan-like forms and the longer rodlets are essentially 8-radiates with more distant prominences and a smooth, often long, shaft.

The stalk surface is densely spiculated with irregular radiates 0.05–0.08 mm long, crosses 0.05–0.08 mm long and rodlets (Fig. 4A).

The interior sclerites of the polypary are 6- and 7-radiate capstans 0.04–0.09 mm long, crosses 0.06–0.09 mm in diameter, and elongated rod-like sclerites 0.10–0.11 mm long (Fig. 4B). The interior of the stalk coenenchyme is populated with sclerites consisting of rod-like forms 0.10–0.11 mm long with a smooth shaft and large warty prominences, and robust crosses around 0.09 mm in diameter are also occasionally present (Fig. 4C).

Polyp sclerites are absent.

Colour. *In situ* the colonies were uniformly bright rusty orange with small, bright, light orange, rounded coenenchymal mounds. The polyp-free encrusting holdfast was uniformly rusty red. The polyps were transparent with bright white tentacles. The colour did not change on deck or in alcohol. In preserved specimens the surface and internal coenenchymal sclerites are brownish dark red to pale-ochre, the sclerites of the polyp mounds are pale-ochre, and the interior coenenchyme is pink.

Habitat. Steep, forward reef slope extending up to the reef crest at 14 metres. On the crest of the slope were small coral outcrops and the underlying base rock was covered with encrusting corals and soft coral communities, dominated by *Sinularia* and *Sarcophyton* as well as several species of gorgonian. The slope was dissected by narrow surge grooves with vertical sides marked by caves and ledges extending to 20 metres. A small group of *Parasphaerasclera grayi* colonies was found attached to the wall in an overhang at 12 metres depth amongst other scattered soft corals.

Remarks. This species has a wide distribution in the Indo-Pacific region, but it is a new record in Australia (Table 1). More recently Benayahu *et al.* (2004) reported *P. grayi* as a new record from Taiwan, and in 2013 it was collected by WAM from Christmas Island (Richards, unpublished). McFadden & Ofwegen (2013) described material from Palau as *P.* aff. *grayi* and also discussed in detail the high variability of shape and size of the sclerites of specimens of *P. grayi* that have been described in the literature, stating the possibility that multiple species might be involved. They also pointed out the similarities between their *P.* aff. *grayi* and the *P. grayi* of Williams (2001) from the Solomon Islands, as well as the differences between their material and the *P.* grayi from Vietnam described by Dautova & Savinkin (2009) and the lectotype of *P. grayi* described by Verseveldt & Bayer's (1988). Specimens from Palau and the Solomon Islands have tuberculated rods that lack a smooth waist. Our material agrees best with the well-illustrated and detailed re-description of the Vietnamese material and with the description of the lectotype based on the presence of distinctive smooth rod-like forms.

***Parasphaerasclera kimberleyensis* sp. nov.**

(Figs. 2C–E, 5, 6; Tabs. 1, 2)

Material examined. *Holotype*: WAM Z59789, Station 44/K10, Long Reef, northern Kimberley, NW Australia, 13.88867° S, 125.74942° E, SCUBA, depth 10 m, coll. M. Bryce, 20 October 2010. *Paratype*: WAM Z67195, 1 specimen, same data as the holotype.

Description. The holotype is a digitiform colony, with a wide base, which tapers distally towards the rounded apex of the polyparium (Fig. 2C–D). It is 15 mm tall, 2 mm in diameter at the apex and 4 mm in diameter across the holdfast. The colony has no real stalk as polyps occur almost to the very base. The polyp-free basal portion occupies less than 20 % of the total colony length. The polyps are rather sparse and evenly distributed. They are monomorphic, large, and when completely retracted, leave a prominent coenenchymal mound on the surface of the polyparium. All polyps are tightly retracted—as they were at the time of collection—and occupy most of the interior of the polyparium.

The majority of the sclerites from the upper part of the polyparium are tuberculate capstans, some slightly club-shaped, 0.05–0.13 mm long (Fig. 5), along with crosses 0.06–0.08 mm diameter and a few rodlets (see Fig. 5a). An apparent triradiate sclerite (see Fig. 5b) has been included to point out where errors are possible, as this is actually the broken end of a sclerite with the fracture side down. The authors believe that the sclerites shown in Fig. 24b–f for *E. grayi* in Versevedt & Bayer (1987), especially d–f, are most probably of this nature.

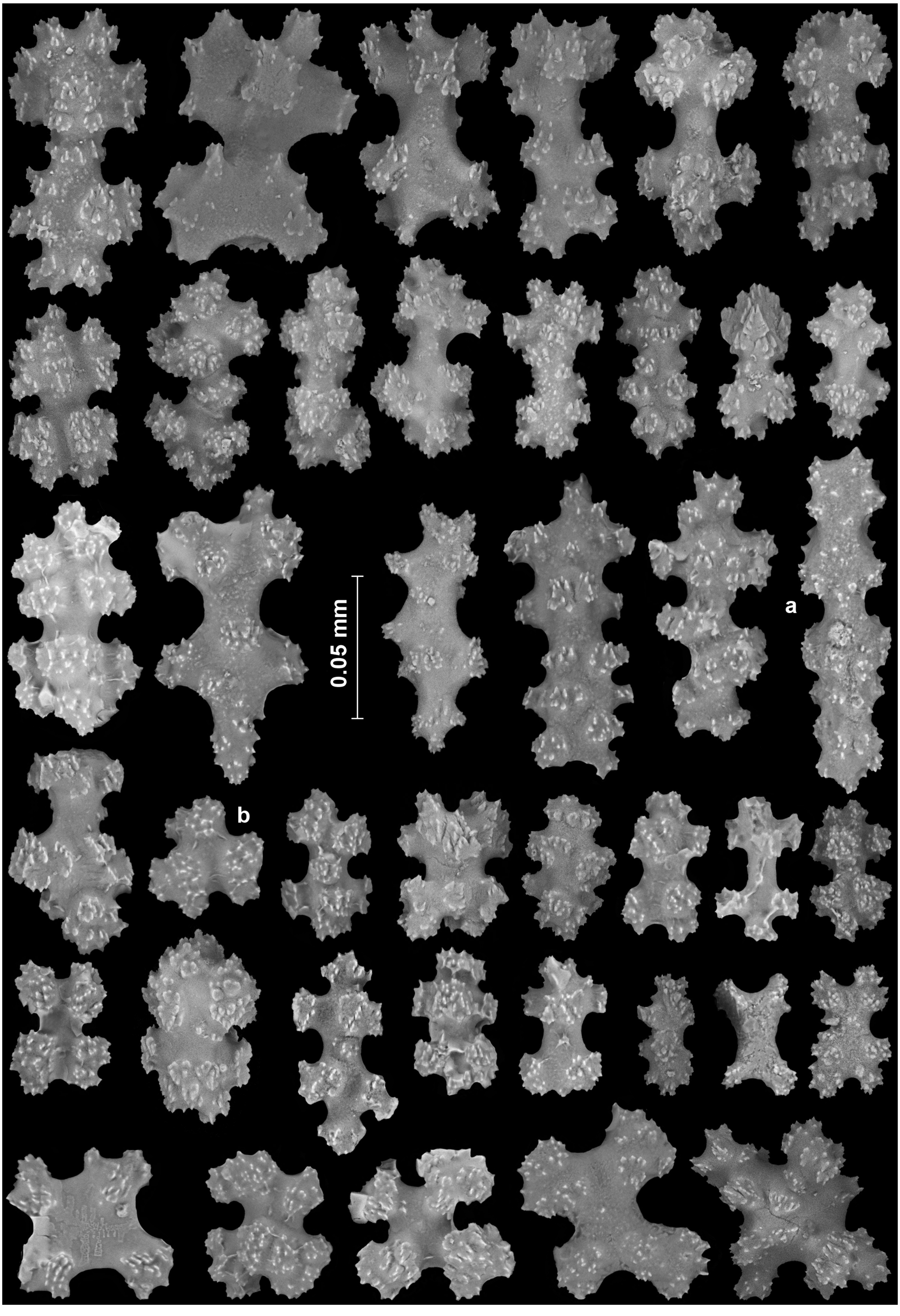

FIGURE 5. *Parasphaerasclera kimberleyensis* **sp. nov.**, holotype WAM Z59789, sclerites: surface of the polyparium (a = rodlet; b = broken end of a sclerite with the fracture side down).

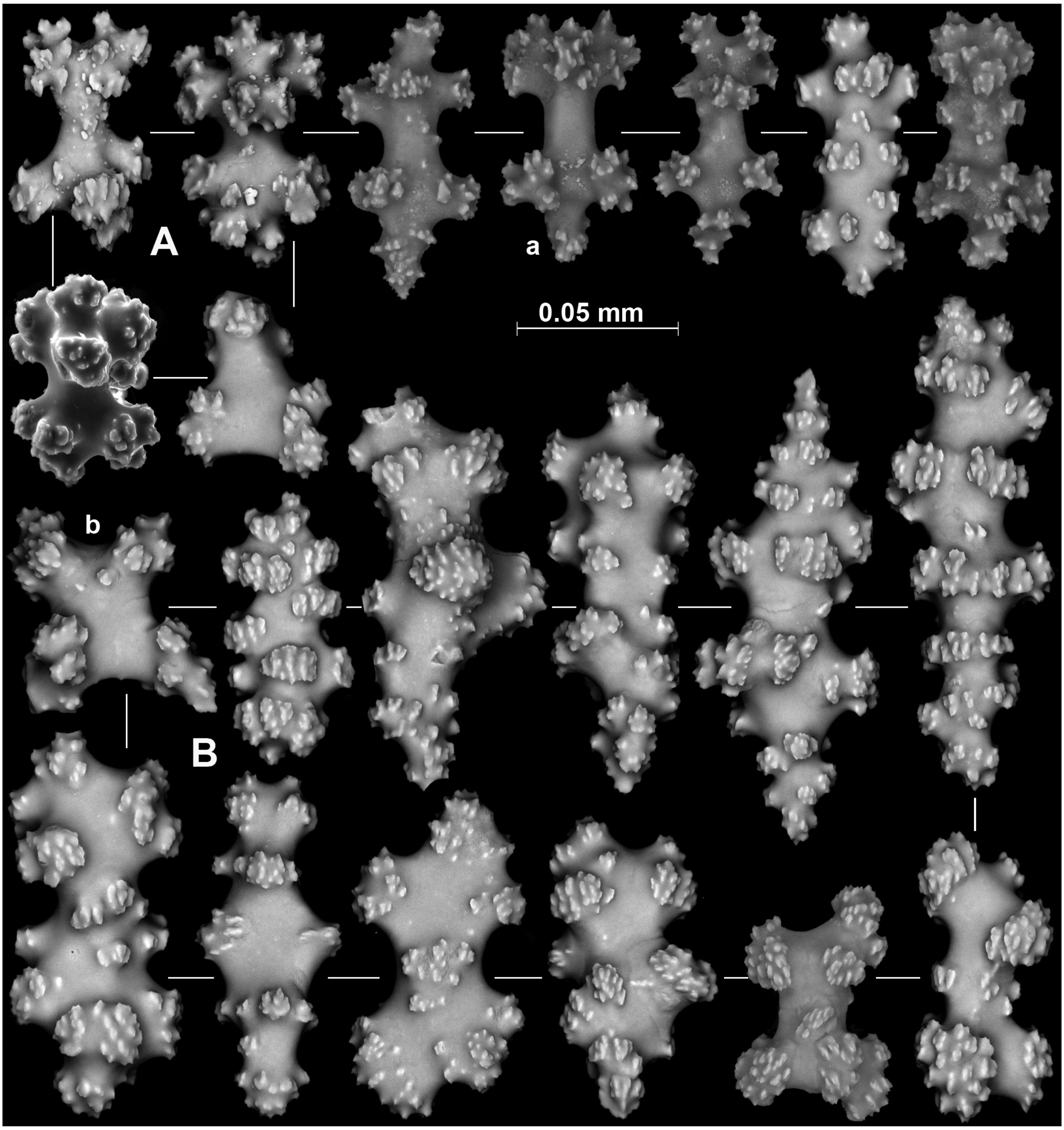

FIGURE 6. *Parasphaerasclera kimberleyensis* **sp. nov.**, holotype, WAM Z59789, sclerites: A, surface of the stalk (a = club); B, interior of the stalk (b = cross).

The sclerites of the coenenchymal mounds of *P. kimberlyensis* **n. sp.** are similarly shaped to those of the polyparium. There are no sclerites in the interior of the polyparium.

The base of the colony is densely spiculated with small radiates and tuberculate rods 0.02–0.10 mm long (Fig. 6A). Rare clubs 0.08–0.13 mm long are also represented in the base of the colony (see Fig. 6Aa). The interior of the base is less densely populated with sclerites, and contains mainly spindles, clubs and irregular forms 0.04–0.15 mm long (Fig. 6B). Crosses 0.09 mm in diameter are also present in the interior of the base (see Fig. 6Bb). The tubercles of all sclerites are ornamented with granules that tend to be elongate and arranged in rows or united to form ridges. This is most obvious in the interior stalk sclerites. Polyp sclerites are absent.

Colour. *In situ* the colonies were uniformly bright yellow-orange with bright red rounded coenenchymal mounds. The polyp-free base was uniformly bright yellow and the polyps were white. The colour did not change on deck or in alcohol. In preserved specimens the surface and internal coenenchymal sclerites are pale-yellow to colourless, the sclerites of the polyp mounds are red, and the interior coenenchyme is white.

Etymology. Named for the type locality, Kimberley, Western Australia.

Habitat. A steep and fractured fore-reef slope with a near vertical wall ascending from 20 metres to a depth of 4 metres. The wall is heavily pocketed with small caves and deep, steep-sided fissures. At 20 metres there are large rocky outcrops forming long reef-gullies, which are almost devoid of life, probably due to the heavy siltation. Sediment between the rocky outcrops is very fine and smothering. The *Parasphaerasclera kimberleyensis* colonies were found in a small group attached to the wall in an overhang at ten metres depth amongst other scattered soft corals.

Variability. The paratype is very similar to the holotype in shape, colour, arrangement of polyps and sclerite composition, but is smaller. It is also digitiform, with a wider base and tapering distally towards the rounded apex of the polyparium. It is 9 mm tall, 3 mm in diameter at the apex and 4 mm in diameter across the holdfast (Fig. 2E).

Remarks. *Parasphaerasclera kimberleyensis* **sp. nov.** does not demonstrate a close resemblance to any currently described species within the genus. Morphologically, it is distinguished by the shape of the colony and the shape and colour of the sclerites, and also by the colony colour, the bright yellow colony being offset by the bright red polyp mounds, ,but there is some superficial resemblance to *P. zanahoria* (Williams, 2000), which was originally described from Tonga in the South Pacific. More recently *P. zanahoria* was recorded from the Great Barrier Reef by one of us (Alderslade, unpublished). Like *P. kimberleyensis* **sp. nov.**, *P. zanahoria*, which is uniformly orange, is characterised by having some sclerites in the form of large crosses, but in that species the crosses have finely tapered and acutely tipped rays. In comparison *P. kimberleyensis* **sp. nov.** has crosses with thorny, rounded rays, and, in addition, all the radiates are distinctly more thorny than those in *P. zanahoria*.

Family Alcyoniidae Lamouroux, 1812

Diagnosis. Membranous or more or less fleshy, massive colonies. The latter with a basal part, the stalk, and a distal part bearing the anthocodiae, the polyparium. Sclerites are often less than one mm long, but they can be over 10 mm. They include spindles, clubs, radiates, and double heads. Polyps monomorphic or dimorphic and the autozooids are retractile. This family has a more or less global distribution. It is especially speciose in the Indo-Pacific, but so far absent in the shallow waters of the tropical western Atlantic (Williams 2003; Fabricius & Alderslade 2001).

Genus *Eleutherobia* Pütter, 1900

Type species. *Eleutherobia japonica* Pütter, 1900 by monotypy; = *E. rigida* (Pütter, 1900).

Diagnosis. Colonies usually small when contracted with symmetrical, conical to cylindrical polyparium, but branched, lobate, or clavate growth forms may occur. Polyps are monomorphic with large anthocodiae, which are retractile into low rounded to conspicuous coenenchymal mounds. The polyp-free basal portion is usually short, but can occupy up to half of the colony. Found mostly in deep water or restricted to caves and overhangs in shallow waters, and often in small groups. Sclerites include radiates, capstans, double heads, spindles, spheroids; rod-like forms or crosses are sometimes present. Anthocodial sclerites present, arranged in points or collaret and points (McFadden & Ofwegen 2013; Fabricius & Alderslade 2001; Verseveldt & Bayer 1988).

Eleutherobia australiensis sp. nov.

(Figs. 7A–C, 8, 9; Tabs. 1, 2)

Material examined. *Holotype*: WAM Z31488, one sectioned colony, Station PF06/S1-200/R2, 190 km NW of Dampier, Pluto Gas Field, NW Australia, 19.9352°–19.9308°S, 115.3261°–115.3288° E, epibenthic sled, depth, 200 m, coll. B.F. Cohen, 8 December 2005. *Paratype*: WAM Z66778, one whole specimen, same data as holotype.

Description. The holotype is a tapering digitiform colony, with a small lobe (Fig. 7A–C) and it is attached to a piece of hard coral skeleton. It is 50 mm tall, 4 mm in diameter at the apex and 10 mm in diameter across the holdfast. The polyp-free basal portion is very short and occupies only 10 % of the total colony length (Fig. 7A). Polyps are large, monomorphic, evenly distributed over the polyparium and are completely retracted leaving distinct, rounded coenenchymal mounds on the surface.

In the surface of the polyparium the majority of the sclerites are spindles, 0.10–0.35 mm long, with pointed ends, and ovals 0.08–0.22 mm long (Fig. 8A). Sclerites of the coenenchymal mounds are small, spindle-like bodies 0.10–0.15 mm long (Fig. 8B). The sclerites of the interior coenenchyme of the polyparium are few, being, thin spindles up to 0.4 mm long (Fig. 8C).

