

Capitate taxa of the soft coral genus *Eleutherobia* (Octocorallia: Alcyoniidae) from Palau and South Africa; a new species and a new combination

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Key words: *Eleutherobia*; Octocorallia; Alcyoniidae; Palau; South Africa, new species, new combination. Two additional species are here added to the Indo-West Pacific soft coral genus *Eleutherobia*. This makes a total of nineteen species considered as valid. Included here is the description of a recently discovered new species from Palau, and a new combination of a common South African species previously referred to as *Alcyonium variabile* (Thomson, 1921) in the recent literature. A table comparing the world-wide species of the genus is also included.

Introduction

The Indo-Pacific soft coral genus *Eleutherobia* Pütter, 1900 (family Alcyoniidae) has previously applied to mostly digitiform colonies, but a few species are clavate or multilobate (table 1). Only *Eleutherobia studeri* (Thomson, 1910) may have colonies that approach a capitate shape (Williams, 1992). Two taxa with distinctly capitulate or mushroom-shaped colonies are here also considered to belong to the genus.

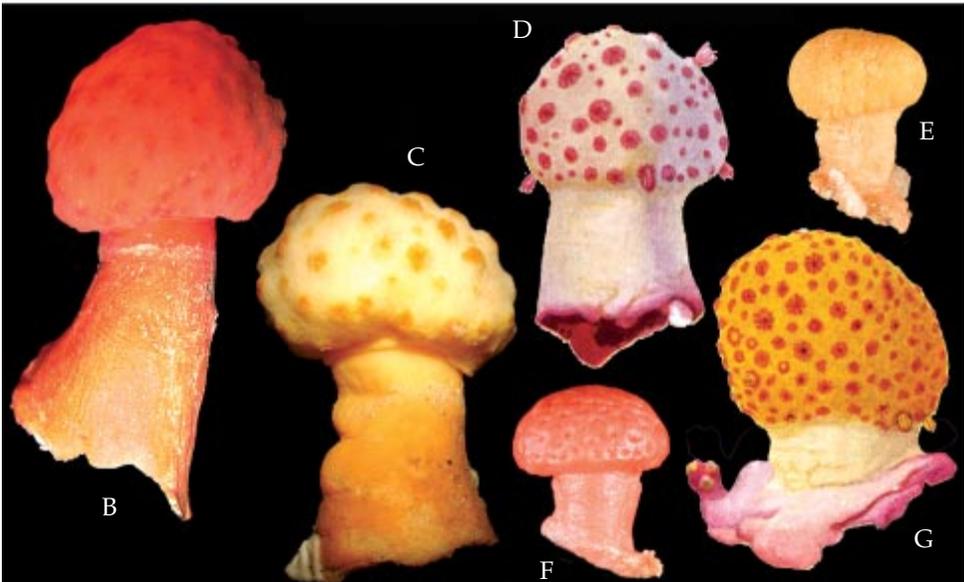
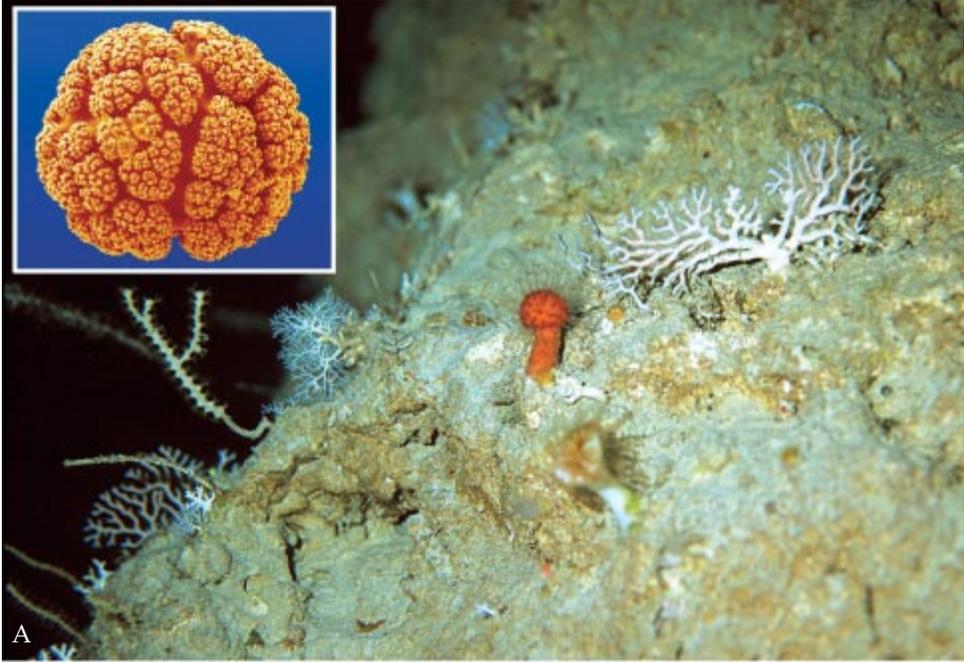
The two additions recorded here are a new species from Palau and a new combination from South Africa, increasing the total number of species considered valid for the genus *Eleutherobia* to nineteen (table 1). In addition, the results presented here extend the geographic range of the genus to the Atlantic side of the Cape Peninsula in South Africa. The genus is known from South Africa in the west to Tonga in the east and from Japan in the north to tropical Australia in the south (fig. 12).

The genus *Eleutherobia* is noteworthy for recent discoveries regarding the isolation of bioactive compounds from two Indian Ocean species (Williams, 2000: 159; Williams & Little, 2001: 195), as well as the property of bioluminescence observed in three other species from archipelagos in the western Pacific (Williams, 2001: 216-219). Pertaining to the latter, these are the only soft coral taxa known to bioluminesce. The only other octocorals known to produce bioluminescence include four species of isidid gorgonians and at least nineteen species of pennatulaceans (Williams, 2001: 217).