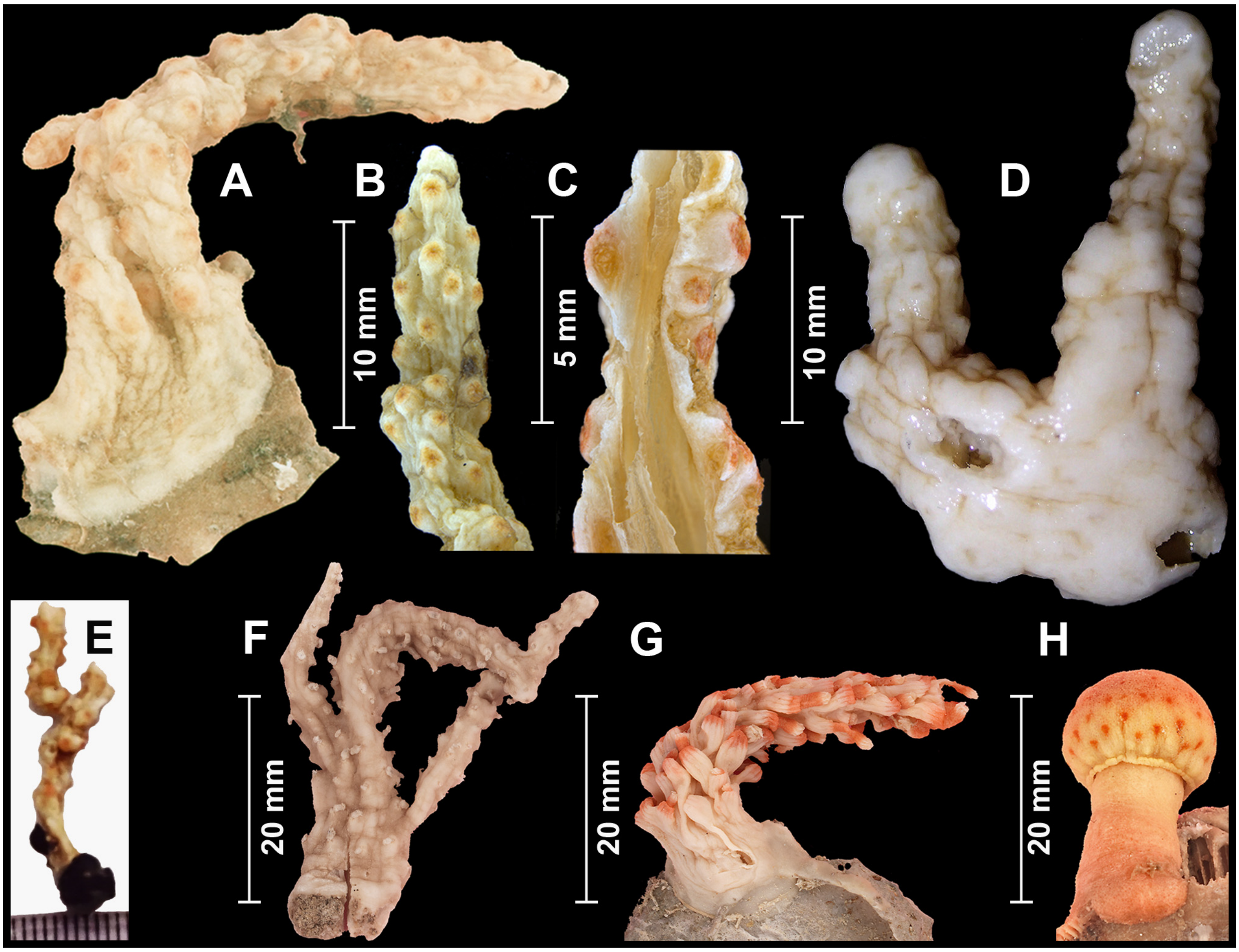

FIGURE 7. A–C, *Eleutherobia australiensis* **sp. nov.**, holotype, WAM Z31488; D, *Eleutherobia imaharai* **sp. nov.**, holotype, WAM Z13252; E, (photo courtesy Y. Imahara) *Eleutherobia dofleini* (Kükenthal, 1906) "Type", ZMB 6524; F, *Eleutherobia somaliensis,* WAM Z31487; G, *Eleutherobia splendens,* WAM Z23988-1; H. *Sphaerasclera flammicerebra,* WAM Z31480.

The stalk surface is densely spiculated mainly with warty ovals, short, plump spindles 0.10–0.30 mm long with tapering ends and some irregular bodies (Fig. 9A). The sclerites of the interior coenenchyme of the stalk are thin spindles, 0.10–0.35 mm long, plump spindles, 0.10–0.25 mm long, with the ends tapering to a point and a few irregular, somewhat triangular forms of similar size (Fig. 9B). All of the above sclerites have high, prickly, complex warts

The armature of the polyps consists of a collaret eight to ten rows deep and points of six to eight pairs of curved flattened spindles 0.25–0.45 mm long (Fig. 8D). The tentacles contain spikey rods up to 0.07 mm long (Fig. 8E; only smaller sclerites up to 0.05 mm are figured due to SEM preparation difficulties). No introvert sclerites are present.

Colour. The preserved colonies are light grey with small orange, rounded coenenchymal mounds. The wider, polyp-free encrusting base is uniformly light grey. The interior coenenchyme is light brown. Surface and internal coenenchymal sclerites are colourless, while the sclerites of the coenenchymal mounds are pale-ochre to reddish.

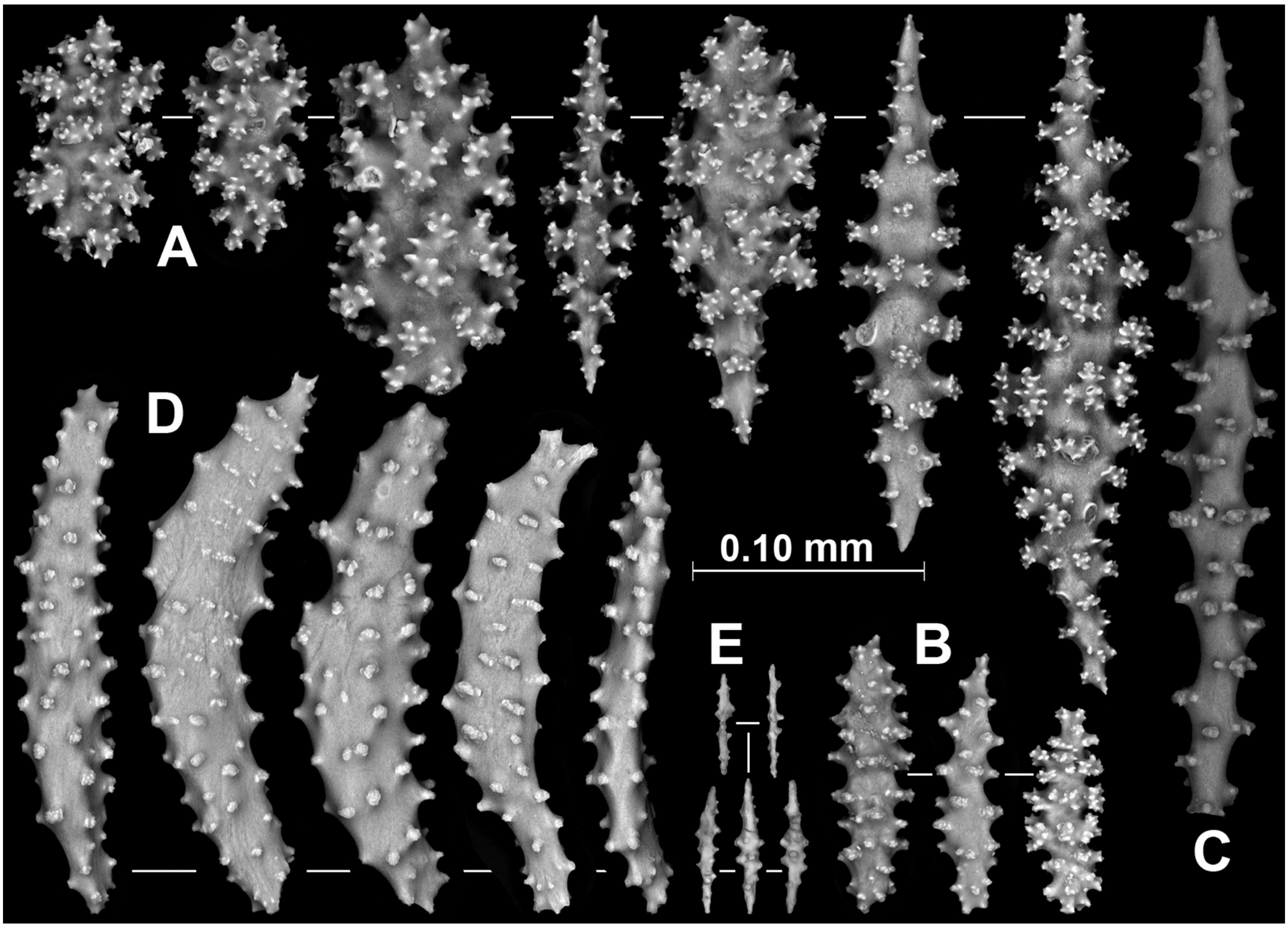

FIGURE 8. *Eleutherobia australiensis* **sp. nov.**, holotype, WAM Z31488, sclerites: A, surface of the polyparium; B, coenenchymal mounds; C, interior of the polyparium; D, polyps; E, tentacles.

Etymology. The species is named for being collected in Australia.

Habitat. The specimens were sampled from 200 m along the continental slope utilising an epibenthic sled, but the exact habitat is unknown.

Variability. The paratype is digitiform, with a wide base, and tapering distally towards the rounded apex of the polyparium. It is 45 mm in total length and 3 mm in diameter at the apex. The holdfast is laterally flattened, 15 mm wide and 4 mm thick. The specimen is attached to a piece of hard coral skeleton.

Remarks. The new species is characterised by coenenchymal mounds which are orange because of the coloured sclerites, anthocodial armature of flattened spindles, distinct oval sclerites and long warty spindles in the polyparium surface, and the occurrence of plump spindles with tapered, pointed ends in the lower part of the colony. The ovals and the plump, tapering spindles found in the new species are very like those found in *E. dofleini* (Kükenthal, 1906), however, in that species these sclerites occur in both the lower and upper parts of the colony. Also, the shape of the colony is very different (see Verseveldt & Bayer 1988: Fig. 19a) and the warts on the sclerites are lower and far less prickly.

Eleutherobia imaharai sp. nov.

(Figs. 7D; 10, 11; Tabs. 1, 2)

Material examined. WAM Z13252, one whole specimen, Station 1031302, North West Cape, 190 km north west of Dampier, NW Australia, 21.2802° S, 114.0606° E, epibenthic sled, depth 200–250 m, coll. AIMS NW Cape survey, 13 March 2001.

Description. The colony is essentially two digitiform lobes with an irregular surface, arising from a common base, each slightly tapering to a rounded summit (Fig 7D). The largest lobe is about 4 mm wide at its base and projects 16 mm above the holdfast, and the smaller lobe extends 3 mm from the base of the larger lobe before it bends upwards and extends a further 9 mm. The aspect of the holdfast seen in Fig. 7D is about 15 mm wide. Apart from the holdfast, the numerous monomorphic polyps are evenly distributed over most of the colony, and they are all retracted within low to moderate coenenchymal mounds.

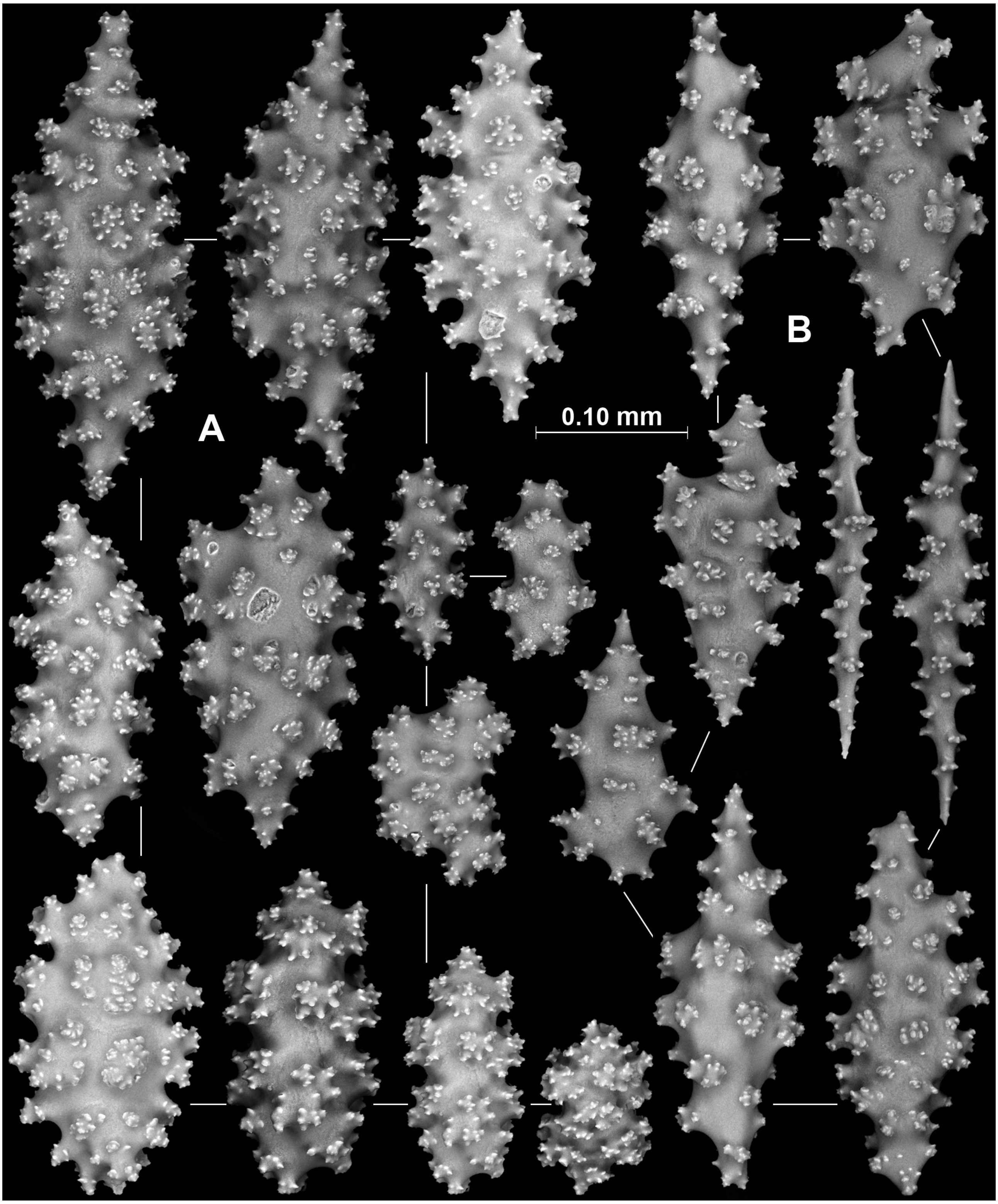

FIGURE 9. *Eleutherobia australiensis* **sp. nov.**, holotype, WAM Z31488, sclerites: A, surface of the base; B, interior of the base.

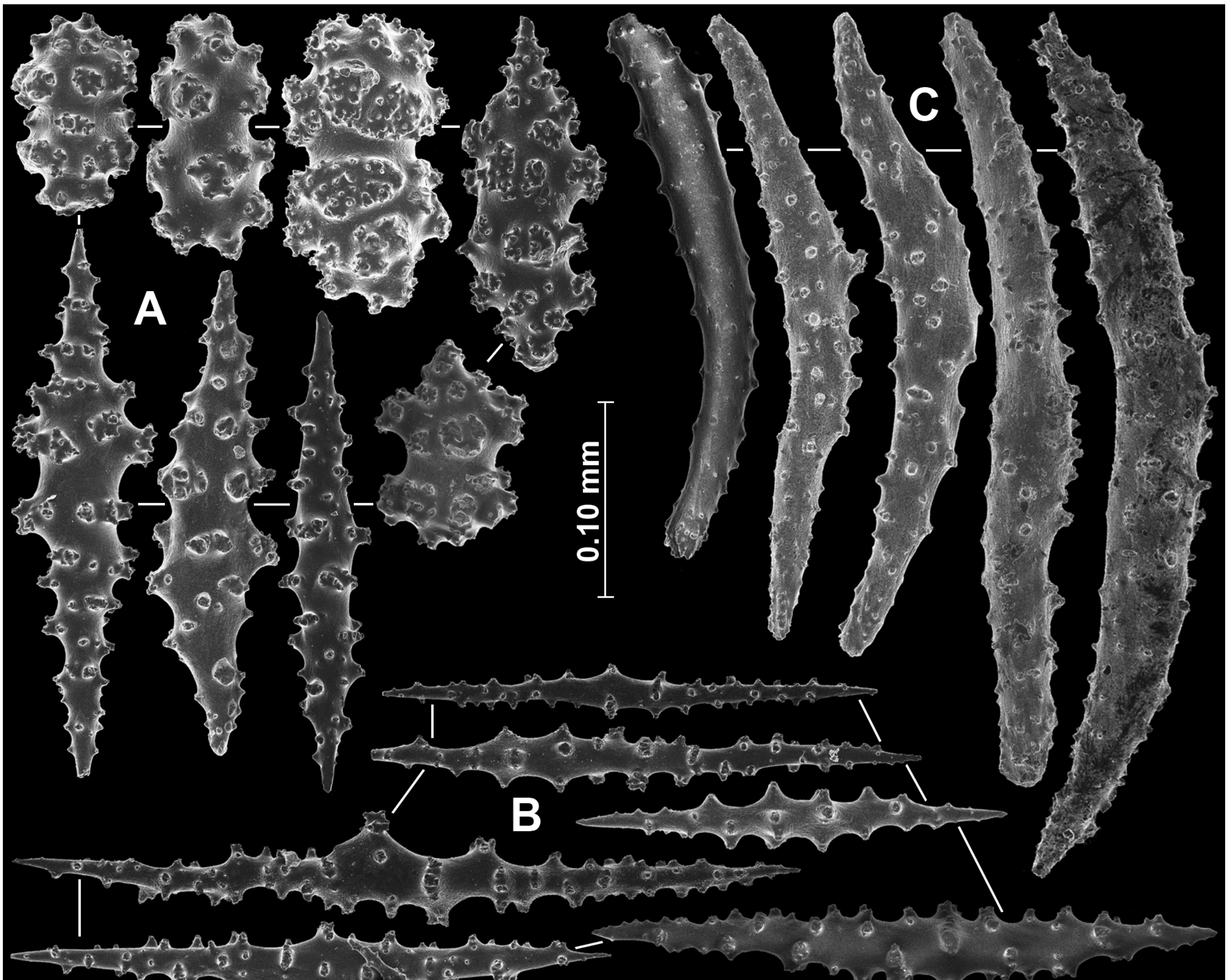

FIGURE 10. *Eleutherobia imaharai* **sp. nov.**, holotype, WAM Z13252, sclerites: A, surface of polyparium; B, interior of polyparium; C, collaret and points; D, tentacle rachis; E, pinnules; F, tentacle rachis sclerites *in situ*; black arrow showing position of pinnules.

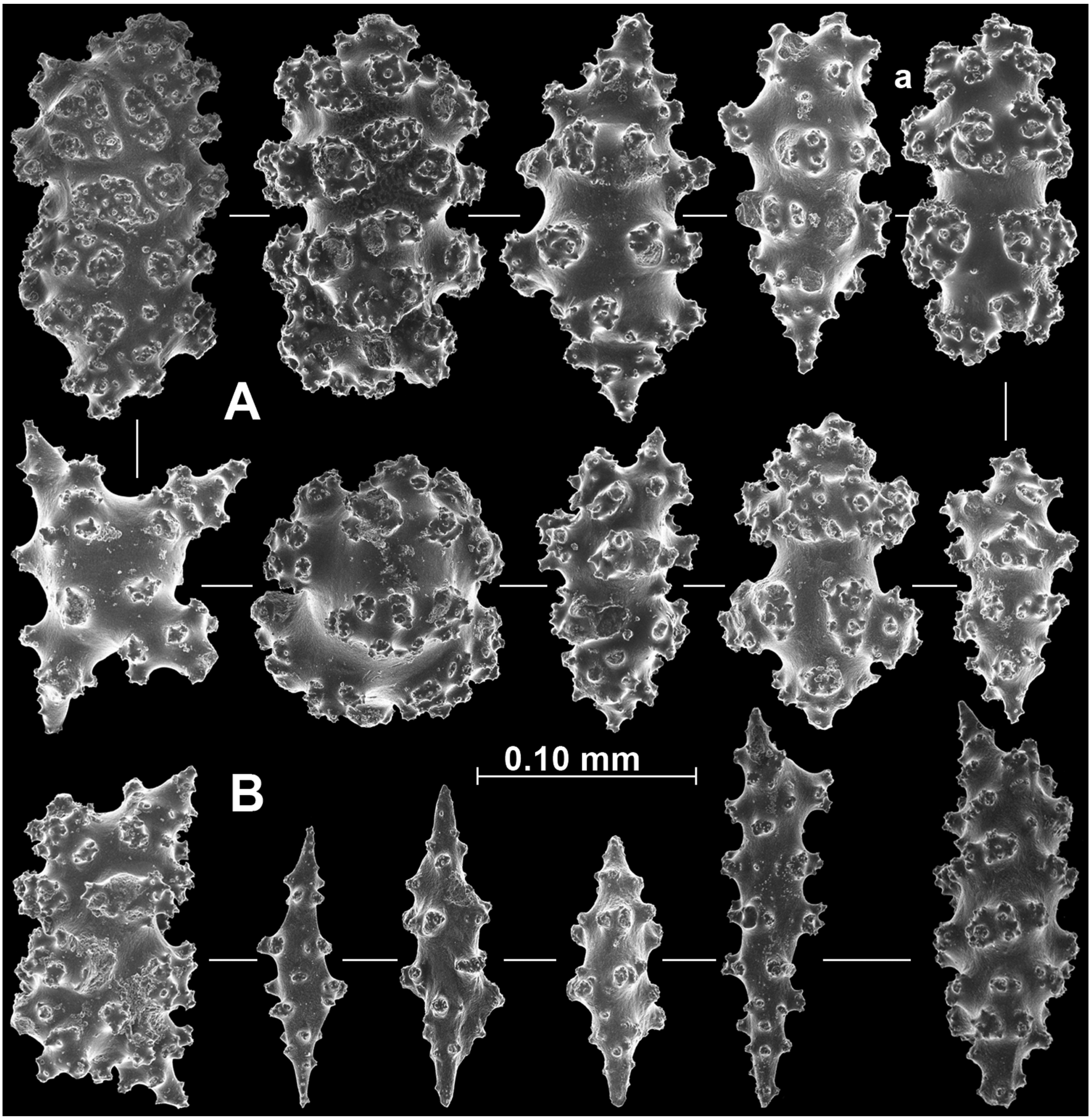

FIGURE 11. *Eleutherobia imaharai* **sp. nov.**, holotype, WAM Z13252, sclerites: A, surface of the base (a = capstan); B, interior of the base.

In the surface of the polyparium the sclerites include spindles, up to 0.29 mm long, with acute ends, and ovals 0.08–0.16 mm long; some of latter may have very large, complex warts and one or two sharply tapering ends (Fig. 10A). The sclerites of the interior of the polyparium are markedly narrow, acute spindles 0.20–0.40 mm long (Fig. 10B).

The polyp armature is formed of slightly curved spindles 0.20–0.55 mm long (Fig. 10C). The collaret is about eight to ten rows deep and the points contain five to six pairs of obliquely arranged sclerites. The tentacles contain densely packed rods with a curved end (Fig. 10D). They are up to 0.30 mm long, their length becoming smaller towards the tentacle tip, and they are obliquely arranged in two rows covering the aboral and lateral faces of the tentacles (Fig. 10F). The pinnules contain a few small spindles, up to 0.12 mm long, with relatively simple tubercles (Figs. 10E, F(arrowed)). A few introvert spindles of a similar size and shape as the pinnule sclerites are also present.

The surface of the common base is densely spiculated, mainly with warty ovals, 0.10–0.20 mm long (Fig. 11A). Short, plump spindle-like forms, up to 0.25 mm in length, with sharply tapering ends are also present at the surface of the base, as are a few crosses and capstans (see Fig. 11Aa). The majority of the sclerites in the interior of the common base are spindles up to 0.30 mm long, which commonly have one or both ends acute (Fig. 11B). Ovals and a few irregular forms of similar size, that may have pointed processes, also occur.

Colour. The preserved colony has a cream interior and exterior and the sclerites are colourless.

Habitat. The specimens were sampled from a muddy-rubble environment between 200–250 m depth along the continental slope utilising an epibenthic sled.

Remarks. The sclerites of the surface and interior of the new species are of the same form as those of *Eleutherobia dofleini* as described and illustrated by Verseveldt & Bayer (1988: 29, Figs. 19, 20), by Imahara *et al.* (2014: 89, Figs. 24, 25) in their new book on the octocorals of Sagami Bay, and to a lesser extent by Utinomi (1954: 45, Fig. 2) when describing colonies collected off Minabe. However, the colony form of *E. dofleini*, which is only known from Sagami Bay to Tosa Bay, Japan, is quite different to that of the new species, having a narrow, commonly branched polypary that generally has pronounced polyp mounds of sufficient size to be termed "Kelche" or "Polypenkelche" by Kükenthal and "calyces" by Imahara *et al.* and Verseveldt & Bayer. There is also a difference in the polyp body armature of the new species. The latter lacks any intermediate sclerites between the points while *E. dofleini* has two (Verseveldt & Bayer 1988: Fig. 20A1).

In order to check the exact nature of the sclerites from the tentacles and the interior of the polypary in *E. dofleini,* neither of which were figured by Verseveldt & Bayer, we approached Dr Leen van Ofwegen, the Naturalis Biodiversity Center, Leiden and Dr Yukimitsu Imahara, Biological Institute of Kuroshio, for assistance. Dr van Ofwegen kindly examined the microscope slides used by Verseveldt and Bayer (1988) but found that there were no preparations present of either character. Dr Imahara examined Utinomi's specimen of *E.dofleini* from Tanabe Bay, Kii Pininsula, Japan (Utinomi 1960) and found that the tentacles contain small, somewhat scale-like, curved, flattened spindles with scalloped edges and not curved bars as in the tentacles of the new species, and that the sclerites of the interior of the polypary are not at all long and thin but are shorter and somewhat stouter, like those illustrated in Fig. 25C of the new book on Sagami Bay (Imahara *et al.* 2014). He also confirmed the difference in colony form by sending an image of colony ZMB 6524 labelled "Nidalia dofleini Kük. Type" (see Fig. 7E) and added the information that the pinnule sclerites of a colony from Tanabe Bay used by Utinomi (1960) are slender rods that are quite unlike those of the new species.

Etymology. It is with pleasure that we name this new species after our colleague, Dr Yukimitsu Imahara, in recognition of his assistance with our enquiries regarding *E. dofleini*, his continuing work on Japanese octocorals, and especially the publication (with Drs Fumihito Iwase & Hiroshi Namikawa) of the extremely valuable book on the Sagami Bay representatives of this faunal group.

Eleutherobia somaliensis **Verseveldt & Bayer, 1988 new record**

(Fig. 7F; 12; Tabs. 1, 2)

Eleutherobia somaliensis Verseveldt & Bayer, 1988: 39–40, Figs. 18g,h; 33b; 34.

Material examined. WAM Z31487, two whole specimens, grooved, digitate, 25 and 41 mm tall, Station PF06/S1-200/R2, 190 km NW of Dampier, Pluto Gas Field, NW Australia, 19.9308°–19.9352° S, 115.2261°–115.2288° E, epibenthic sled, depth 200 m, coll. B.F. Cohen, 8 December 2005; WAM Z12201, one whole specimen, branched with two side branchlets, 65 mm tall, Station 1031302, North West Cape, 21.4666° S, 114.1016° E, epibenthic sled, depth 200–250 m, coll. AIMS North West Cape survey, 13 March 2001.

Description. Two of the colonies are unbranched, and the third is branched. The colonies are stiff, grooved, with a wider base and taper distally towards the rounded apex of the cylindrical polyparium (Fig. 7F). The colonies are between 25–65 mm tall, 3 mm in diameter at the apex and between 6–11 mm in diameter across the holdfast. No distinct stalk is present. Polyps are monomorphic, numerous and mostly irregularly distributed over the colony. In some areas of the base the polyps are arranged in longitudinal rows, in other places they are absent. In the preserved specimens all polyp bodies are retracted.

The sclerites in the surface of the polyparium (Fig. 12A) are mostly 8-radiate derivatives, between 0.08–0.10

mm long, with a medial waist, the larger ones approaching clubs, together with some longer spindles up to 0.38 mm long. The sclerites of the interior of the polyparium are spindles and needles, 0.23–0.50 mm long, (Fig. 12B). The surface of the base is densely spiculated with small rods and crosses, 8-radiate derivatives, sub-spheroidal forms and plump spindles with sharply tapering ends. The sclerites are about 0.10-0.2 mm long (Fig. 12C). The sclerites in the interior of the base are warty spindles up to 0.20-0.30 mm long (Fig. 12D). They are similar to the sclerites in the interior of the polyparium, but are slightly shorter and wider. All of the polyparium and basal sclerites have very prickly warts.

The polyp armature consists of crown and points and is formed of slightly spiny spindles around 0.03 mm long (Fig. 12E). The tentacles contain flattened sclerites, the larger ones curved, up to 0.25 mm long (Fig. 12F).

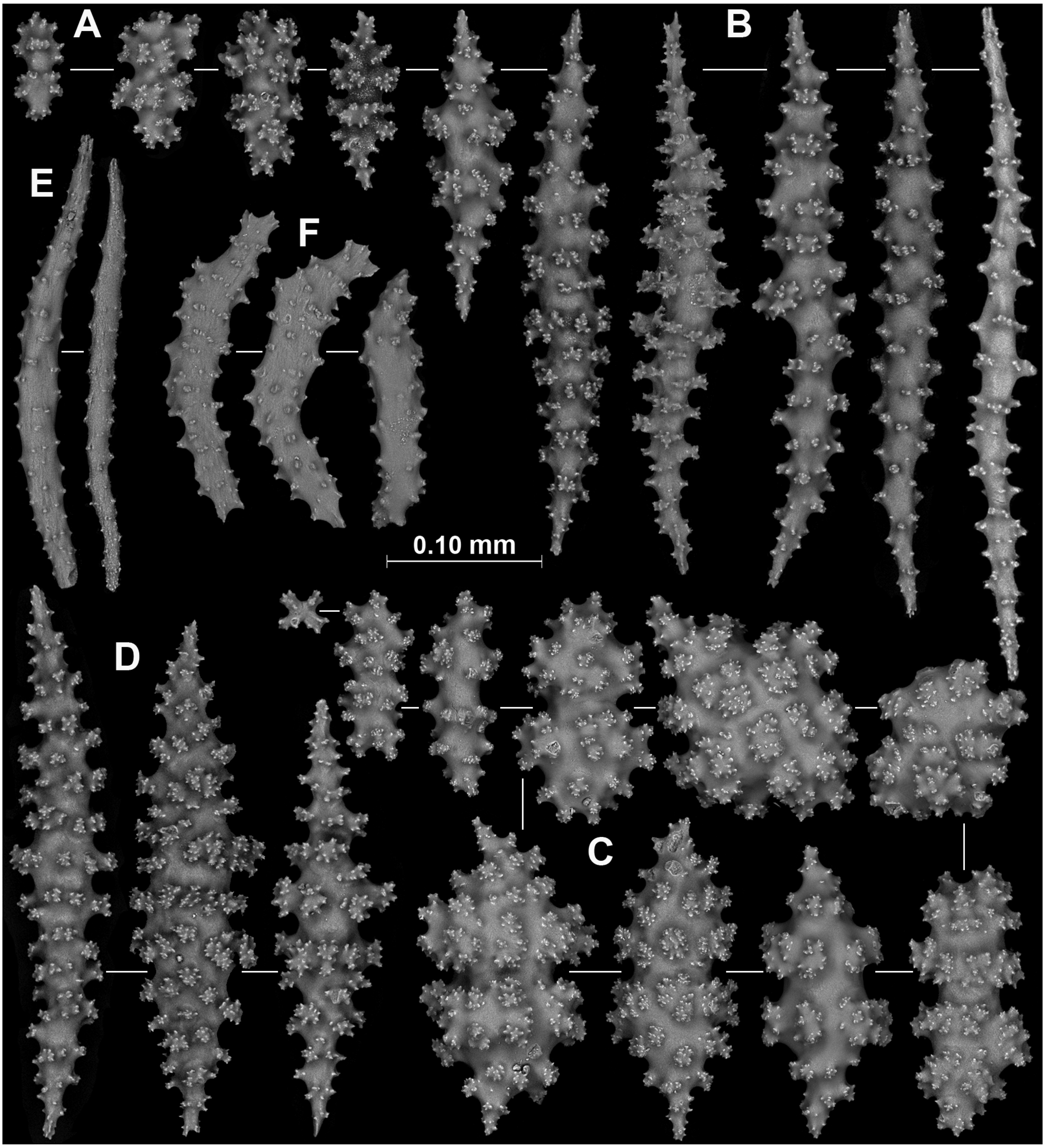

FIGURE 12. *Eleutherobia somaliensis* WAM Z31487, sclerites: A, surface of polyparium; B, surface of the base; C, interior of the polyparium; D, interior of the base; E, polyps; F, tentacles.

TABLE 1. Distribution and occurrences of former species and currently valid species of *Eleutherobia.* Data in this table are based on records from the literature. (NR): new record in Australia.

Species	Distribution	Depth (m)	Source Literature
Alcyonium Linnaeus, 1758			
A. studeri (Thomson, 1910)	South Africa	42–121	Verseveldt & Bayer 1988; Williams 1992; Williams & Little 2001; Williams 2003
A. variabile (Thomson, 1921)	South Africa	13–468	Williams 1986; Williams 1992; Williams 2003
Eleutherobia Pütter, 1900			
E. australiensis **sp. nov.**	NW Australia	200	
E. dofleini (Kükenthal, 1906)	Japan	69–250	Kükenthal, 1906; Thomson & Dean 1931; Utinomi 1954; Utinomi 1957; Williams 2003; Verseveldt & Bayer 1988; Imahara *et al.* 2014
E. imaharai **sp. nov.**	NW Australia	200–250	
E. duriuscula (Thomson & Dean, 1931)	Indonesia	69–204	Thomson & Dean 1931; Verseveldt & Bayer 1988; Williams 2003
E. flava (Nutting, 1912)	Japan	174	Nutting 1912; Verseveldt & Bayer 1988; Williams 2003; Imahara et al 2014
E. grandiflora (Kükenthal, 1906)	Japan	shallow	Kükenthal 1906; Utinomi 1957; Verseveldt & Bayer 1988; Williams 2003
E. rigida (Pütter, 1900)	Japan	24–150	Utinomi 1954; Utinomi 1957; Verseveldt & Bayer 1988; Williams 2003; Imahara *et al.* 2014
E. rubra (Brundin, 1896)	Japan; USA; NW Australia	80–128	Thomson & Dean 1931; Utinomi 1957; Verseveldt & Bayer 1988; Williams 2003
E. somaliensis Verseveldt & Bayer, 1988	Somalia; NWAustralia (NR)	70–200	Verseveldt & Bayer 1988; Williams 2003
E. splendens (Thomson & Dean, 1931)	Indonesia; Philippines; Australia (NR)	204–511	Thomson & Dean, 1931; Verseveldt & Bayer 1988; Williams 2003

……*continued on the next page*

TABLE 1. (Continued)

Species	Distribution	Depth (m)	Source Literature
E. unicolor (Kükenthal, 1906)	Japan	70–73	Kükenthal 1906; Utinomi 1957; Verseveldt & Bayer 1988; Williams 2003
E. sumbawaensis Verseveldt & Bayer, 1988	Indonesia	69	Verseveldt & Bayer 1988; Williams 2003
E. vinadigitaria Williams & Little, 2001	South Africa	52–86	Williams & Little 2001
***Parasphaerasclera* gen.n.** (McFadden & van Ofwegen, 2013)			
P. albiflora (Utinomi, 1957)	Japan	45	Utinomi 1957; Williams 2003
P. aurea (Benayahu & Schleyer, 1995)	South Africa	24–36	Benayahu & Schleyer 1995; Williams & Little 2001; Williams 2003; McFadden & Ofwegen 2013
P. grayi (Thomson & Dean, 1931)	New Guinea; Solomon Islands; Indonesia; Japan, Taiwan; Vietnam; Australia (NR);	5–73	Thomson & Dean 1931; Verseveldt & Bayer 1988; Williams 2001; Benayahu *et al.* 2004 Williams 2003; McFadden & Ofwegen 2013
P. kimberleyensis **sp. nov.**	NW Australia	10	
P. nezdoliyi (Dautova & Savinkin, 2009)	Vietnam	12–27	Dautova & Savinkin 2009
P. rotifera (Thomson, 1910)	South Africa	27–120	Verseveldt & Bayer 1988; Williams & Little 2001; Williams 1992; Williams 2003; McFadden & Ofwegen 2013
P. zanahoria Williams, 2000	Tonga; NE Australia	25–30	Williams 2000; Williams 2003
***Sphaerasclera* gen.n.** (McFadden & van Ofwegen, 2013)			
S. flammicerebra (Williams, 2003)	Palau; New Caledonia; Mauritius; Australia (NR)	142–450	Williams 2003; McFadden & Ofwegen 2013

TABLE 2. Morphological comparison of the Western Australian digitate and capitate species of *Parasphaerasclera, Eleutherobia, Sphaerasclera* and *Paraminabea.*
*Plump spindles with sharply tapering ends. N.R.: new record; Sp. nov: new species.