Methods

South African material was collected by SCUBA, while specimens from Palau were collected using the research submersible "Deep Worker". All material was preserved in 70% ethanol. Sclerites were isolated from soft coral tissues by using house-

hold bleach (sodium hypochlorite). Micrographs were made using a Nikon Coolpix 990 digital camera with a Nikon SMZ-10 dissecting microscope or an Olympus CH-2 compound microscope. Scanning electron micrographs were made using a Leo 1400 series scanning electron microscope. Digital imaging for the production of plates was made using Adobe Photoshop software. Abbreviations used in the text are CAS (Cali-



fornia Academy of Sciences, San Francisco), SAM (South African Museum, Cape Town), CRRF (Coral Reef Research Foundation, Palau), and NCI (National Cancer Institute, Washington, D.C.).

Systematic account

Family Alcyoniidae Lamouroux, 1812

(see: Williams 1992: 266; Fabricius & Alderslade, 2001: 49)

Growth form is highly variable. Sclerites may include spindles, clubs, radiates, ovals, and double heads; rarely absent. A large family of thirty valid genera, twelve of which (or 40%), have been described in the past fifteen years. Ten (or 33% of the genera) are dimorphic. Seven (or 23% of the genera) are zooxanthellate. The family has worldwide distribution, particularly speciose on Indo-Pacific coral reefs, but absent from tropical western Atlantic coral reefs. Bathymetrically, the family is restricted to relatively shallow water: intertidal to approximately 1000 m in depth, but the vast majority of taxa inhabit depths of less than 250 m, along the margins of oceanic islands or on continental shelves.

Eleutherobia Pütter, 1900

Eleutherobia Pütter, 1900: 449; Verseveldt & Bayer, 1988: 27; Williams, 1992: 306; 2000: 160; 2001: 210;

Williams & Little, 2001: 198; Fabricius & Alderslade, 2001: 100.

Nidalia (in part): non Gray, 1835.

Bellonella (in part): non Gray, 1862.

Metalcyonium (in part): non Pfeffer, 1889.

Diagnosis.— Alcyoniid soft corals, usually digitiform (conical to cylindrical), sometimes digitate, lobate, subglobular, clavate, or capitate; polyparium arising from a common unbranched stalk. Azooxanthellate. Polyps monomorphic, mostly expanded nocturnally, retracted diurnally. Calyces absent, although retracted polyps may form low rounded or mound-like protuberances of the coenenchyme. Coenenchymal sclerites mostly derived from radiates, although spindles, barrels, tuberculate spheroids, rod-like forms or crosses sometimes present. Anthocodial sclerites arranged in points or crown and points, or absent altogether. Colour is permanent and contained in the sclerites; variable (orange, red, pink, yellow, rarely white or gray, sometimes mottled or bicolored).

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

- ◀ Fig. 1A-C. *Eleutherobia flammicerebra* spec. nov. A. Underwater photograph of the living holotype taken with a submersible camera at the type locality. Photo courtesy of Pat Colin, Coral Reef Research Foundation; inset shows a false colour scanning electron micrograph approximating the colour of a single sclerite from the holotype; sclerite shown is same as fig. 3A, 0.18 mm in length. B. Photograph of wet-preserved holotype (CAS 147480), 40 mm in length. C. Photograph of wet-preserved paratype (CAS 147481), 25 mm in length. D-G. *Eleutherobia variabile* (Thomson, 1921) comb. nov. D. A 27 mm long bicoloured colony; from J.S. Thomson, 1921, pl. 5, no. 3 (watercolor illustration). E. Photograph of a yellow colony, 20 mm in length (SAM-H3167). F. Photograph of a red colony, 20 mm in length (SAM-H3167). G. A 25 mm long bicolored colony; from Thomson, 1921, pl. 5, no. 4 (watercolour illustration).

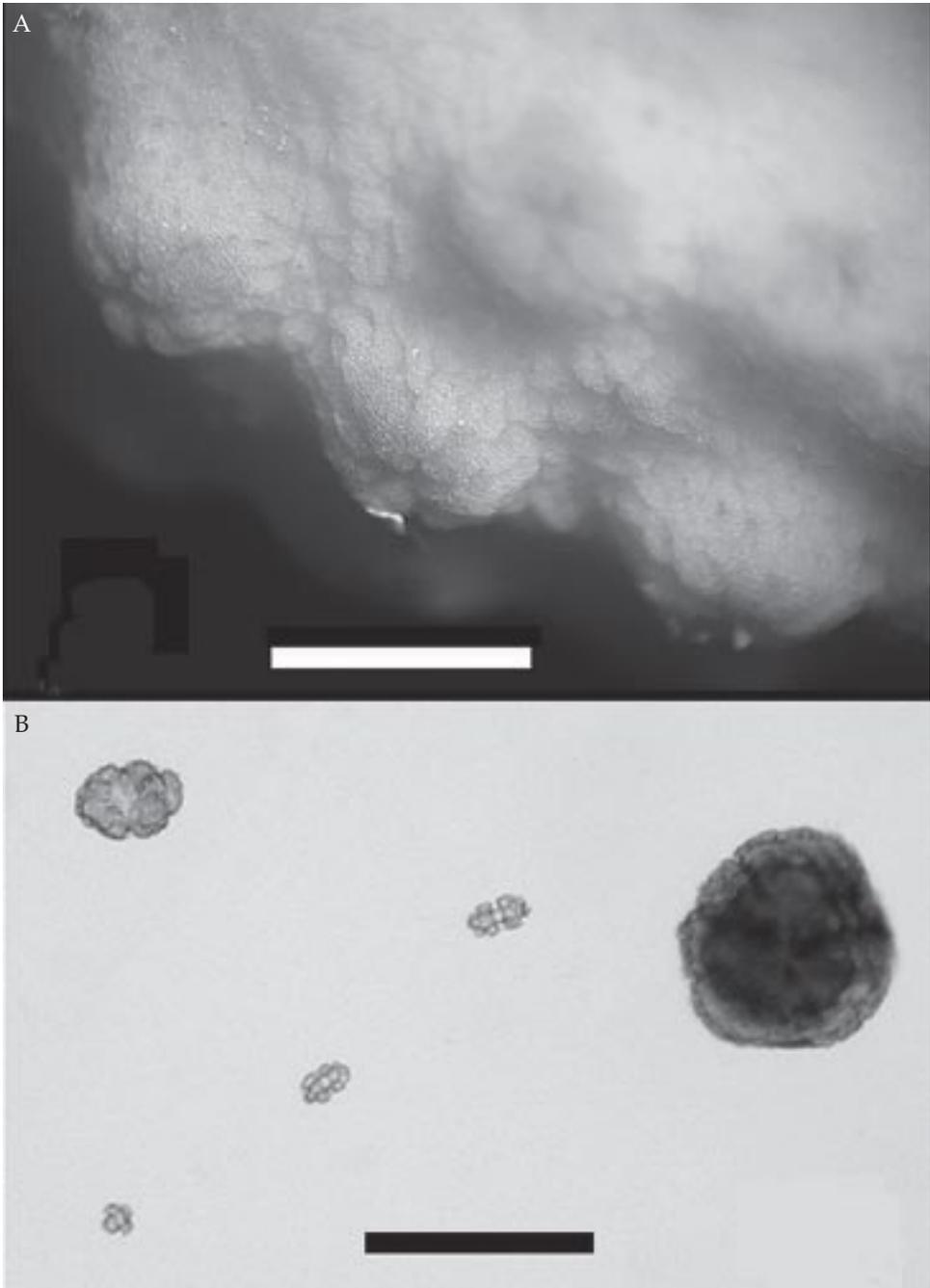


Fig. 2. *Eleutherobia flammicerebra* spec. nov. A. Detail of capitulum of paratype showing retracted polyps; scale bar = 2.0 mm. B. Compound microscope micrograph of sclerites from the surface of the holdfast of the paratype showing three distinct size classes; scale bar = 0.2 mm.

Diversity and distribution.— Nineteen species of the Indo-West Pacific (southern and eastern African to Japan and Tonga).

Eleutherobia flammicerebra spec. nov.
(figs 1A-C, 2-8, 12)

Material examined.— Holotype: CAS 147480, station number CRRF OCDN 7879-X, Palau, Uchelbeluu Reef, Koror, W. side of Uchelbeluu reef, just south of Mutremdiu (7.00°16.27'N; 134.00°34.37'E), 216 m depth, 21.iii.2001, collected by Pat Colin aboard research submersible 'Deep Worker', one specimen cut longitudinally into two parts. Paratype: CAS 147481, station number CR CNI 416, Palau, Koror, Mutremdiu (07°16.41'N; 134°31.43'E), 142 m depth, 12.iii.2001, collected by Pat Colin aboard research submersible 'Deep Worker', one whole specimen.

Diagnosis.— Colonies unbranched, mushroom-shaped, capitate. A spheroidal or globular capitulum arises from a conspicuous upright stalk. Capitulum is 36-39% of total colony length. Retracted polyps form low rounded protuberances over entire surface of capitulum. Coenenchymal sclerites are in three distinctive size classes: large tuberculate spheroids and radiates (0.15-0.23 mm long), medium tuberculate spheroids and radiates (0.10-0.13 mm long), and small radiates (0.05-0.08 mm). Polyp sclerites absent. Colour red-orange to pale yellow with darker spots on the capitulum representing retracted polyps.

Description.— Growth form and size (fig. 1A-C, 3A): Both the wet-preserved holotype and paratype are mushroom-shaped, unbranched, capitate (fig. 1A). In the holotype, the plane of the holdfast is oblique to the vertical plane of the colony, hence the length of the colony varies from one side to the other (fig. 1B). The length of the specimen varies from 30 mm on the shortest side to 42 mm on the longest. The capitulum is 20 mm in diameter and 15 mm in length. The stalk varies in diameter from 10 mm at its boundary with the capitulum to 20 mm at the level of the holdfast. The stalk comprises 61-64% of the total colony length. Unlike the holotype, the capitulum of the paratype is somewhat laterally flattened, and the width varies from 12 to 16 mm. The length of the paratype is 28 mm. The capitulum is 11 mm high. The stalk is 17 mm long, 8 mm wide at its juncture with the capitulum and 13 mm wide at the level of the holdfast. The stalk therefore comprises approximately 61% of the total length of the paratype (fig. 1C).

Internal anatomy of the holotype (fig 3A).— The capitulum of the holotype was cut longitudinally into two more-or-less equal halves to reveal internal anatomy. The lower margin of the capitulum is sharply deflexed, partly rolled and scroll-like. Part of the ring-like space created by the rolled margin is occupied by an unidentified species of polychaete worm, which lies transversely around the uppermost part of the stalk. The retracted polyps with mesenterial filaments appear as cylindrical white masses, 3 mm in length, withdrawn at least one mm below the surface of the capitulum. The tubular gastric cavities are conspicuous and presumably extend throughout the length of the colony. The coenenchyme between the gastric cavities is densely filled with sclerites that are almost entirely tuberculate spheroids. The gastric cavities of the polyps disposed along the lower part of the capitulum are strongly bent.