Species	Status in Australia	Colour in EtOH	Growth form	Introvert sclerites	Collaret sclerites	Tentacle sclerites	Polyparium surface (mm)	Polyparium interior (mm)	Stalk surface (mm)	Base interior (mm)
I. *Parasphaerasclera*										
P. grayi	N.R.	rusty orange with bright orange coenenchymal mounds	digitiform	absent	absent	absent	6–, 7, – 8-radiates, rodlets, crosses: 0.03–0.08	6–, 7–radiates, crosses: 0.04–0.09; rods: 0.010–0.011	irregular radiates, crosses, rods: 0.05–0.08	crosses, rods: 0.10–0.11
P. kimberleyensis	Sp. nov.	bright yellow with red coenenchymal mounds	digitiform	absent	absent	absent	capstans: 0.05–0.13; crosses 0.06–0.08; rodlets: 0.05	absent	radiates, rods: 0.02–0.10	radiates, crosses: 0.07–0.09; spindles, clubs, irregular bodies: 0.04–0.15
II. *Eleutherobia*										
E. australiensis	Sp. nov.	grey with orange coenenchymal mounds	digitiform	absent	present	present	ovals : 0.08–0.22; spindles: 0.10–0.35	thin spindles up to 0.40	ovals, *spindles: 0.10–0.30	thin spindles: 0.10–0.35; *spindles: 0.10–0.25
E. imaharai	Sp. nov.	cream	digitiform to digitate	few or absent	present	present	ovals: 0.08–0.16 *spindles 0.20–0.29	spindles up to 0.40	ovals, rare crosses: 0.10–0.20; *spindles up to 0.25	ovals, *spindles, irregular bodies: 0.20–0.30
E. somaliensis	N.R.	light brown	digitiform to digitate	present	present	present	8–radiates: 0.08–0.10; spindles: 0.18–0.38	narrow spindles and needles: 0.23–0.50	8-radiates, capstans, ovals, *spindles: 0.1–0.2; crosses present	long narrow spindles 0.20–0.30
E. splendens	N.R.	cream to light orange with white to light red coenenchymal mounds	digitiform to digitate	present	present	present	8–radiates, clubs: 0.08–0.15	narrow spindles: 0.34–0.47; rods: 0.16–0.20	8–radiates, clubs: 0.07–0.16	spindles: 0.25–0.35
III. *Sphaerasclera*										
S. flammicerebra	N.R.	orange with red coenenchymal mounds	capitate	absent	absent	absent	8–radiates: 0.05–0.08; spheroids: 0.12–0.20	radiates, double-heads, barrels, spheroids: 0.13–0.20	radiates: 0.05–0.08 spheroids: large 0.15–0.20 medium 0.10–0.13	predominately spheroids: 0.17–0.21
IV. *Paraminabea*										
P. aldersladei	recorded	orange	digitiform	absent	absent	absent	8–radiates, double-heads: 0.04–0.09	8-–radiates, double-heads: 0.04–0.09	8–radiates, double-heads: 0.05–0.11	8–radiates, double-heads: 0.05–0.11
P. cf. aldersladei	recorded	orange	digitiform	absent	absent	absent	8–radiates, double-heads: 0.04–0.09	8–radiates, double-heads: 0.04–0.09	8–radiates, double-heads: 0.06–0.09	8–radiates, double-heads: 0.06–0.09

Colour. The preserved colonies are uniformly cream.

Habitat. The specimens were sampled from a depth range between 200–250 m along the continental slope utilising an epibenthic sled, but the exact habitat is unknown.

Remarks. *Eleutherobia somaliensis* has only been described from off the coast of Somalia, Africa (Table 1), and this is the first record for Australia. Although Verseveldt & Bayer's (1988) original description of the holotype did not include illustrations of the sclerites from the polyps or the interior of the base, we think the sclerites of our specimens bear a very close resemblance to those that were illustrated and to the descriptions of those that were not. The notable differences are the more prickly nature of the sclerite warting and the lack of well defined 8-radiates as shown in Verseveldt & Bayer's Fig 34a–d.

Eleutherobia splendens (Thomson & Dean, 1931) new record

(Fig. 7G; 13; Tabs. 1, 2)

Nidalia splendens Thomson & Dean, 1931: 38, Pl. 1, Fig. 7; Pl. 6, Fig. 9; Pl. 25, Fig. 8.
Eleutherobia splendens Verseveldt & Bayer, 1988: 40–41, Figs. 18a, 33a, 35, 36c.

Material examined. WAM Z23988, two whole specimens, cylindrical, colony 1 unbranched, 45.3 mm tall, attached to a mollusc shell, colony 2 branched with three branches in one plane, 51.6 mm tall, Station SO1/84/055, Lacepede Archipelago, NW Australia, 19.9500°–19.9833° S, 120.7338°–120.7350° E, CSIRO FRV "Soela" cruise VI, trawl, depth 297 m, coll. S.M. Slack-Smith, 10 February 1984; WAM Z54996, one whole specimen, unbranched, 31.5 mm tall, Station SO1/84/056, Kimberley, Beagle Bay, NW Australia, 16.9297° S, 122.5411° E, CSIRO FRV "Soela" cruise VI, trawl, depth 301 m, coll. S.M. Slack-Smith, 11 February 1984. NTM C002899, one whole specimen, 19.3338° S, 115. 6836° E, FRV "Soela" cruise 0184, trawl, depth , 306–308 m, coll. A.J. Bruce, 29 January 1984; NTM C013059, one whole specimen, Station SS1005 130-015, off Red Bluff, 23.9908° S, 112. 3547° E, RV "Southern Surveyor", beam trawl, depth 411 m, K. Gowlett-Holmes, 8 December 2005.

Description. The colonies are erect, cylindrical, with large bodied anthocodiae up to 4 mm long (Fig. 7G). The colonies are unbranched or branched in one plane and are up to 51.6 mm tall. Some specimens are attached to a mollusc shell.

In the surface of the polyparium the majority of the sclerites are thorny clubs, up to 0.22 mm long but mainly between 0.08–0.15 mm , with the warts below the head arranged in girdles (Fig. 13A). There are also a few 8-radiates present. The majority of sclerites of the base are thorny 8-radiates up to about 0.10 mm long, but there are also a few larger sclerites are up to 0.16 mm that are club-shaped (13B). The sclerites of the interior of the polyparium are markedly narrow, needle-like forms, 0.34–0.47 mm long, with girdles of high spines (Fig. 13C). The sclerites in the interior of the base are spindles up to 0.35 mm long. They are similar to the sclerites in the interior of the polyparium, but are slightly shorter and wider (Fig. 13D).

The tentacles contain densely packed stout, flattened rods with a curved end up to 0.45 mm long (Fig. 13E). The polyp armature is strongly developed. It consists of collaret and point and is formed of slightly curved, spiny spindles around 0.05 mm long (Fig. 13F).

Colour. The preserved colonies are cream with the distal part of the coenenchymal mounds being sometimes of the same colour, but usually are a distinct pink to red (Fig. 7G). The tentacles are white. The introvert contains brick-red sclerites.

Habitat. The specimens were sampled from a depth range between 297–411 m along the continental slope utilising otter and beam trawls, but the exact habitat is unknown.

Remarks. Previously this species has only been described from Indonesia and the Philippines (Table 1), making this the first record for Australia. Our specimens agree well with the holotype colony described and figured in the original report of Thomson and Dean, but it is impossible to make any worthwhile comparisons with the rest of their brief description. The notable difference between the characters of our material and the comparable features reported by those authors is the more prickly warting of the sclerites (as was the case with *E. somaliensis* above). Unfortunately, the redescription did not include illustrations of the polyp sclerites, so we asked Dr Leen van Ofwegen to make a comparison using Verseveldt & Bayer's microscopic slides of the holotype sclerites of *E. splendens* held in the Naturalis Biodiversity Centre, Leiden, and he was able to confirm they are of the same form.

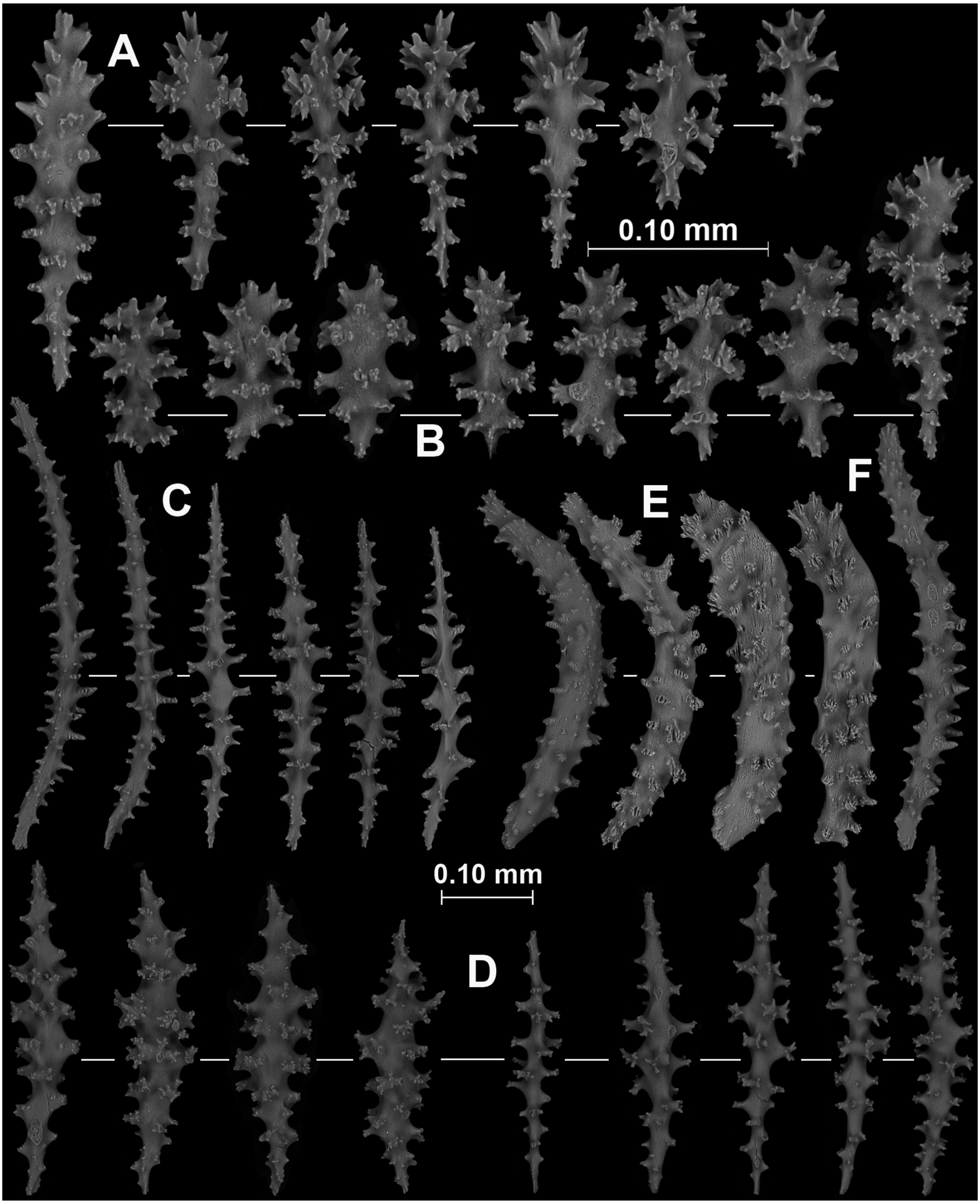

FIGURE 13. *Eleutherobia splendens* WAM Z23988-1, sclerites: A, surface of polyparium; B, surface of the base; C, interior of the polyparium; D, interior of the base; E, tentacle rachis; F, collaret and points.

Genus *Sphaerasclera* McFadden & Ofwegen 2013

Type species. *Eleutherobia flammicerebra* Williams, 2003, by original designation

Diagnosis. Colonies with capitate growth form, with distinct, spherical polyparium raised on a bare stalk. Polyps are monomorphic and form rounded coenenchymal mounds over the entire surface of the capitulum. Sclerites are coloured spheroids and smaller radiates. Polyp sclerites are absent. Species are found mostly in deep water. Azooxanthellate. (adapted from McFadden & Ofwegen 2013).

***Sphaerasclera flammicerebra* (Williams, 2003) new record**
(Fig. 7H; 14; Tabs. 1, 2)

Eleutherobia flammicerebra Williams, 2003: 423–434, Figs. 1 a–c, 2–8.
Sphaerasclera flammicerebra McFadden & Ofwegen 2013: 66–67, Fig. 2–3.

Material examined. WAM Z31480, three whole specimens, 21.6–26.3 mm tall, stalk length 12.0–20.4 mm, polyparium diameter 10.2–11.2 mm, Station PF06/S1-200/R2, 190 km NW of Dampier, Pluto Gas Field, NW Australia, 19.9352°–19.9308° S, 115.2261°–115.2288° E, epibenthic sled, depth 200 m, coll. B.F. Cohen, 7 December 2005; WAM Z31465, one small colony, 16.2 mm tall, stalk length 9.4 mm, polyparium diameter 7.9 mm, Station PF06/S1-200/R2, 190 km of NW of Dampier, Pluto Gas Field, 19.9352°–19.9308° S, 115.2261°–115.2288° E, epibenthic sled, depth, 200 m, coll. B.F. Cohen, 7 December 2005; WAM Z13065, Station 1031302, North West Cape, 21.4672° S, 114.1016° E, epibenthic sled, depth 200–250 m, coll. P. Alderslade, J. Fromont and L.M. Marsh, 21 March 2002; WAM Z55265, one whole colony, 22.0 mm tall, stalk length 13.2mm, polyparium diameter 15.2 mm, Station SO1/84/055, Lacepede Archipelago, 19.9500°–19.9833°S, 120.7683°–120.7350° E, CSIRO FRV "Soela" cruise VI, trawl, depth 297 m, coll. S.M. Slack-Smith, 10 February 1984; WAM Z54995, one whole specimen, 32.4 mm tall, stalk length 20.9 mm, polyparium diameter 16.1 mm, Station SO1/84/056, Kimberley, Beagle Bay, 16.9297° S , 122.5411° E, CSIRO FRV "Soela" cruise VI, trawl, depth 301 m, coll. S.M. Slack-Smith, 1 February 1984; WAM Z55271, one whole specimen, 20.4 mm tall, stalk length 11.3 mm, polyparium diameter 14.9 mm, Station SO1/84/059, Kimberley, Beagle Bay, 15.1500°–15.1833° S, 121.0833°–120.0500° E, CSIRO FRV "Soela" cruise VI, trawl, depth 449 m, coll. S.M. Slack-Smith, 11 February 1984. All colonies are attached to a fragment of hard coral skeleton.

Description. All colonies are attached to hard corals and have a capitate growth form, with a rounded capitulum with a scrolled lower margin and a straight or slightly bent, distinct stalk (Fig. 7H). The polyps are monomorphic, numerous and evenly distributed over the entire surface of the capitulum. In the preserved specimens all polyp bodies are retracted forming low, round coenenchymal mounds at the surface. The stem is polyp free. Colonies are between 16.2–32.3 mm tall and the length of the stalks ranges between 9.40–20.9 mm. The height of the polypariums range between 7.0–11.4 mm and have diameters between 7.9–16.1 mm. The diameter of the stalks ranges at base between 6.3–13.1 mm and between 4.2–11.5 mm at the distal end.

The surface of the polyparium is densely spiculated with large tuberculated spheroids between 0.12–0.20 mm long and smaller, oval 8-radiates 0.05–0.08 mm long (Fig. 14A). The sclerites of the interior of the polyparium are predominately round to oval-shaped tuberculated spheroids between 0.13–0.20 mm in length (Fig. 14B). Some robust 8-radiates around 0.17 mm in length are also present. The sclerites of the surface of the base is densely spiculated with large tuberculated spheroids 0.15–0.20 mm in length, medium-sized tuberculated spheroids mainly between 0.10–0.13 mm long, and smaller, oval 8-radiates 0.05–0.08 mm long (Fig. 14C). The sclerites in the interior of the stalk are predominately large tuberculated spheroids 0.17–0.21 mm in length and very robust radiates mainly around 0.10 mm long (14D). Polyp sclerites are absent.

Colour. The polyparium of the preserved colonies are cream to light orange with dark orange spots representing the protuberances. One colony has a uniformly light pink capitulum. The stalks are cream to orange. Sclerites are colourless and orange to around the protuberances.

Habitat. The specimens were sampled by epibenthic sled and trawl from a depth range between 200–449 m along the continental slope, but the exact habitat is unknown.

Remarks. *Sphaerasclera flammicerebra* (Williams, 2003) was first described from Palau, Pacific Ocean. McFadden & Ofwegen (2013: 62, 66, 67, Table 1, Fig. 2, 3) included museum material of *S. flammicerebra* collected from New Caledonia in 2008 and Mauritius collected in 1929 in their phylogenetic and morphological analyses. This material of *S. flammicerebra* agrees with the original description by Williams (2003: 423–430, Fig. 1–8) in most characters. The main difference are the rather spiky 8-radiates of our material in comparison to more rounded 8-radiates of Williams (2003) material. As the colonies agree with the original description of *S. flammicerebra* by being monomorphic, in the absence of polyp sclerites, the size and shape of the colonies, the size and distribution of sclerites types, and the genetic similarity, we consider the difference in sclerite shape of the smaller 8-radiates as a intraspecific variation (Fig. 7, 14, 19, 20).