Polyps (figs. 1A, 2A, 3A).— The polyps in both the holotype and paratype are

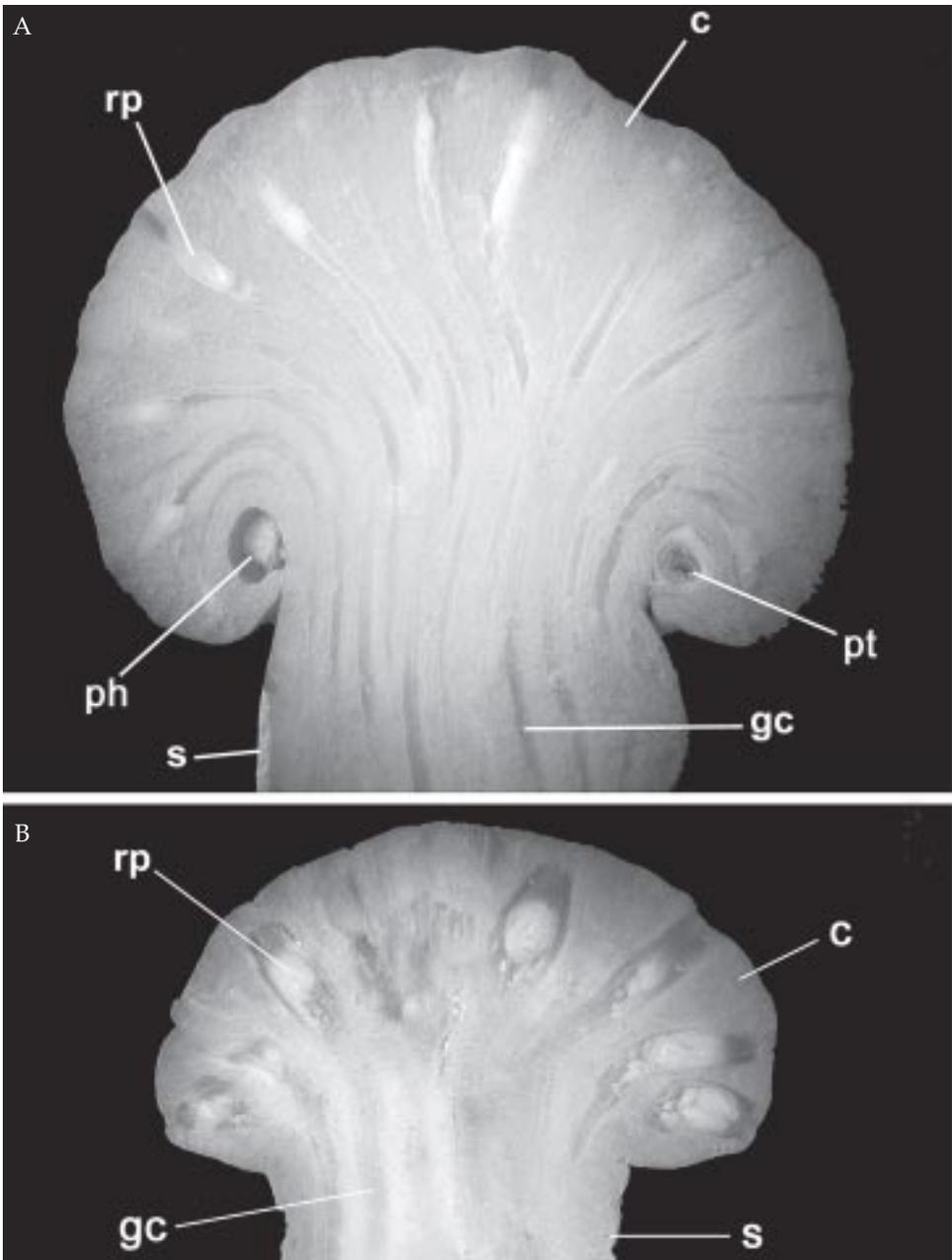


Fig. 3. Medial longitudinal sections through colonies. A. Holotype of *Eleutherobia flammicerebra* spec. nov., capitulum and distal part of stalk, portion shown 19 mm in length. B. *Eleutherobia variabile* (SAM-H3167), capitulum and distal part of stalk, portion shown 10 mm in length. Abbreviations: c - coenenchyme of capitulum; gc - gastric cavity; ph - polychaete worm (head); pt - polychaete worm (transverse section through posterior portion of body); rp - retracted polyp; s - stalk.

entirely withdrawn into the capitulum. The coenenchyme covering the retracted polyps forms low rounded or mammiform protuberances on the surface of the capitulum (fig. 2A). The polyps are free of sclerites. An underwater photo of the holotype in life shows the polyps expand in length to at least the height and/or diameter of the capitulum - approximately 15-20 mm (fig. 1A)

Sclerites (figs 2B, 4-8).— Coenenchymal sclerites are predominantly eight radiates and tuberculate spheroids, with some intermediate forms that approach double heads or barrels. The superficial coenenchyme of the capitulum is densely set with two predominant size classes and types of sclerites - larger tuberculate spheroids (0.10-0.18 mm in diameter) (fig. 8), and smaller eight radiates (0.05-0.08 mm in length) (fig. 7). The coenenchyme of the stalk surface and holdfast region is densely set with sclerites in three size classes - larger tuberculate spheroids and robust radiates (0.15-0.23 mm long in length), medium-sized tuberculate spheroids and robust radiates (0.10-0.13 mm long), and smaller radiates (0.05-0.08 mm long) (figs 2B, 4). The interior of the capitulum is densely set with robust eight radiates, some of which approach double heads or barrels in shape (0.15-0.18 mm long) (fig. 5), and tuberculate spheroids (0.13-0.20 mm in diameter). The interior of the stalk contains densely set sclerites that are predominantly large tuberculate spheroids (0.17-0.23 mm in diameter) (fig. 6A-E), and a few robust radiates approximating 0.10 mm in length (fig. 6F). Overall, the tuberculate spheroids from the holotype and paratype exhibit a fine surface ornamentation composed of rounded clumps of tubercles (fig. 6B-C).

Colour (fig. 1A-C).— In the holotype, the capitulum is deep red-orange with dark red spots representing the retracted polyps. The stalk is orange. The paratype has the capitulum cream-white distally and yellow proximally, with orange spots representing the retracted polyps. The stalk is tan to pale orange. The sclerites in both specimens vary in colour from orange (fig. 1A, inset) to pale-yellow.

Distribution (fig. 12).— Known only from the type locality - Koror, Palau, western Pacific Ocean; 142-216 m in depth.

Etymology.— The specific epithet is derived from the Latin, *flamma* (a flame), and *cerebrum* (the brain); in reference to the brain-like appearance of the pale orange or flame-colored largest sclerites (tuberculate spheroids), which are characteristic of the holotype of this species of soft coral (fig. 1A, inset).

Remarks.— Of the nineteen species of the genus *Eleutherobia*, *E. duriuscula* (Thomson & Dean, 1931) from Indonesia, and *E. rotifera* (Thomson, 1910) from South Africa, both have tuberculate spheroids. However, the former is distinctly digitiform and has anthocodial armature (Verseveldt & Bayer, 1988: figs 18B, 22C), while the latter is digitate in colony shape and lacks anthocodial sclerites (Williams, 1992: fig. 29A-B). *Eleutherobia flammicerebra* spec. nov. is conspicuously capitata and lacks anthocodial armature.

This is the first species of *Eleutherobia* described with a scrolled lower margin of the capitulum, and in which a polychaete worm is observed in the circular tunnel of the rolled margin (fig. 3A). It is not known if the polychaete in some way causes or induces this peculiar growth in the soft coral, or if the worm opportunistically seeks and inhabits such a preexisting suitable and habitable space.

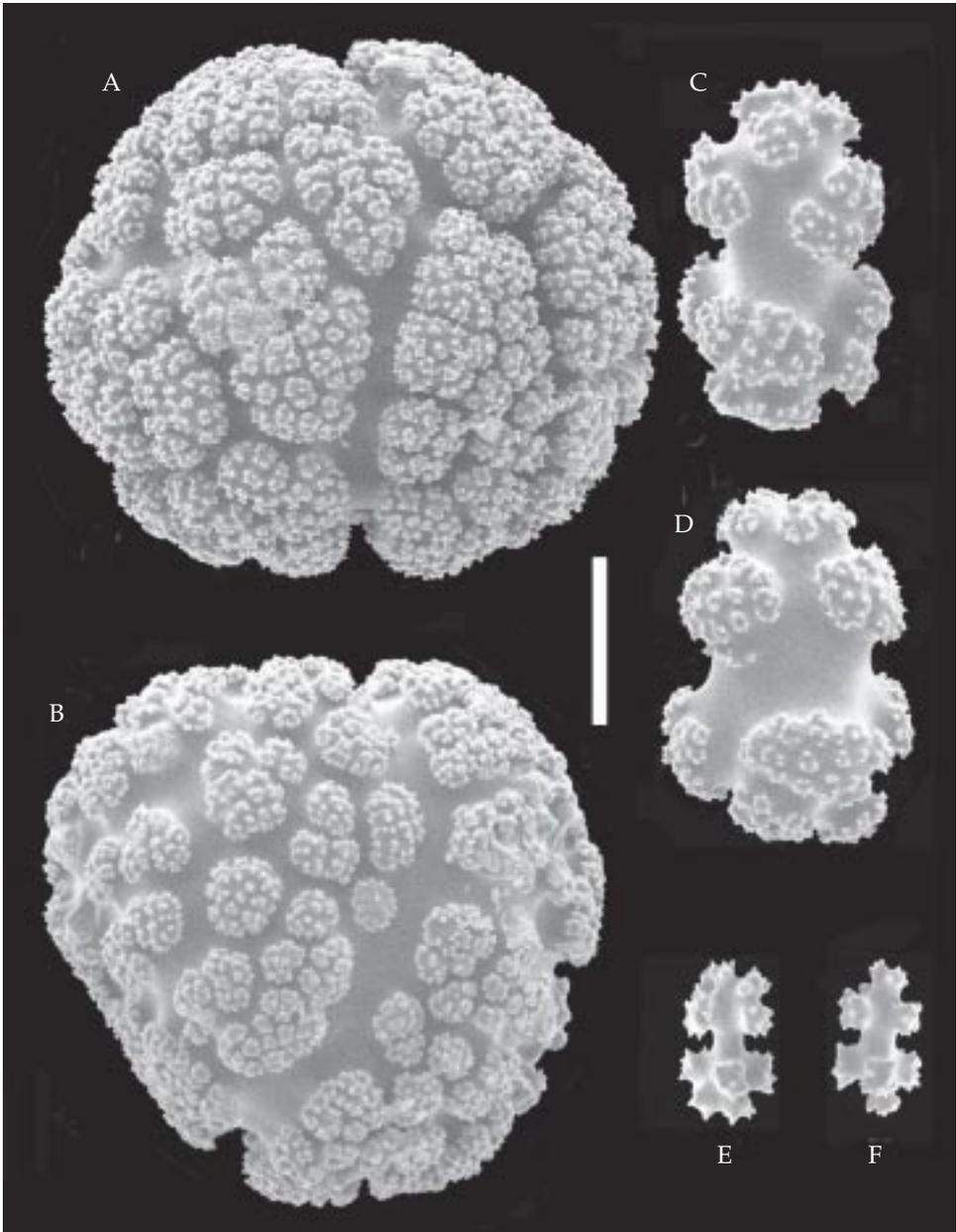


Fig. 4. *Eleutherobia flammicerebra* spec. nov., holotype. Scanning electron micrographs of sclerites from the surface coenenchyme of the holdfast region (base of stalk), showing three size classes to scale. Measurements represent maximum linear dimension: A. Tuberculate spheroid, 0.18 mm. B. Tuberculate spheroid, 0.17 mm. C. Radiate, 0.10 mm. D. Radiate, 0.10 mm. E. Radiate, 0.05 mm. F. Radiate, 0.05 mm. Scale bar = 0.05 mm.