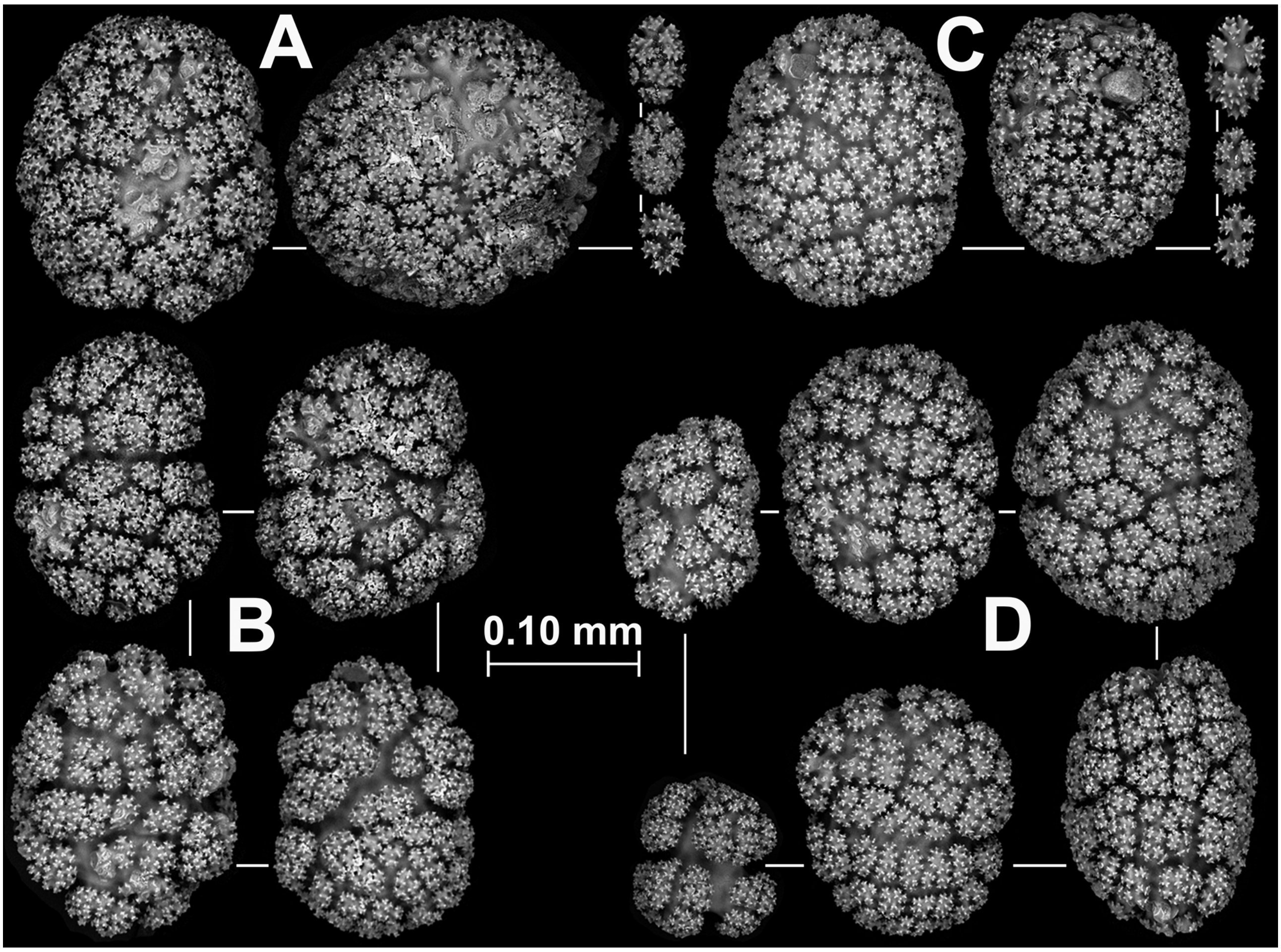

FIGURE 14. *Sphaerasclera flammicerebra,* WAM Z31480, sclerites: A, surface of polyparium; B, interior of the polyparium; C, surface of the base; D, interior of the base.

Genus *Paraminabea* Williams & Alderslade, 1999

Type species. *Bellonella indica* Thomson & Henderson, 1905 by subsequent designation (Williams & Alderslade 1999).

Diagnosis. Colonies usually small, unbranched, with symmetrical, cylindrical polyparium. Growth forms such as dome-shaped, digitiform, hemispherical, or digitate-lobate can occur. Dimorphic polyps are evenly distributed over the polyparium and are devoid of sclerites. Autozoids are large and completely retractile. Siphonozooids scarce, small to minute, distributed between the autozooids. The polyp-free basal portion is variable in length.

Mostly in deep water or restricted to caves and overhangs in shallow waters. Sclerites of polyparium mostly barrels, double heads and 6- or 8-radiates. Also, radiates, tuberculate spheroids, 7-radiates or double stars and spindle-like forms derived from radiates may occur.
(Williams & Alderslade 1999).

Paraminabea aldersladei **(Williams, 1992)**
(Figs. 15A,B,C; 16A–D; Tab. 2)

Bellonella indica (*non* Thomson & Henderson, 1905) Bayer 1974: 261; Faulkner and Chesher 1979: 267, Pl. 22; *Minabea aldersladei* Williams, 1992: 3–9, Figs 1b, 4, 5.

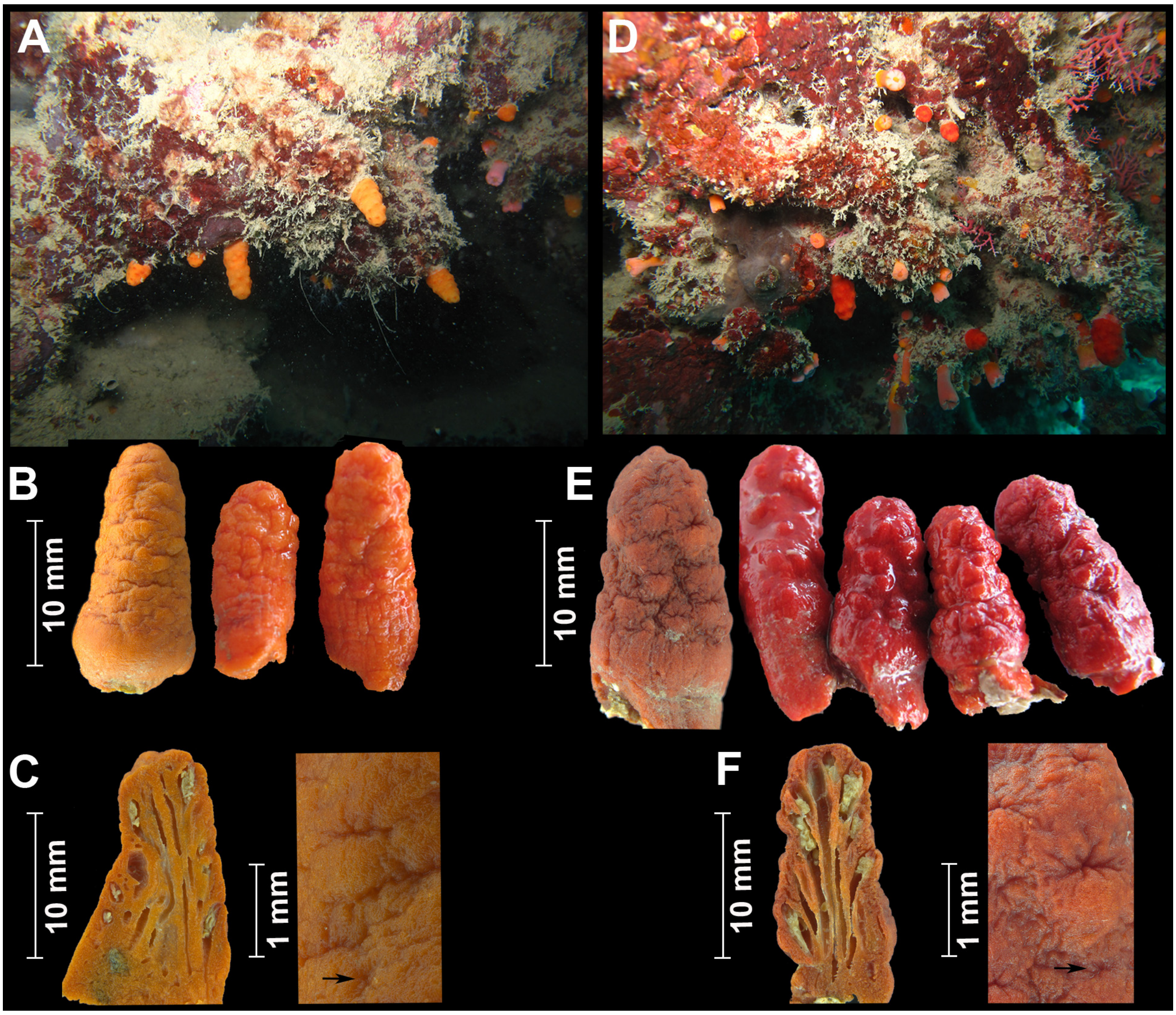

FIGURE 15. A–C, *Paraminabea aldersladei,* WAM Z59775: A, *in situ*; B, a preserved specimen and fresh specimens on deck after collection; C, longitudinal section showing gastric cavities of autozooids and siphonozooids and detail of the colony surface, black arrow pointing to siphonozooids; D–F, *Paraminabea* cf. *aldersladei,* WAM Z59783: D, *in situ*; E, a preserved specimen and fresh specimens on deck after collection; F, longitudinal section showing gastric cavities of autozooids and siphonozooids and detail of the colony surface, black arrow pointing to siphonozooids.

Material examined. WAM Z59775, five whole specimens, Station 43/K10, Long Reef, Kimberley, NW Australia, 13.92155° S, 125.73268° E, scuba, depth 12–20 m, coll. M. Bryce, 20 October 2010; WAM Z66736, six whole specimens, Station 115/K11, Heritage reef, Kimberley, NW Australia, 14.30367° S, 115.20915° E, scuba, depth 12–20 m, coll. M. Bryce, 22 September 2011; WAM Z67010, four whole specimens, Station 130/K13, Ashmore Reef, NW Australia, 12.18848° S, 123.12887° E, scuba, depth 12–20 m, coll. M. Bryce, 29 September 2013; WAM Z67106, 33 whole specimens, Station 144/K13, Hibernia Reef, NW Australia, 11.97404° S, 123.32208° E, scuba, depth 14 m, coll. M. Bryce, 5 October 2013; WAM Z67241, 24 whole specimens, Station 152/K14, Clerke Reef, NW Australia, 17.25188° S, 119.38378° E, scuba, depth 16 m, coll. M. Bryce, 3 October 2014; WAM Z67271, 1 whole specimens, Station 156/K14, Clerke Reef, NW Australia, 17.29298° S, 119.37819° E, scuba, depth 16 m, coll. M. Bryce, 5 October 2014; WAM Z67366, 1 whole specimens, Station 170/K14, Clerke Reef, NW Australia, 17.31697° S, 119.38378° E, scuba, depth 15 m, coll. M. Bryce, 10 October 2014; WAM Z67385, 1 whole specimens, Station 173/K14, Clerke Reef, NW Australia, 17.31753° S, 119.31216° E, scuba, depth 15 m, coll. M. Bryce, 11 October 2014; WAM Z67404, 2 whole specimens, Station 178/K14, Mermaid Reef, NW Australia, 17.16154° S, 119.6471° E, scuba, depth 15 m, coll. M. Bryce, 13 October 2014.

Description. All colonies are digitiform, slightly laterally flattened, tapering toward the rounded apical end and have a short, polyp-free base (Fig. 15A,B,C). They are between 10–53 mm tall, 4–18 mm in diameter at the apex and 4–25 mm in diameter across the holdfast. The polyps are dimorphic, and arranged uniformly over the surface of the colonies. In all colonies the autozooid polyps are completely retracted and surrounded by minute pores representing the siphonozooids.

Sclerites from the polyparium surface are predominantly eight radiates with double heads, that appear to be derived from 6- and 8-radiates, 0.04–0.09 mm long (Fig. 16A). Those from the interior of the polyparium are more robust barrels and sub-sheroidal forms of similar size with a very short waist (Fig. 16B). Sclerites from the base surface and interior are similar in shape to those of the polyparium, but slightly longer, 0.05–0.11 (Fig. 16C,D). Polyp sclerites are absent.

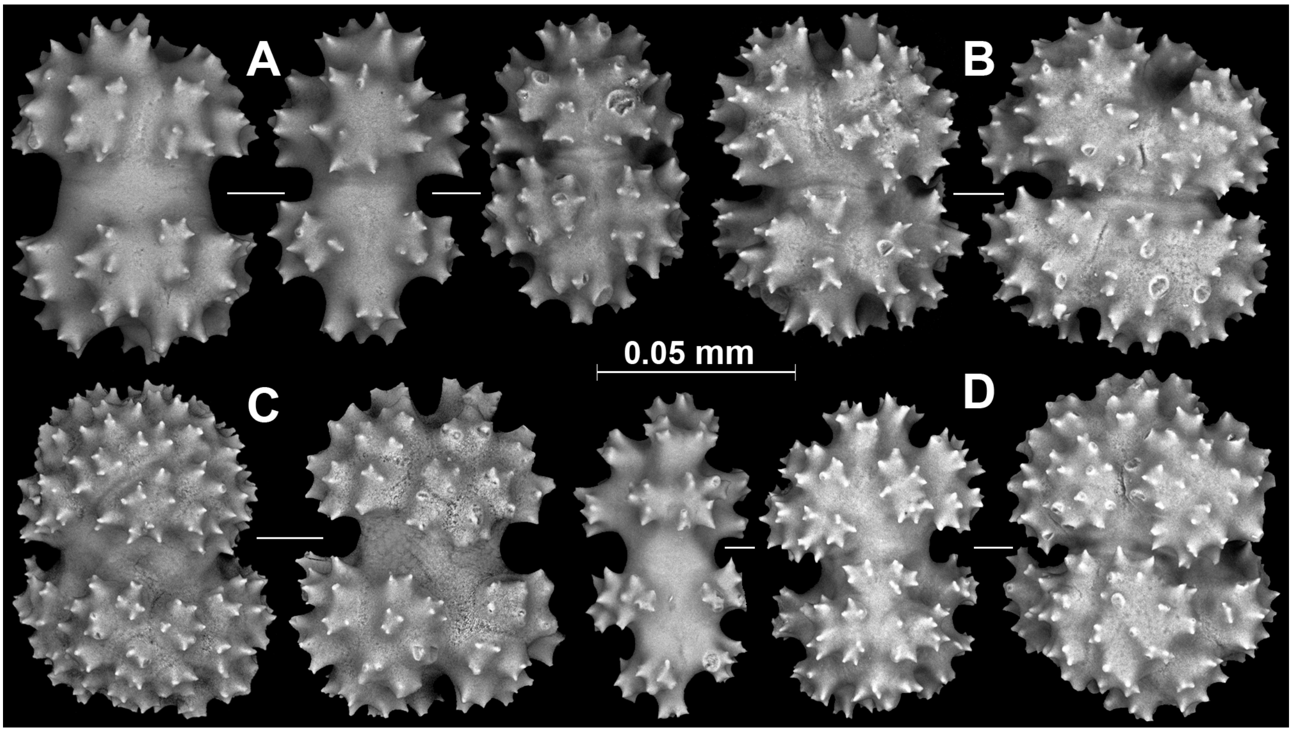

FIGURE 16. *Paraminabea aldersladei,* WAM Z59775, sclerites: A, surface of the polyparium; B, interior of the polyparium; C, surface of the base; D, interior of the base.

Colour. The colonies were uniformly bright orange *in situ*, on deck and in alcohol. The polyps in the preserved specimen are cream. Sclerite colour is orange.

Habitat. Station 43/K10: steep outer reef wall descending to 20 meters where the bottom is of fine silt. From there the honeycombed wall extends upwards with encrusting corals and soft corals, which rapidly increase in coverage. Specimens of *Paraminabea aldersladei* were found attached to the wall between 12 and 20 metres.

Station 115/K11: fore-reef slope with a vertical wall descending down to a coral rubble bottom. The reef crest has a high diversity of hard and soft corals, sea fans, and sponges. The vertical wall has small caves and ledges with little benthic invertebrate life. Specimens of *Paraminabea aldersladei* were attached to the wall between 12 and 20 metres.

Station 130/K13: a very steep and fractured fore-reef slope descending to a depth of 20 metres. The slope is deeply incised with caves and small ledges which are well covered with encrusting invertebrates. The small group of *Paraminabea aldersladei* colonies was found attached to a wall in an overhang at 20 metres depth.

Station 144/K13: the fore-reef cemented slope consists of separate "hillocks" that are joined at the base with deep "gullies" between. There is a high diversity of soft and hard corals and an abundant occurrence of *Paraminabea aldersladei*. The colonies were attached to the walls under overhangs amongst other scattered soft corals.

Remarks. *Paraminabea aldersladei* is a well-known species from the Indo-Pacific (Williams 1992; Table 2). In Australia *P. aldersladei* has been reported from the Great Barrier Reef and also from the Rowley Shoals, north-western Australia. The characters of this material agree well with the original description by Williams (1992, although no yellow colonies were encountered.

***Paraminabea* cf. *aldersladei* Williams & Alderslade, 1999**
(Figs. 15D,E,F, 17A,B; 18A,B; Tab. 2)

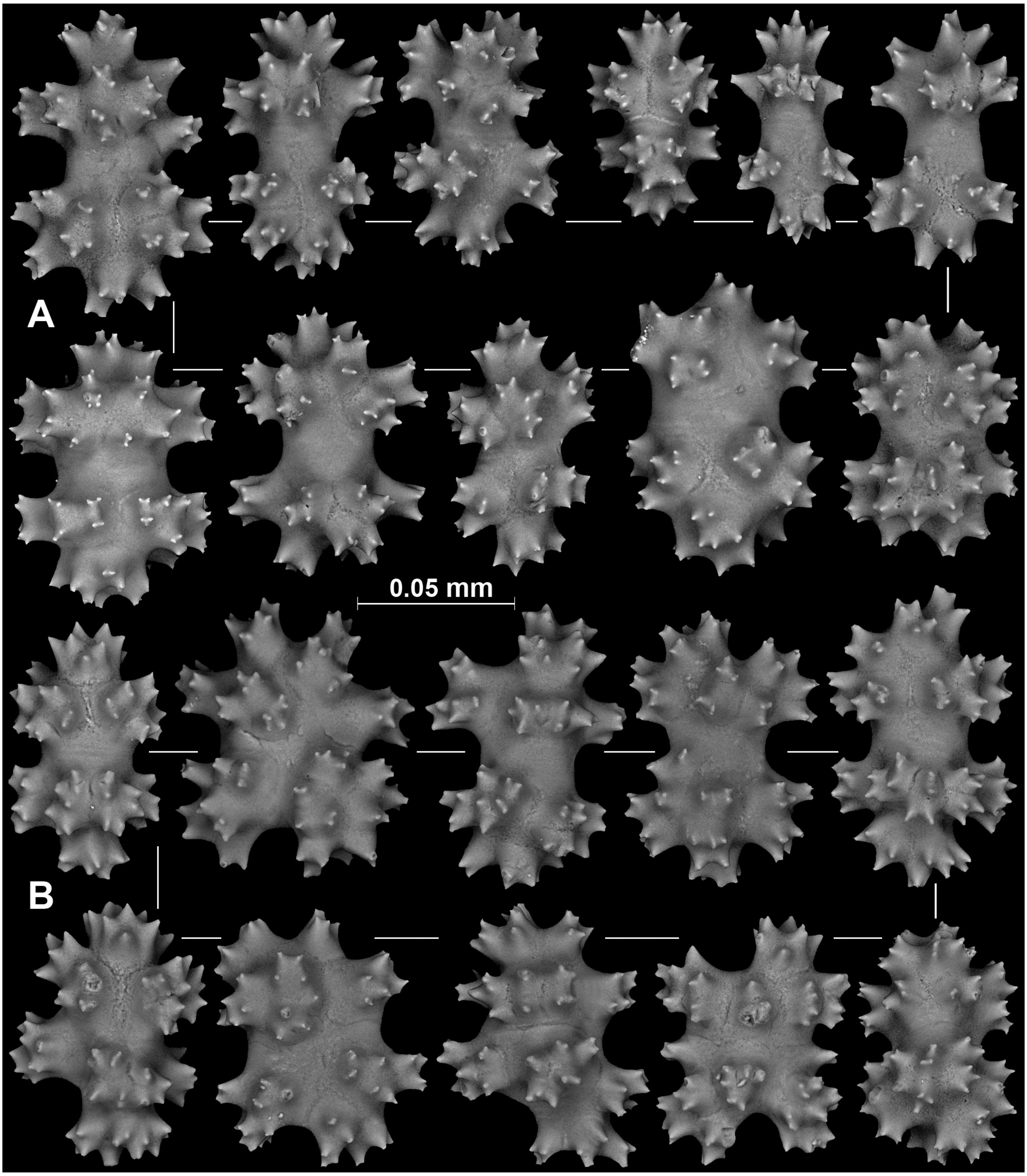

FIGURE 17. *Paraminabea* cf. *aldersladei,* WAM Z59783, sclerites: A, surface of the polyparium; B, interior of the polyparium.

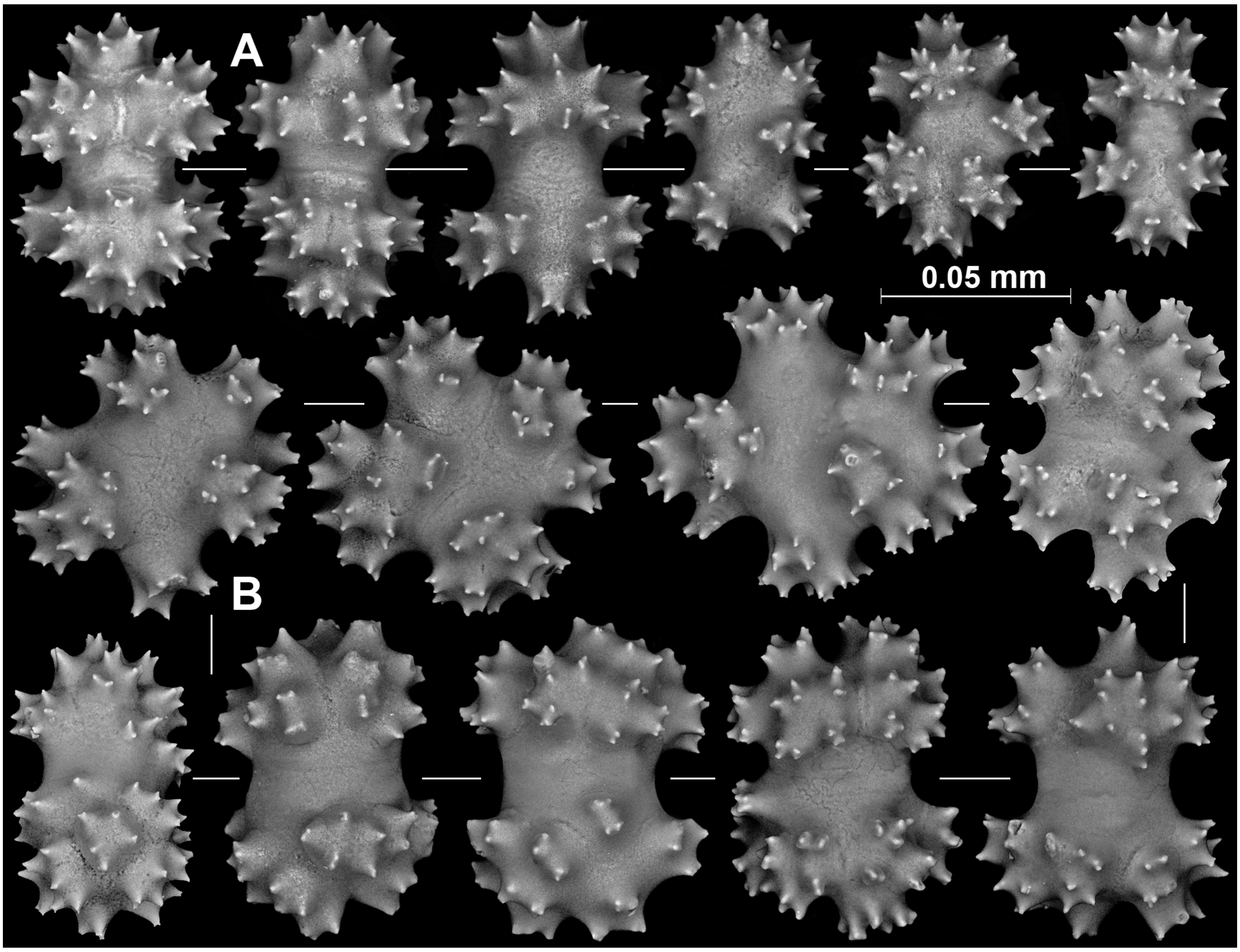

FIGURE 18. *Paraminabea* cf. *aldersladei,* WAM Z59783, sclerites: A, surface of the base; B, interior of the base.

Material examined. WAM Z59783, five whole specimens, Station 44/K10, Long Reef, Kimberley, NW Australia, 13.92155° S, 125.73268° E, scuba, depth 10–20 m, coll. M. Bryce, 20 October 2010.

Description. The colonies are either uniformly cylindrical from the base to the apical tip or are tapering toward the rounded apical end (Fig. 15D,E,F). They have a short, slightly laterally flattened polyp-free base. The polyps are dimorphic, and arranged uniformly over 60–90 % of the surface of the colonies. In all colonies the autozoids are completely retracted. The surface of the preserved specimens is extremely contracted and appears convoluted, which makes the siphonozooids difficult to locate. The gastric cavities of the autozooids form curved tubes (Fig. 15F). Colonies are between 16–24 mm tall, 3–7 mm in diameter at the apex and 5–7 mm in diameter across the holdfast.

In the surface of the polyparium the sclerites are mostly 8-radiates and some cylindrical to oval forms, 0.04 to 0.09 mm long (Fig. 17A), and in the interior the sclerites are double stars or double heads and irregular forms, some approaching crosses, from about 0.05 to 0.07 mm long (Fig. 17B). The sclerites from the base are similar to those of the polyparium, consisting mostly of 8-radiates in the surface, from 0.06 to 0.08 mm long (Fig.18A), and double heads or double-stars, with a long waist, together with irregular forms approaching crosses, up to 0.09 mm long, in the interior (Fig. 18B). Polyp sclerites are absent.

Colour. The colonies were uniformly dark red *in situ* and on deck. In alcohol the specimens are dark orange. The polyps in the preserved specimens are cream. The colour of the sclerites is red.

Habitat. Very steep and fractured fore-reef slope ascending from 20 up to four metres depth. The slope is heavily pocketed with small caves and deep, steep-sided fissures. At 20 metres there are large rocky outcrops forming long-reef gullies, which are almost devoid of life, probably due to the heavy siltation. Sediment between the rocky outcrops is very fine and smothering. A small group of *Paraminabea cf. aldersladei* was found attached to the wall together with a group of *Eleutherobia kimberleyensis* **sp. nov.** in an overhang at ten meters depth amongst other scattered soft corals.

Remarks. *Paraminabea cf. aldersladei* has similarities to *P. aldersladei, P. indica,* and *P. robusta.* It resembles *P. aldersladei* in growth form, but differs in type and distribution of the sclerites. *P. aldersladei* is bright orange and has mainly orange 8-radiates, double-heads, robust barrels and subspheroidal forms, while this species has red sclerites consisting predominately of radiates, double heads and complex cross-like forms. *Paraminabea indica* differs from *Paraminabea cf. aldersladei* by being dichromatic, the restriction of the polyps to less than half of the colony length, and the lack of tuberculated spheroids. It also appears to be restricted to deep water. The main differences between *P. cf. aldersladei* and *P. robusta* are colour, colony length and the morphology and distribution of the siphonozooids.

Molecular Phylogeny

The mitochondrial marker *mtMutS* was successfully amplified for all analyzed specimens, except for *E. splendens* (Table 3). In contrast, the ~800 bp fragment of the 28S nuclear ribosomal gene was only successfully amplified for five specimens. For *Parasphaerasclera grayi*, *Parasphaerasclera kimberleyensis* **sp. nov.** and *Eleutherobia somaliensis* only partial sequences were recovered and amplification was not possible for *Sphaerasclera flammicerebra* and *Eleutherobia splendens*. Both *mtMutS* and 28S phylogenies resulted in a polyphyletic family Alcyoniidae (Figs. 19, 20). The mitochondrial phylogenetic tree separates the genera *Eleutherobia*, *Paraminabea*, *Parasphaerasclera* and *Sphaerasclera* in four monophyletic groups. Apart from the clade including the genus *Parasphaerasclera*, supported only in the ML analysis, the others were well supported by both methods. The sampled specimens belonging to these genera were distributed in three clades in the mitochondrial phylogeny. In particular the new species *Parasphaerasclera kimberleyensis* was included in a clade with five other species of *Parasphaerasclera* (*P. aurea*, *P. grayi*, *P.* aff. *grayi*, *P. rotifera* and *P. valdiviae*). *P. grayi* and *P.* aff. *grayi* were respectively sister to *P. aurea* and *P. kimberleyensis,* while the relationship between *P. rotifera* and other members of *Parasphaerasclera* was unresolved. *S. flammicerebra* was sister to *Paraminabea aldersladei*, *P.* cf. *aldersladei* and a clade including the scleraxonians *Paragorgia wahine*, *Corallium laauense* and the alcyoniid *Anthomastus ritteri*. The nuclear phylogenetic tree recovered a monophyletic *Paraminabea* and *Eleutherobia*, but did not clarify the relationships within *Parasphaerasclera*, as many of the nodes including those species were collapsed into polytomies due to their low support values (Figs. 19, 20). The species belonging the genus *Paraminabea* (i.e. *P. aldersladei* and *P.* cf. *aldersladei*) formed a well supported clade, but their relationships with other alcyoniids remained largely unresolved. Notably, both the mitochondrial and nuclear phylogenies recovered the three sampled species belonging the genus *Eleutherobia* (i.e. *E. australiensis* **sp. nov.**, *E. imahari* **sp. nov.** and *E. somaliensis*) as monophyletic, and this clade nested in a larger clade composed of *Alcyonium* species.

Discussion

General summary. The present account is the first comprehensive inventory of digitate and capitate soft corals of the genera *Eleutherobia, Parasphaerasclera, Sphaerasclera* and *Paraminabea* of tropical Western Australia. It reports on three new species (*Parasphaerasclera kimberleyensis, Eleutherobia australiensis*, *Eleutherobia imaharai*), three range extensions (*Parasphaerasclera grayi, Eleutherobia somaliensis*, *Eleutherobia splendens),* and one new geographical record *(Sphaerasclera flammicerebra*), and discusses their taxonomic placement. Given the limitations of traditional morphological taxonomy, we used an integrative approach for the Western Australian material, combining morphological examinations with molecular phylogenetic analyses to clarify the status and placement of the specimens.

The literature detailing species of the genus *Eleutherobia* prior to 2013 is plagued with confusion (Williams 1986). Verseveldt & Bayer revised the genus *Eleutherobia* in 1988, but a new taxonomic revision of this genus was overdue as more species had subsequently been added. Benayahu & Schleyer (1995) mentioned the possible poly- or paraphyly of *Eleutherobia,* as the genus incorporated species with highly variable sclerites and body plans resulting in confusion over its generic characters. In 2013 McFadden & Ofwegen used morphology together with molecular investigation of some nominal species of the genus, to provide sufficient evidence to propose the new family Parasphaerascleridae and the new genera *Parasphaerasclera* and *Sphaerasclera*. Six nominal species of *Eleutherobia* without polyp sclerites were assigned to the new genus *Parasphaerasclera* (Table 1, 2), the only capitate nominal species of *Eleutherobia* with spheroids (*E. flammicerebra*) was assigned to the new genus *Sphaerasclera* and the capitate *E. variabile* was re-assigned to *Alcyonium*. Our molecular results confirm the separation of *Eleutherobia, Parasphaerasclera,* and *Sphaerasclera* as different genera and provide further evidence that the genus *Eleutherobia* is monophyletic (Figs. 19, 20; Table 2).

FIGURE 19. Phylogenetic tree of *mtMutS.* Numbers at the nodes represent: on the left ML bootstrap values and on the right Bayesian posterior probabilities (pp). Nodes with bootstrap value < 70 % and pp < 0.95 were collapsed. Triangles represent collapsed clades with strong support (pp = 1). Specimens analyzed belonging to *Parasphaerasclera*, *Eleutherobia*, and *Sphaerasclera* are in bold. *Cornularia pabloi* was used as the outgroup.

Former species of *Eleutherobia* and those species of the genus currently considered valid, incorporate possible rare species with an Indo-Pacific biogeography, ranging from South Africa to the central west Pacific, Japan and Australia (Table 1) (Williams, 1999; 2001), but the known geographic range of some of the species has been expanded. Two species, *Eleutherobia somaliensis* and *Sphaerasclera flammicerebra*, have now been reported from areas far removed from their type locality, and Benayahu *et al.* (2004) reported *P. grayi* as a new record from Taiwan. The latter authors suggest that the position of Taiwan, between the West Pacific Ocean, the East China Sea and the crossroad of the Philippine-Japan Island Arc forms a stepping stone for the dispersal of shallow reef organisms. The finding of new species and geographical records in this paper may indicate that species diversity, and associated distributional ranges of *Eleutherobia* and *Parasphaerasclera,* may have been underestimated in remote areas, such as along the Western Australian coast.

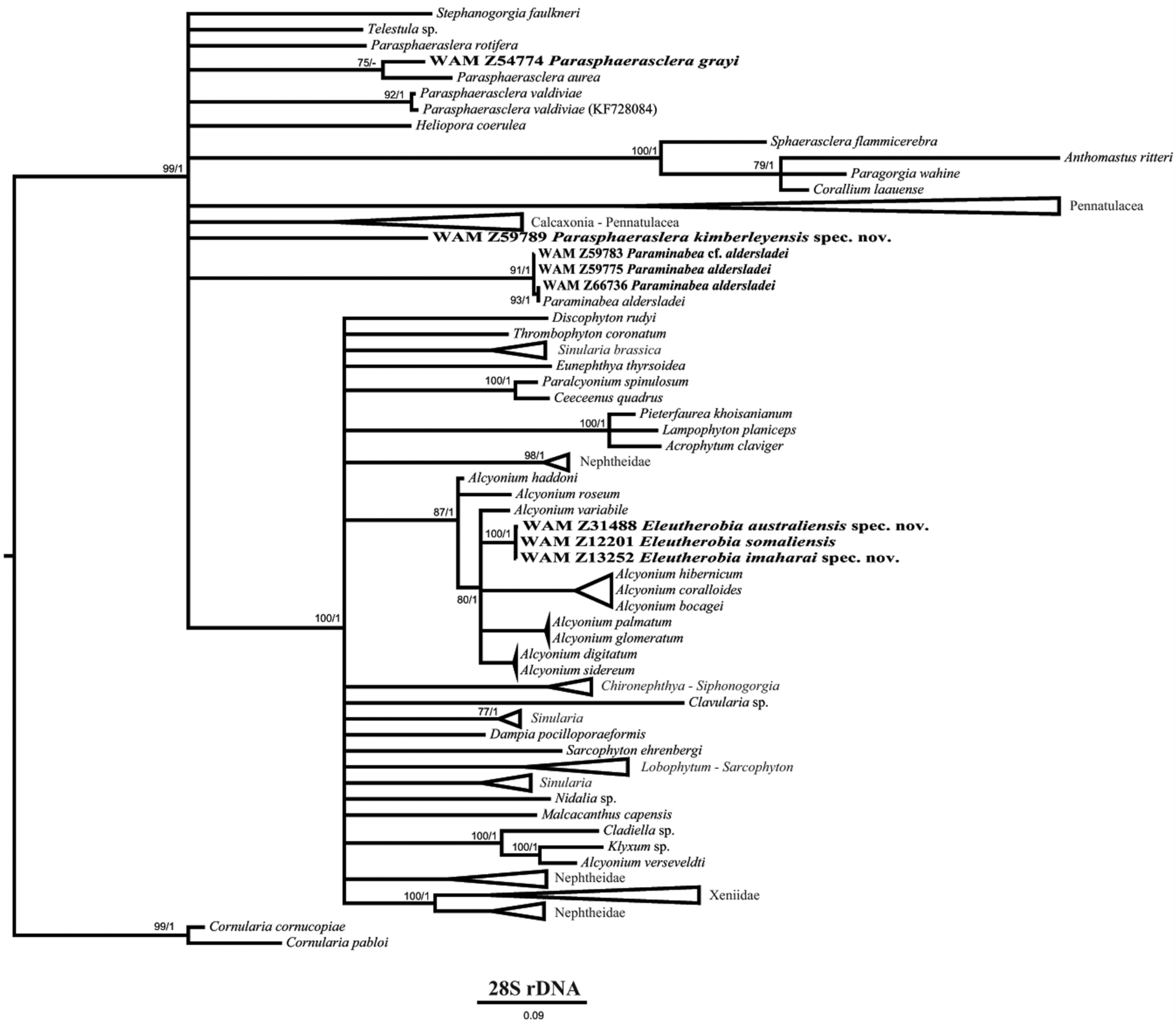

FIGURE 20. Phylogenetic tree of the 28S ribosomal gene. Numbers at the nodes represent: on the left ML bootstrap values and on the right Bayesian posterior probabilities (pp). Nodes with bootstrap value < 70 % and pp < 0.9 were collapsed. Triangles represent collapsed clades with strong support (pp ≥ 0.95). Specimens analyzed belonging to *Parasphaerasclera, Eleutherobia*, and *Sphaerasclera* are in bold. *Cornularia cornucopiae* and *Cornularia pabloi* were used as outgroup.