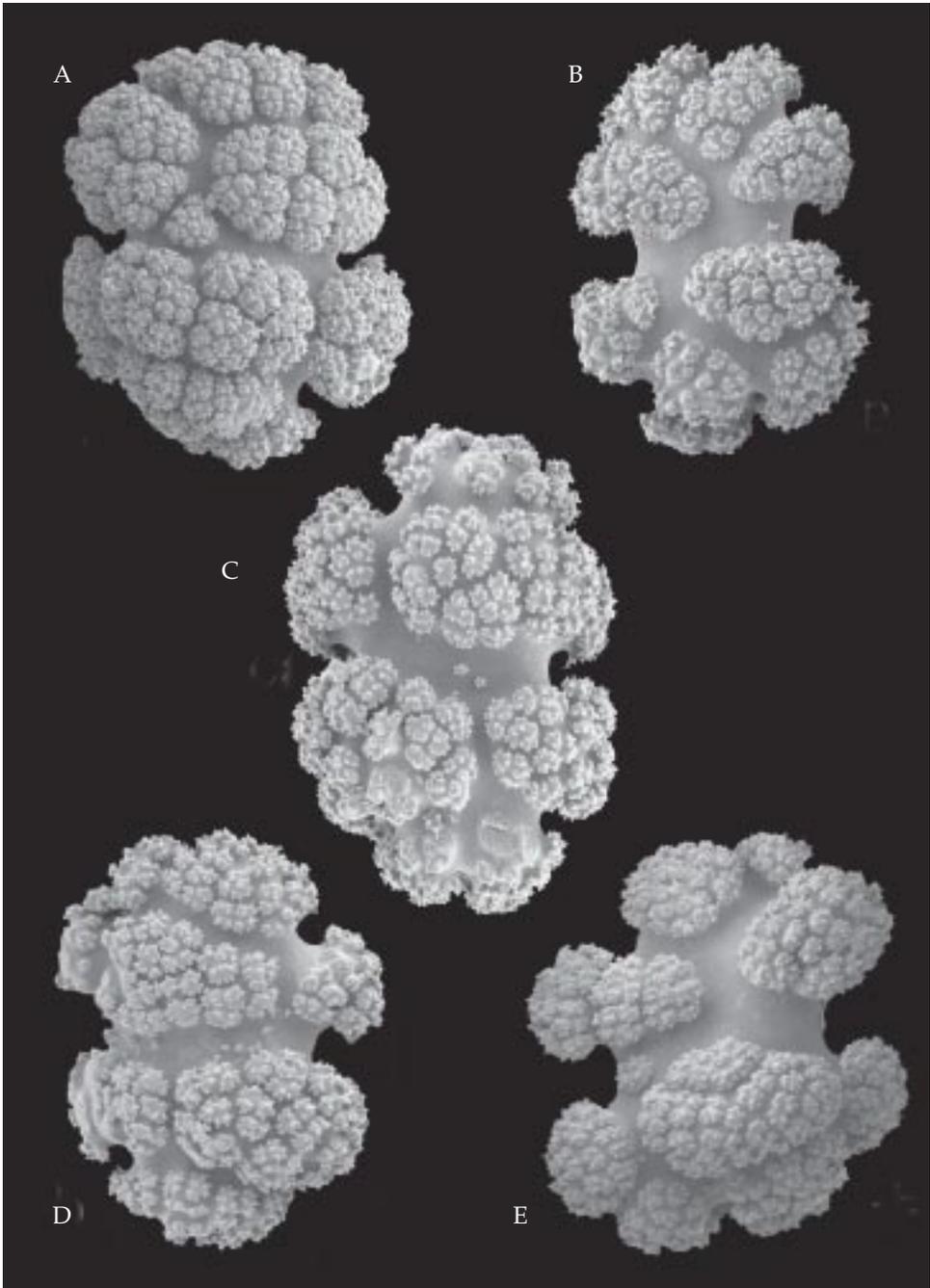


Fig. 5. *Eleutherobia flammicerebra* spec. nov., holotype. Scanning electron micrographs of sclerites from the interior of the capitulum. A. 0.17 mm. B. 0.18 mm. C. 0.16 mm. D. 0.16 mm. E. 0.15 mm.

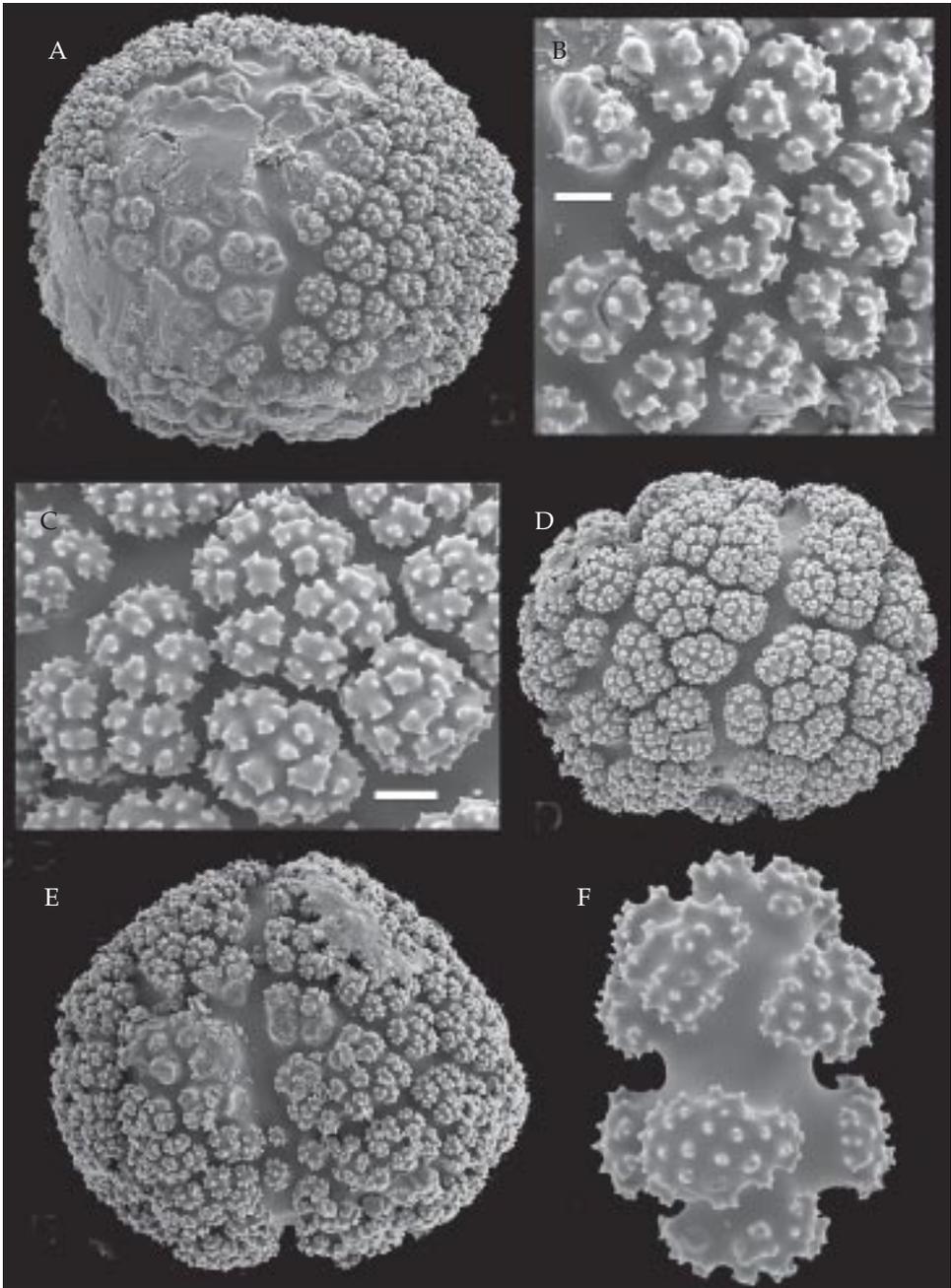


Fig. 6. *Eleutherobia flammicerebra* spec. nov., holotype. Scanning electron micrographs of sclerites from the interior of the stalk. A. Tuberculate spheroid, 0.23 mm. B. Detail of ornamentation from spheroid shown in A; scale bar = 0.01 mm. C. Detail of ornamentation from spheroid shown in D; scale bar = 0.01 mm. D. Tuberculate spheroid, 0.19 mm. E. Tuberculate spheroid, 0.20 mm. F. Radiate, 0.10 mm.