One new species, *Parasphaerasclera kimberleyensis* **sp. nov.**, was found together with *Paraminabea aldersladei* at Long Reef. These species found in shallower habitats have adapted to a cryptic lifestyle, preferring darker areas, such as overhangs and caves. A dark red specimen identified herein as *Paraminabea* cf. *aldersladei* was also found at this site. Despite these two specimens of *Paraminabea, Paraminabea aldersladei and Paraminabea cf. aldersladei,* being exposed to the same environmental conditions, colour and sclerite shape are distinctly different. Nevertheless, the genus is known for its high intraspecific phenotypic variability. Using sclerite shape as the only determining factor for species identification is problematic (Williams & Alderslade 1999). The lack of molecular differences between the dark red *Paraminabea* cf. *aldersladei* specimen and that of *P. aldersladei* point to them being colour and morphological variants of the latter species, rather than separate species. However, we acknowledge that the lack of divergence in the *mtMutS* marker does not necessarily mean conspecificity, given the slow rates of molecular evolution reported for the mitochondria of anthozoans (Shearer *et al.* 2002). Further studies and the analysis of rapidly evolving molecular markers seem necessary to clarify this matter (see Pante *et al.* 2014).

Molecular considerations. The combination of morphological characters, geographic distribution and the compatibility with the generic diagnoses provide enough evidence to propose the placement of the new species *P. kimberleyensis* **sp. nov.** in the newly erected genus *Parasphaerasclera* and the second and third new species, *E. australiensis* **sp. nov.** and *E. imaharai* **sp. nov.**, in the genus *Eleutherobia*.

TABLE 3. Octocoral taxa used for phylogenetic analysis with voucher and GenBank accession numbers. New specimens here analysed are in boldface. RMNH = Naturalis Biodiversity Center; ZSM = Zoologische Staatssammlung München; ZMTAU = Zoological Museum, Tel Aviv University; WAM = Western Australian Museum; NTM = Museum and Art Gallery of the Northern Territory; CSM = C.S. McFadden Laboratory; MNHN = Museum National d'Histoire Naturelle, Paris; SBMNH: Santa Barbara Museum of Natural History; QM = Queensland Museum; USNM = National Museum of Natural History (Smithsonian Institute); CRCNI = Palau International Coral Reef Center; UF = Florida Natural History Museum; NIWA = National Institute of Water and Atmospheric Research (New Zealand); OCDN = Coral Reef Research Foundation (Palau). *see Pante *et al.* (2012).

					GenBank accession numbers	
Order	**Suborder**	**Family**	**Species**	**Voucher**	***mtMutS***	**28S rDNA**
Alcyonacea	Alcyoniina	Alcyoniidae	*Acrophytum claviger*	RMNH Coel. 40222	JX203770	JX203655
			Alcyonium acaule		AY607775	
			Alcyonium aurantiacum		DQ302806	
			Alcyonium bocagei	RMNH Coel. 39672	GU355960	KF728088
			Alcyonium coralloides		AY607772	JX203640
			Alcyonium digitatum		AY607777	JX203641
			Alcyonium glomeratum	RMNH Coel. 39666	AY607776	KF728091
			Alcyonium haddoni	ZSM 20061191	GU355974	JX203642
			Alcyonium hibernicum	RMNH Coel. 39661	AY607771	KF728089
			Alcyonium palmatum		GQ342467	JX203643
			Alcyonium sidereum		GU355972	KF728090
			Alcyonium roseum	ZSM 20061195	GQ342468	JX203644
			Alcyonium variabile		KF728095	JX203645
			Alcyonium verseveldti	ZMTAU CO33097	GU356012	JX991219
			Anthomastus ritteri	RMNH Coel. 40802	DQ302816	JX203761
			Alcyonium bocagei		AY607774	
			Cladiella sp.	WAM Z59835	HG970087	HG970073
			Dampia pocilloporaeformis	WAM Z59725	HG970088	HG970074
			Discophyton rudyi	CSM-DIRU15	DQ302808	JX203659
			Elbeenus lauramartinae		DQ536320	
			***Eleutherobia australiensis*, sp. nov.**	**WAM Z31488**	**HG970078**	**HG970065**
			***Eleutherobia imaharai*, sp. nov.**	**WAM Z13252**	**HG970080**	**HG970067**
			Eleutherobia somaliensis	**WAM Z12201**	**HG970079**	**HG970066**
			Klyxum sp.	WAM Z59659	HG970089	HG970076

......continued on the next page

TABLE 3. (Continued)

Order	Suborder	Family	Species	Voucher	GenBank accession numbers	
					mtMutS	**28S rDNA**
			Lampophyton planiceps	RMNH Coel. 40201	GQ342477	JX203656
			Lobophytum cf. *altum*	WAM Z59839		HG970075
			Lobophytum compactum	NTM-C011566	DQ280559	
			Lobophytum legitimum	NTM-C013980	DQ280571	
			Lobophytum pauciflorum	UF 2856		JX203649
			Lobophytum ransoni	NTM-C013929	DQ280578	
			Lobophytum sarcophytoides	RMNH-Coel.33065	DQ280582	
			Lobophytum strictum	NTM-C011271	DQ280584	
			Malcacanthus capensis	RMNH Coel. 40801	DQ302811	JX203660
			Paraminabea aldersladei	NTM C14895	JX203767	JX203763
			Paraminabea aldersladei	**WAM Z66736**	**HG970083**	**HG970070**
			Paraminabea aldersladei	**WAM Z59775**	**HG970084**	**HG970071**
			Paraminabea* cf. *aldersladei	**WAM Z59783**	**HG970085**	**HG970072**
			Rhytisma sp.	NTM-C001942	DQ302812	
			Sarcophyton ehrenbergi	NTM C14455		JX203650
			Sarcophyton elegans	UF2637	DQ280520	
			Sarcophyton gemmatum	ZMTAU CO34091	GU356017	
			Sarcophyton mililatensis	RMNH-Coel.33080	DQ280541	
			Sarcophyton trocheliophorum	NTM C14854		JX203651
			Sarcophyton trocheliophorum		AB759314	
			Sarcophyton trocheliophorum	NTM-C014469	DQ280549	
			Sinularia abrupta	ZMTAU CO33623		KC542822
			Sinularia brassica	NTM C13507	FJ621379	
			Sinularia brassica	NTM C14185	FJ621380	
			Sinularia brassica	WAM Z59651	HG970090	
			Sinularia brassica	RMNH Coel. 41306		KF915494
			Sinularia brassica	RMNH Coel. 41309		KF915493
			Sinularia compressa	ZMTAU CO34142	FJ621387	

......*continued on the next page*

TABLE 3. (Continued)

Order	Suborder	Family	Species	Voucher	GenBank accession numbers	
					mtMutS	28S rDNA
			Sinularia digitata	RMNH Coel.40841		KC542830
			Sinularia dura	NTM C13808	FJ621402	
			Sinularia erecta	ZMTAU CO34144	FJ621404	KC542835
			Sinularia finitima	RMNH Coel.38728	FJ621407	
			Sinularia finitima	RMNH Coel.41332		KF915495
			Sinularia gardineri	ZMTAU CO34097		KC542819
			Sinularia hirta	ZMTAU CO34103	FJ621429	
			Sinularia hirta	ZMTAU CO34100		KC542820
			Sinularia leptoclados	ZMTAU CO35308		KC542836
			Sinularia mammifera	NTM C14198	FJ621444	
			Sinularia maxima	NTM C14512	FJ621448	KC542839
			Sinularia polydactyla	ZMTAU CO34138	FJ621466	
			Sinularia polydactyla	RMNH Coel.41339		KF915515
			Sinularia querciformis	ZMTAU CO34096	FJ621469	JX203652
			Sinularia robusta	NTM C14518		KC542843
			Sinularia sp.	WAM Z59808	HG970091	
			Sinularia sp.	WAM Z59770		HG970077
			Sinularia terspilli	ZMTAU CO34156		KC542821
			Sphaerasclera flammicerebra	MNHN-IK-2012-12004	JX203765	JX203638
			Sphaerasclera flammicerebra	**WAM Z31480**	**HG970086**	
			Thrombophyton coronatum	SBMNH 145123	DQ302814	JX203661
		Nephtheidae	*Capnella imbricata*		DQ302817	
			Dendronephthya sinaiensis	ZMTAU CO34163		JX124349
			Dendronephthya sp.	NTM-C012655	DQ302818	
			Dendronephthya sp. A	RMNH Coel. 40907		KF915354
			Eunephthya thyrsoidea	RMNH Coel. 40182	JX124364	JX124340

......*continued on the next page*

TABLE 3. (Continued)

Order	Suborder	Family	Species	Voucher	GenBank accession numbers	
					mtMutS	28S rDNA
			Lemnalia sp.	RMNH Coel. 40818	JX203802	JX203726
			Leptophyton benayahui		GQ342507	
			Nephthea acuticonica	ZMTAU CO34070	GU356023	
			Nephthea sp.	NTM-C012400	DQ302822	
			Nephthea sp.		JN383340	
			Nephthea sp. B	RMNH Coel. 40972		KF915417
			Neospongodes sp.	NTM-C013130	DQ302823	
			Paralemnalia digitiformis		DQ302824	
			Paralemnalia digitiformis	RMNH Coel. 40941		KF915418
			Paralemnalia eburnea	ZMTAU CO34081	GU356030	
			Paralemnalia thyrsoides	ZMTAU CO34087		JX203727
			Scleronephthya corymbosa	ZMTAU CO34159	GQ342511	JX124350
			Scleronephthya sp.	NTM-C011489	DQ302825	
			Scleronephthya sp. A	RMNH Coel. 41039		KF915486
			Stereonephthya cundabiluensis	ZMTAU CO34204		JX124351
			Stereonephthya sp.	NTM-C011307	DQ302826	
			Stereonephthya sp. B	RMNH Coel. 41061		KF915541
			Umbellulifera sp.	NTM-C011063	DQ302827	
		Nidaliidae	*Chironephthya* sp.	NTM-C012426	DQ302830	
			Chironephthya sp.	ZMTAU CO34203	GQ342513	JX203730
			Chironephthya sp. 1	ZMTAU CO34223	GU356025	
			Chironephthya sp. 2	ZMTAU CO34222	GU356024	
			Chironephthya sp. 3	ZMTAU CO34226	GU356026	
			Chironephthya sp. A	RMNH Coel. 40893		KF915337

......*continued on the next page*

TABLE 3. (Continued)

Order	Suborder	Family	Species	Voucher	GenBank accession numbers	
					mtMutS	28S rDNA
			Chironephthya sp. B	RMNH Coel. 40889		KF915339
			Chironephthya sp. C	RMNH Coel. 40890		KF915343
			Chironephthya sp. D	RMNH Coel. 40900		KF915348
			Chironephthya sp. D	RMNH Coel. 40897		KF915347
			Nephthyigorgia sp.	NTM-C011345	DQ302831	
			Nephthyigorgia sp.	RMNH Coel.40819	JX203804	JX203732
			Nidalia sp.	NTM C014876	DQ302828	JX203729
			Pieterfaurea khoisanianum	CSM-SAF183	GQ342510	JX203657
			Siphonogorgia sp.	NTM-C011159	DQ302832	
			Siphonogorgia sp. A	RMNH Coel. 41044		KF915529
			Siphonogorgia godeffroyi	RMNH Coel. 40833	JX203803	JX203731
		Paralcyoniidae	*Ceeceenus quadrus*	UF2858	GQ342514	JX124346
			Paralcyonium spinulosum	RMNH Coel. 40820	DQ302833	JX124347
		Parasphaerascleridae	*Parasphaerasclera aurea*	RMNH Coel. 40799	JX203766	GQ377456
			Parasphaerasclera grayi	**WAM Z54774**	**HG970081**	**HG970068**
			Parasphaerasclera aff. grayi	NTM C14902	DQ302809	
			***Parasphaerasclera kimberleyensis*, sp. nov.**	**WAM Z59789**	**HG970082**	**HG970069**
			Parasphaerasclera rotifera	UF3890	GQ342472	JX203639
			Parasphaerasclera valdiviae	RMNH Coel. 41532	KF728097	KF728085
			Parasphaerasclera valdiviae	RMNH Coel. 41534	KF728096	KF728084
		Xeniidae	*Anthelia glauca*	ZMTAU CO34183	JX203812	JX203753
			Asterospicularia randalli		DQ302836	
			Asterospicularia randalli	RMNH Coel. 41521		KF915316
			Cespitularia erecta	OCDN-8504C	JX203813	JX203755
			Cespitularia sp.	NTM-C013542	DQ302837	
			Efflatounaria sp.	NTM-C012311	DQ302838	
			Ovabunda obscuronata	ZMTAU CO34077	GU356027	

......continued on the next page

TABLE 3. (Continued)

Order	Suborder	Family	Species	Voucher	GenBank accession numbers	
					mtMutS	**28S rDNA**
			Sansibia sp.	NTM-C012955	DQ302840	
			Sarcothelia edmondsoni	CSM-SKB		JX203757
			Sarcothelia sp.	NTM-C015151	DQ302841	
			Sarcothelia sp.			KM201434
			Xenia hicksoni	ZMTAU CO34072	GQ342529	JX203759
	Calcaxonia	Chrysogorgiidae	**Stephanogorgia faulkneri*	NTM C14927	GQ342485	JX203718
		Ellisellidae	*Viminella* sp.	RMNH Coel. 40032	JX203794	JX203703
	Scleraxonia	Corallidae	*Corallium laauense*	USNM 1071433	GQ293301	GQ293265
		Paragorgiidae	*Paragorgia wahine*	NIWA 3326	GQ293314	GQ293263
	Stolonifera	Clavulariidae	*Clavularia* sp.	RMNH Coel.40809	JX203778	JX203678
			Cornularia cornucopiae	PLG 2012		JX203760
		Cornulariidae	*Cornularia pabloi*	RMNH Coel.40197	JX203791	
			Cornularia pabloi	USNM 1178390	JX203792	JX203699
		Telestidae	*Telestula* cf. *spiculicola*		GU563311	
			Telestula sp.	NTM C14984		JX203697
Helioporacea		Helioporidae	*Heliopora coerulea*	CRCNI 577	DQ302872	JX203716
Pennatulacea		Echinoptilidae	*Actinoptilum molle*	RMNH Coel. 40822	GQ342491	JX203738
		Halipteridae	*Halipteris finmarchica*	NTM C14596	DQ302868	JX203741
		Pennatulidae	*Gyrophyllum sibogae*	NOR89/53		JX203740
			Gyrophyllum sp.	NTM-C014392	DQ302869	
	Subsessiliflorae	Virgulariidae	*Virgularia schultzei*	RMNH Coel. 40823	GQ342527	JX203743

From a molecular perspective, in the mitochondrial tree, *Parasphaerasclera kimberleyensis* **sp. nov.** is sister to *Parasphaerasclera grayi,* both being collected from shallow water habitats of the Kimberley, and is included in a supported clade together with *Parasphaerasclera rotifera*, *Parasphaerasclera aurea, and Parasphaerasclera valdiviae*. These species are characterized by lacking sclerites in their polyps. In contrast, the 28S rDNA phylogeny resulted in *Parasphaerasclera kimberleyensis* **sp. nov.** being separated from the co-generic species. However, the relationships shown in the 28S rDNA phylogeny are poorly resolved in this part of the tree, with several deep nodes collapsed into polytomies due to their low support values. In addition, it is worth noting that only a partial 28S rDNA sequence (~250 bp) was recovered from *Parasphaerasclera kimberleyensis* **sp. nov.** and the recovered fragment includes a highly conserved region of the 28S rDNA gene. Thus the phylogenetic placement of *Parasphaerasclera kimberleyensis* **sp. nov.** should be treated as uncertain in the 28S rDNA phylogeny.

Until now the only published records of *Eleutherobia* from the west coast of Australia were for *E. rubra* (Brundin, 1896) from Port Headland (Verseveldt & Bayer, 1988). Colonies of this species are slightly flattened and have dome-shaped polyp mounds with the openings offset to the top of the colony. Our molecular analyses supported a clade including *E. australiensis* **sp. nov.**, *E. somaliensis* and *E. imaharai* **sp. nov.** and in both phylogenies these taxa nested in a clade including *Alcyonium* species. These results are in agreement with McFadden & Ofwegen (2013) who reassigned two species of *Eleutherobia* with capitate growth form to the genus *Alcyonium* and stated that all species of *Eleutherobia,* 'with polyps with distinct collaret and points of spindles; radiates, spindles and club-like sclerites in the colony surface; and spindles in the interior coenenchyme' likely belong to *Alcyonium sensu stricto*. These species include the new species *E. australiensis* **sp. nov.** and *E. imaharai* **sp. nov.**, as well as the remaining *Eleutherobia* species *E. dofleini*, *E. duriuscula*, *E. flava*, *E. grandiflora*, *E. rigida*, *E. rubra*, *E. splendens*, *E. somaliensis*, *E. sumbawaensis*, *E. unicolor*, and *E. vinadigitaria*.

In the interest of efficiency and clarity over time we believe that all remaining *Eleutherobia* species and the newly described ones will move into the *Alcyonium* clade once further molecular information is forthcoming. However, to prevent confusion the authors prefer at this stage that this action is better undertaken as a single change at a future date.

The distinct, curved bars found in the tentacles of *E. imaharai* **sp. nov.** are different from the tentacle sclerites found in all other species of *Eleutherobia* where they are known. There are, however, some similarities to the flattened, curved spindles of *E. australiensis* **sp. nov.**, which themselves may be similar to those of *E. somaliensis* described by Verseveldt & Bayer (1988: 39) as "two rows of distally diverging, flat, marginally toothed sclerites…".

E. splendens DNA did not amplify and therefore no genetic or phylogenetic information exists on this species. Finally, the capitate *Sphaerasclera flammicerebra* shows as being related to species of *Paraminabea* in the mitochondrial tree.

Implications. We would also like to highlight the role of comprehensive surveys in remote areas, such as the surveys of Kimberley marine environments by the Western Australian Museum. These surveys provide a clearer understanding of soft coral taxonomy, systematics and distributional patterns in tropical marine environments. This has implications for marine area protection (Fabricius 2008; Schleyer & Benayahu 2008; Keesing *et al.* 2011) as collections of new and known species are growing and new records of soft corals can be expected from this poorly studied area of the eastern Indian Ocean. Molecular techniques clarifying soft coral taxonomy are rapidly advancing and becoming a reliable tool for understanding their taxonomic relationships (McFadden *et al*. 2006; Breedy *et al.* 2012; McFadden *et al.* 2013). Future integrative studies will increase our knowledge and result in a more reliable system for the Octocorallia. This work underpins the hypothesis that the west coast of Australia is a unique ecosystem supporting a rich and diverse marine fauna (Marsh 1993; Bryce 2009; Masini *et al.* 2009; Wilson 2013), and further investigations will enhance our understanding of these unique environments.

Acknowledgements

Invertebrate collections were made as part of the Census of Marine Life (CReefs Program) funded by the Australian Government under auspices of the Australian Institute of Marine Science, the Great Barrier Reef Research Foundation and BHP Billiton. This research is part of Australian Biological Resources Study (ABRS) National Taxonomic Research Grant (number 209-05) "Taxonomy of tropical Australian Octocorallia (Anthozoa: Coelenterata) (J.N.A. Hooper & P.N.A. Alderslade).

The work was made possible due to logistical support from the WAM funded by Woodside Energy, as a part of the Kimberley Woodside Collection Project (2008–2011). The authors would like to gratefully acknowledge the help provided by the collection manager of the QM, Merrick Ekins, as well as the scientific staff and ship's company aboard the *Kimberley Quest II*. Angelo Poliseno acknowledges financial support from the Deutsche Akademische Austauschdienst (DAAD). We also thank Prof. Gert Wörheide for providing access to the laboratory facilities of the Department of Earth & Environmental Sciences, Paleontology & Geobiology. Leen P. van Ofwegen, Naturalis Biodiversity Center, is thanked for providing information concerning the holotype of *E. splendens*. Gary C. Williams is also acknowledged for taxonomic information concerning *Paraminabea*. Michael Verrall (CSIRO, Perth) is thanked for SEM assistance.

References

Alderslade, P. (1998) Revisionary systematics in the gorgonian family Isididae, with descriptions of numerous new taxa (Coelenterata: Octocorallia). *Records of the Western Australian Museum*, Supplement No. 55, 1–359.

Bayer, F.M. (1974) A new species of *Trichogorgia* and records of two other octocorals new to Palau Islands. *Micronesica,* 10, 257–271.

Benayahu, Y. & Schleyer, M.H. (1995) Corals of the south-west Indian Ocean II. *Eleutherobia aurea* spec. nov. (Cnidaria, Alcyonacea) from deep reefs on the KwaZulu-Natal Coast, South Africa. *South African Association for marine biological research, Oceanographic Research Institute, Investigational Report*, 68, 1–12.

Benayahu, Y., Jeng, M.S., Perkol-Finkel, S. & Dai, C.F. (2004) Soft Corals (Octocorallia: Alcyonacea) from Southern Taiwan. II. Species Diversity and distributional patterns. *Zoological Studies,* 43(3), 548–560.

Breedy, O., van Ofwegen, L. & Vargas, S. (2012) A new family of soft corals (Anthozoa, Octocorallia, Alcyonacea) from the aphotic tropical eastern Pacific waters revealed by integrative taxonomy. *Systematics and Biodiversity,* 10, 351–359. http://dx.doi.org/10.1080/14772000.2012.707694

Brugler, M.R. & France, S.C. (2008) The mitochondrial genome of a deep-sea bamboo coral (Cnidaria, Anthozoa, Octocorallia, Isididae): genome structure and putative origins of replication are not conserved among octocorals. *Journal of Molecular Evolution,* 67, 125–136. http://dx.doi.org/10.1007/s00239-008-9116-2

Bryce, C. (Ed.) (2009) Marine Biodiversity Survey of Mermaid Reef (Rowley Shoals), Scott and Seringapatam Reef. *Records of the Western Australian Museum,* 77, 1–255.

Bryce, M. & Sampey, A. (2014) Kimberley Marine Biota: Soft corals and sea fans (Octocorallia). *Records of the Western Australian Museum* 84 (in press).

Dautova, T.N. & Savinkin, O.S. (2009) New data on soft corals (Cnidaria: Octocorallia: Alcyonacea) from Nha Trang Bay, South China Sea. *Zootaxa,* 2027, 1–27.

Darriba, D., Taboada, G.L., Doallo, R. & Posada D. (2012) jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods* 9 (8), 772. http://dx.doi.org/10.1038/nmeth.2109

Dayrat, B. (2005) Towards integrative taxonomy. *Biological Journal of the Linnean Society*, 85, 407–415. http://dx.doi.org/10.1111/j.1095-8312.2005.00503.x

Edgar, RC. (2004) MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research* 32, 1792–1797. http://dx.doi.org/10.1093/nar/gkh340

Fabricius, K. & Alderslade, P. (2001) *Soft corals and sea fans - a comprehensive guide to the tropical shallow water genera of the central-west Pacific, the Indian Ocean and the Red Sea*. Australian Institute of Marine Science, Townsville, 264 pp.

Fabricius, K. (2008) *A brief photo guide to the shallow-water octocorals of the Rowley Shoals, Western Australia*. Report to the Department of Environment and Conservation, Government of Western Australia, 39 pp.

Faulkner, D. & Chesher, R. (1979) *Living corals*. Clarkson N. Potter, Inc., New York, 311 pp.

Imahara, Y., Iwase, F. & Namakawa, H. (2014) *The octocorals of Sagami Bay.* Tokyo University Press, 398 pp.

Keesing, J.K., Irvine, T.R., Alderslade, P., Clapin, G., Fromont, J., Hosie, A.M., Huisman, J.M., Phillips, J.C., Naughton, K.M., Marsh, L.M., Slack-Smith, S.M., Thomson, D.P. & Watson, J.E (2008) Marine benthic flora and fauna of Gourdon Bay and the Dampier Peninsula in the Kimberley region of north-west Australia. *Journal of the Royal Society of Western Australia*, 94, 285–301.

Kükenthal, W. (1906a) Alcyonaria. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition*, 13 (1), 1–111.

Kükenthal, W. (1906b) *Japanische Alcyonaceen. Abhandlungen der königlich Bayerischen Akademie der Wissenschaften. II.* KL. Suppl. Bd. 1 Abt. (Beitraege zur Naturgeschichte Ostasiens), pp. 1–86.

Lamouroux, J.V.F. (1812) Extrait d'un mémoire sur la classification des polypiers coralligènes non entièrement pierreux. *Nouveaux Bulletin Des Sciences par la Société. Philomathique de Paris,* 3, 181-188.

Marsh, LM. (1993) Cnidaria, other than reef-building corals, of Ashmore Reef and Cartier Island. *In*: Berry, P.F. (Ed.) Marine

Faunal Survey of Ashmore Reef and Cartier Island, North-western Australia. *Records of the Western Australian Museum,* 44, 1–91.
Masini, R, Sim, C.B. & Simpson, C.J. (2009) *Protecting the Kimberley. A synthesis of scientific knowledge to support conservation management in the Kimberley region of Western Australia.* Department of Environment and Conservation, Western Australia, 45 pp.
McFadden, C.S., Tullis, I.D., Hutchinson, M.B., Winner, K. & Sohm, J.A. (2004) Variation in coding (NADH dehydrogenase subunits 2, 3 and 6) and non-coding intergenic spacer regions of the mitochondrial genome in Octocorallia (Cnidaria: Anthozoa). *Marine Biotechnology,* 7 (4), 405–406.
http://dx.doi.org/10.1007/s10126-005-1000-0
McFadden, C.S., France, S.C., Sanchez, J.A. & Alderslade, P. (2006) A molecular phylogenetic analysis of the octocorallia (Cnidaria: Anthozoa) based on mitochondrial protein–coding sequences. *Molecular Phylogenetics and Evolution,* 41, 513–527.
http://dx.doi.org/10.1016/j.ympev.2006.06.010
McFadden, C.S., Benayahu, Y., Pante, E., Thoma, J.N, Nevarez, P.A. & France, S.C. (2011) Limitations of mitochondrial gene barcoding in the cnidarian sub-class Octocorallia. *Molecular Ecology Resources,* 11, 19–31.
http://dx.doi.org/10.1111/j.1755-0998.2010.02875.x
McFadden, C.S. & van Ofwegen, L.P. (2012) Stoloniferous octocorals (Anthozoa, Octocorallia) from South Africa, with descriptions of a new family of Alcyonacea, a new genus of Clavulariidae, and a new species of *Cornularia* (Cornulariidae). *Invertebrate Systematics,* 26, 331–356.
http://dx.doi.org/10.1071/IS12035
McFadden, C.S. & Ofwegen, L.P. (2013) Molecular phylogenetic evidence supports a new family of octocorals and a new genus of Alcyoniidae (Octocorallia, Alcyonacea). *ZooKeys,* 346, 59–83.
http://dx.doi.org/10.3897/zookeys.346.6270
McFadden, C.S., Brown, A.S., Brayton, C., Hunt, C.B. & Ofwegen, L.P. (2014) Application of DNA barcoding in biodiversity studies of shallow-water octocorals: molecular proxies agree with morphological estimates of richness in Palau. *Coral Reefs*, 33, 275–286.
http://dx.doi.org/10.1007/s00338-013-1123-0
Nutting, C.C. (1912) Description of the Alcyonaria collected by the U.S. Fisheries steamer "Albatross", mainly in Japanese waters, during 1906. *Proceedings of the United States National Museum* 43, 1–104.
http://dx.doi.org/10.5479/si.00963801.43-1923.1
Pante, E., France, S.C., Couloux, A., Cruaud, C., McFadden, C.S, Samadi, S. & Watling, L. (2012) Deep-Sea origin and in-situ diversification of Chrysogorgiid octocorals. *PLOS ONE* 7 (6), 1–14.
http://dx.doi.org/10.1371/journal.pone.0038357
Pante, E., Abdelkrim, J., Viricel, A., Gey, D., France, S., Boisselier, M.C. & Samadi, S. (2014) Use of RAD sequencing for delimiting species.
http://dx.doi.org/10.1038/hdy.2014.105
Pütter, A. (1990) Alcyonaceen des Breslauer Museum. *Zoologische Jahrbücher (Systematik)*, 13, 443–462.
Ronquist, F. & Huelsenbeck, J. (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics,* 19, 1572–1574.
http://dx.doi.org/10.1093/bioinformatics/btg180
Schleyer, M.H. & Benayahu, Y. (2008) *Soft coral biodiversity and distribution in East Africa: Gradients, function and significance.* Proceedings of the 11th International Reef Symposium, Ft. Lauderdale, Florida, 7–11 July 2008, pp. 1388–1391.
Sanchez, J.A., McFadden, C.S., France, S.C. & Lasker, H.R. (2003) Molecular phylogenetic analyses of shallow-water Caribbean octocorals. *Marine Biology,* 142, 975–987.
Shearer, T.L., van Oppen, M.J.H., Romano, S.L. & Wörheide, G. (2002) Slow mitochondrial DNA sequence evolution in the Anthozoa (Cnidaria). *Molecular Ecology*, 11, 2475–2487.
http://dx.doi.org/10.1046/j.1365-294X.2002.01652.x
Stöver, B.C. & Müller, K.F. (2010) TreeGraph 2: Combining and visualizing evidence from different phylogenetic analyses. *BMC Bioinformatics,* 11, 7.
http://dx.doi.org/10.1186/1471-2105-11-7
Stamatakis, A. (2006) RAxML–VI-HPC: maximum likelihood based phylogenetic analyses with thousands of taxa and mixed models. *Bioinformatics,* 22, 2688–2690.
http://dx.doi.org/10.1093/bioinformatics/btl446
Stamatakis, A. Hoover, P. & Rougemont, J. (2008) A rapid bootstrap algorithm for the RAxML Web servers. *Systematic Biology*, 57, 758–771.
http://dx.doi.org/10.1080/10635150802429642
Thoma, J.N., Pante, E., Brugler, M.R. & France, S.C. (2009) Deep-sea octocorals and antipatharians show no evidence of seamount-scale endemism in the NW Atlantic. *Marine Ecology Progress Series* 397, 25–35.
http://dx.doi.org/10.3354/meps08318
Thomson, J.S. (1910) The Alcyonaria of the Cape of Good Hope and Natal. Alcyonacea. *Transactions of the Royal Society of Edinburgh,* XLVII, 549–589.

Thomson, J.A. & Henderson, W.D. (1906) *An account of the Alcyonarians collected by the Royal Indian Marine survey ship Investigator in the Indian Ocean.* Printed by order of the trustees of the Indian Museum, 128 pp. http://dx.doi.org/10.5962/bhl.title.26574

Thomson, J.A. & Dean, L.M.I. (1931) Alcyonacea of the Siboga Expedition with an addendum to the Gorgonacea. *Siboga-Expedition Reports,* 13d, 1–227.

Utinomi, H. (1954) Some alcyoniid octocorals from Kii coast, middle Japan, with descriptions of two new species. *Publications of Seto Marine Biological Laboratory,* 6 (2), 147–168.

Utinomi, H. (1957) The Alcyonarian genus *Bellonella* from Japan, with description of two new species. *Publications of Seto Marine Biological Laboratory*, 6 (2), 24–44.

Utinomi, H. (1960) Noteworthy octocorals collected off the southwest coast of Kii Peninsula, middle Japan. 1. Stolonifera and Alcyonacea. *Publications of Seto Marine Biological Laboratory*, 8 (1), 1–26.

Utinomi, H. & Harada, E. (1958) A list of bottom animals collected by a trawler "Kaiun-maru" off the southwest coast of Kii Peninsula. *Publications of Seto Marine Biological Laboratory,* 6 (3), 385–395.

Vargas, S., Guzman, H.M., Breedy, O. & Wörheide, G. (2014) Molecular phylogeny and DNA barcoding of tropical eastern Pacific shallow-water gorgonian octocorals. *Marine Biology*, 161 (5), 1027–1038 http://dx.doi.org/10.1007/s00227-014-2396-8

Verseveldt, J. & Bayer, F.M. (1988) Revision of the genera *Bellonella, Eleutherobia, Nidalia* and *Nidaliopsis* (Octocorallia: Alcyoniidae and Nidalliidae), with description of two new genera. *Zoologische Verhandelingen Leiden*, 245, 1–131.

Will, K.P., Mishler, B.D. & Wheeler, Q.D. (2005) The perils of DNA Barcoding and the need for integrative taxonomy. *Systematic Biology,* 4, 844–851. http://dx.doi.org/10.1080/10635150500354878

Williams, G.C. (1986) Morphology, systematics and variability of the southern African soft coral *Alcyonium variabile* (J. Stuart Thomson, 1921) (Octocorallia, Alcyoniidae). *Annals of the South Africa Museum,* 96, 241–270.

Williams, G.C. (1992) Revision of the soft coral genus *Minabea* (Octocorallia: Alcyoniidae), with new taxa from the Indo-West Pacific. *Proceedings of the California Academy of Sciences,* 48, 1–26.

Williams, C.G. (1992) The Alcyonacea of southern Africa. Stoloniferous octocorals and soft corals (Coelenterata, Anthozoa). *Annals of the South African Museum,* 100, 249–358.

Williams, G.C. (2000) A new species of the soft coral genus *Eleutherobia* Pütter, 1900 (Coelenterata: Alcyonacea) from the Tonga Islands. *Proceedings of the California Academy of Sciences,* 52, 159–169.

Williams, G.C. (2001) First record of a bioluminescent soft coral: description of a disjunct population of *Eleutherobia grayi* (Thomson & Dean, 1931) from the Solomon Islands, with a review of bioluminescence in the Octocorallia. *Proceedings of the California Academy of Science,* 52, 209–225.

Williams, G.C. (2003) Capitate taxa of the soft coral genus *Eleutherobia* (Octocorallia: Alcyoniidae) from Palau and South Africa: a new species and a new combination. *Zoologische Verhandelingen Leiden,* 345, 419–436.

Williams, G.C. & Alderslade, P. (1999) Revisionary systematics of the western Pacific soft coral genus *Minabea* (Octocorallia: Alcyoniidae), with descriptions of a related new genus and species from the Indo-Pacific. *Proceedings of the California Academy of Sciences,* 51, 337–364.

Williams, G.C. & Little, S.A (2001) A new species of the soft coral genus *Eleutherobia* Pütter, 1900, (Octocorallia: Alcyoniidae) from South Africa. *Proceedings of the California Academy of Sciences,* 52, 195–208.

Wilson, B. (2013) *The biogeography of the Australian North West Shelf: Environmental change and life's response*. Elsevier, 413 pp.

Yang, Z. (1994) Maximum–likelihood phylogenetic estimation from DNA-sequences with variable rates over sites–approximate methods. *Journal of Molecular Evolution*, 39, 306–314. http://dx.doi.org/10.1007/BF00160154