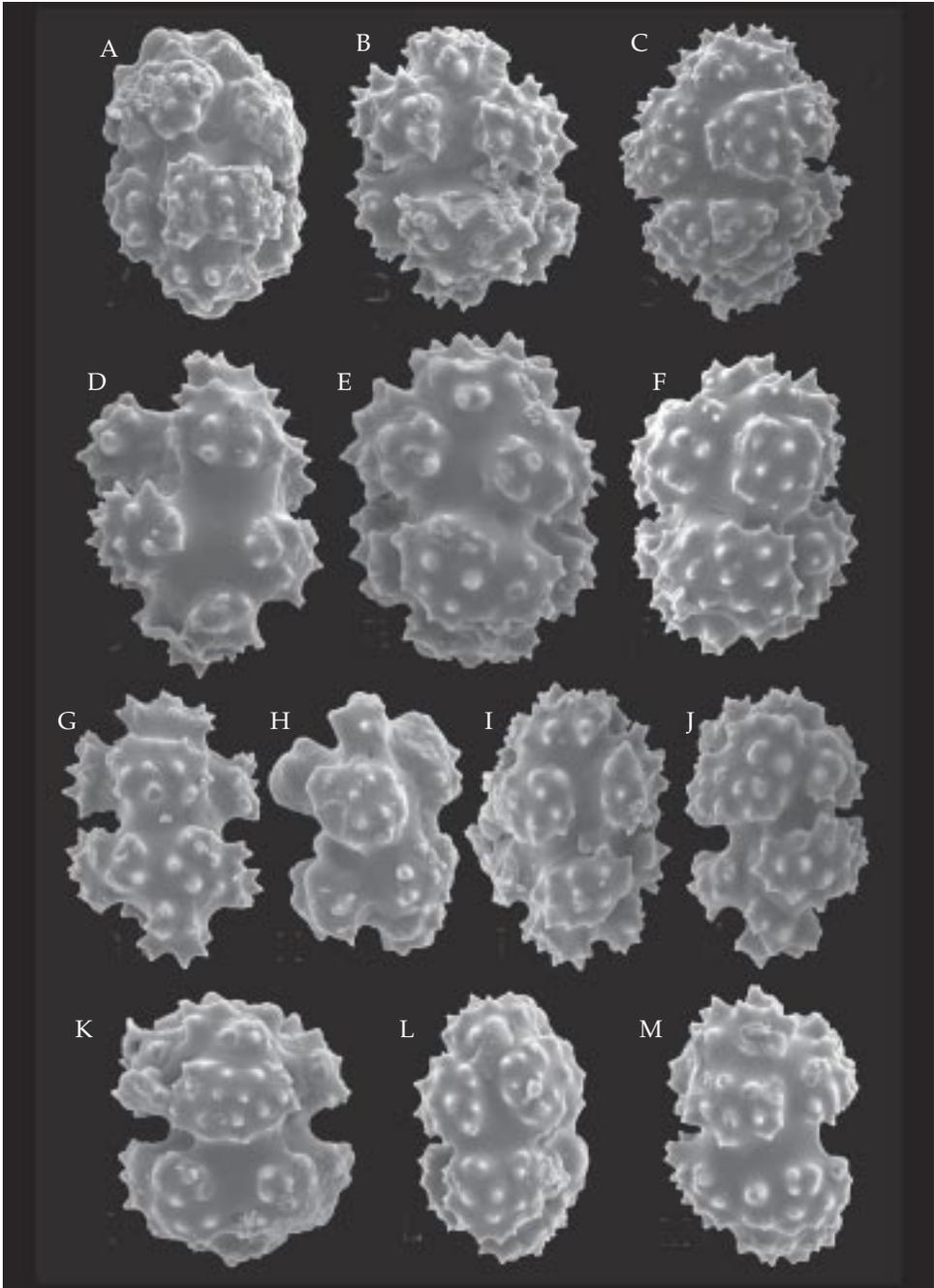


Fig. 7. *Eleutherobia flammicerebra* spec. nov., paratype. Scanning electron micrographs of sclerites (radiates) from the surface of the capitulum. A. 0.06 mm. B. 0.07 mm. C. 0.07 mm. D. 0.06 mm. E. 0.06 mm. F. 0.05 mm. G. 0.06 mm. H. 0.06 mm. I. 0.06 mm. J. 0.06 mm. K. 0.06 mm. L. 0.06 mm. M. 0.06 mm.

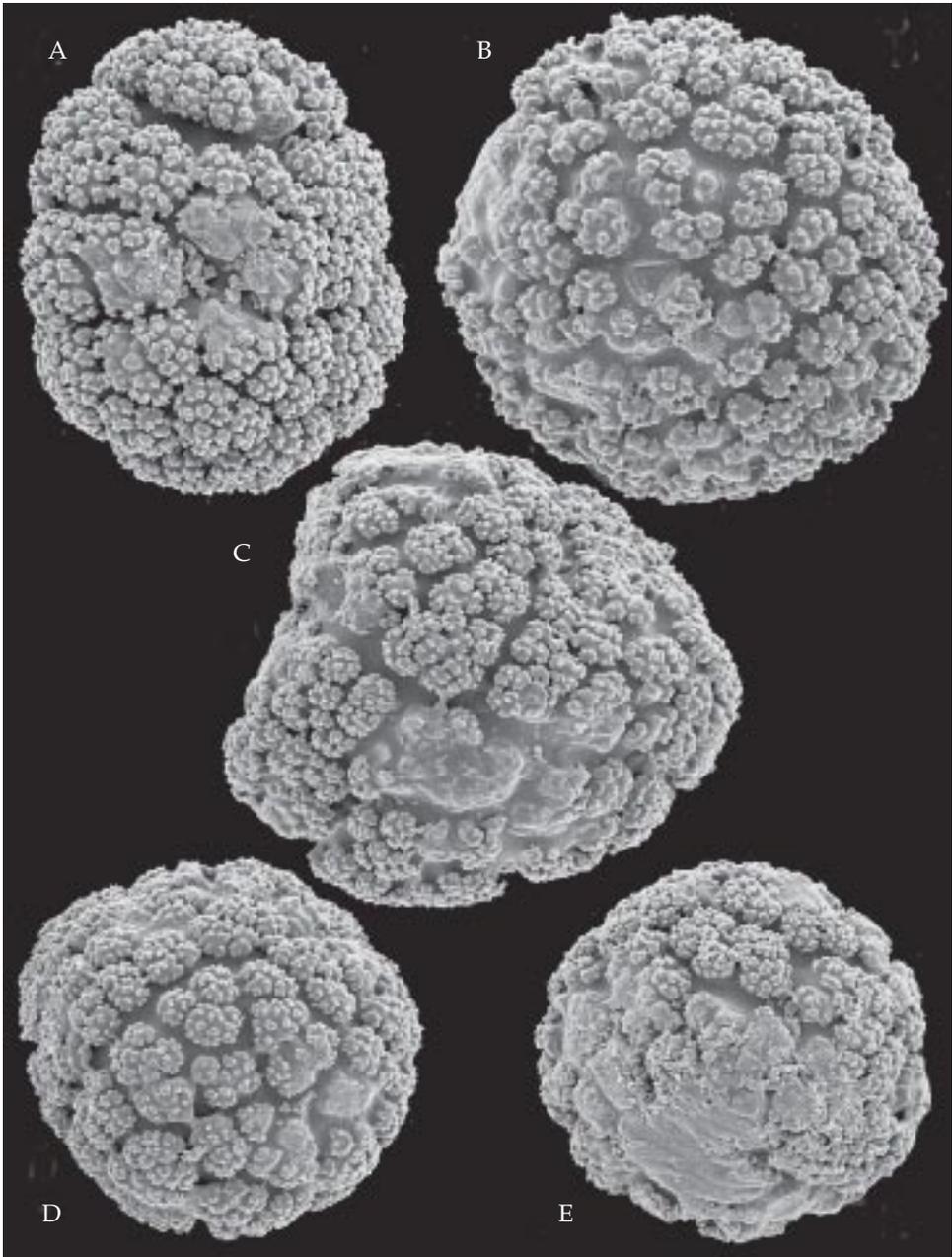


Fig. 8. *Eleutherobia flammicerebra* spec. nov., paratype. Scanning electron micrographs of sclerites (tuberculate spheroids) from the surface of the capitulum. A. 0.16 mm. B. 0.17 mm. C. 0.17 mm. D. 0.16 mm. E. 0.16 mm.

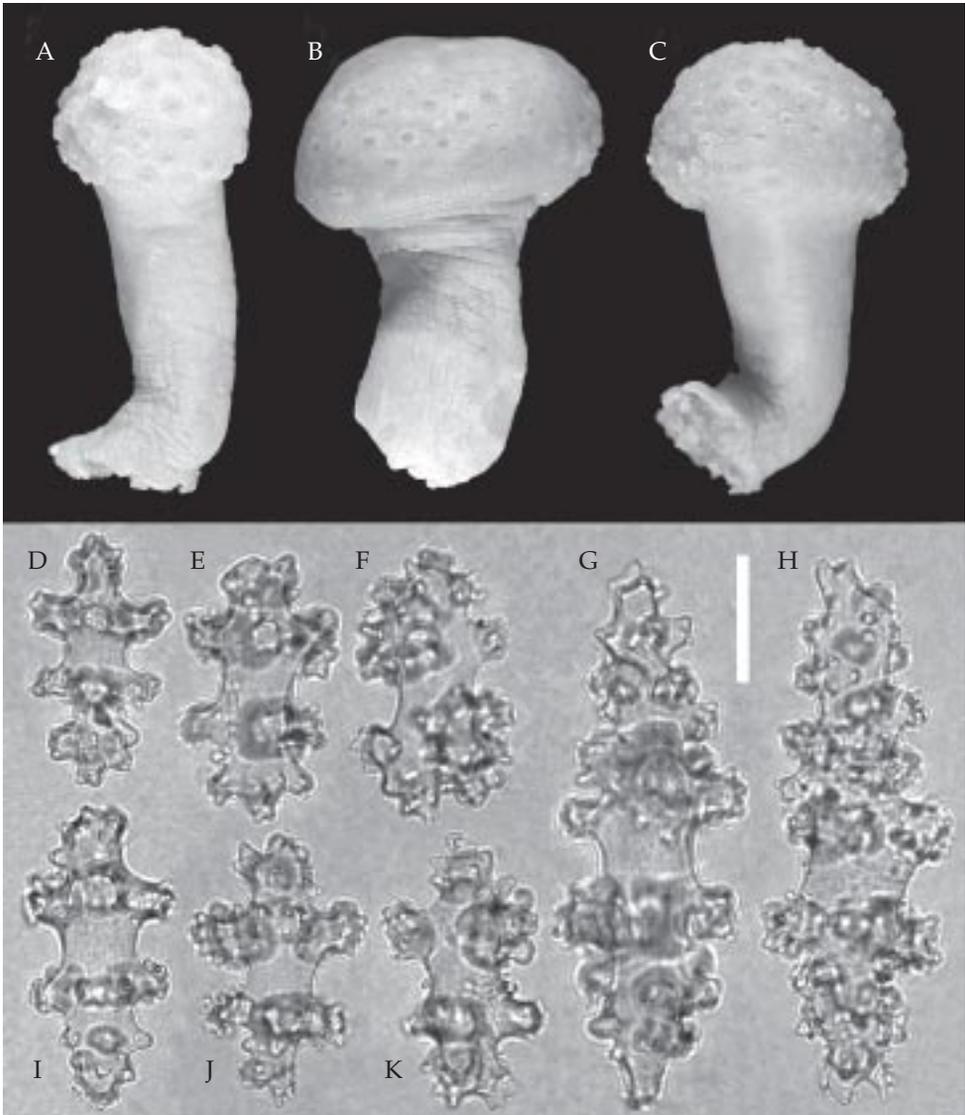


Fig. 9. *Eleutherobia variabile* (Thomson, 1921) (SAM-H3167). A. A yellow colony 35 mm in length. B. A red colony 30 mm in length. C. A yellow colony 45 mm in length. D-K. Compound microscope micrographs of sclerites from the superficial coenenchyme; scale bar = 0.035 mm.

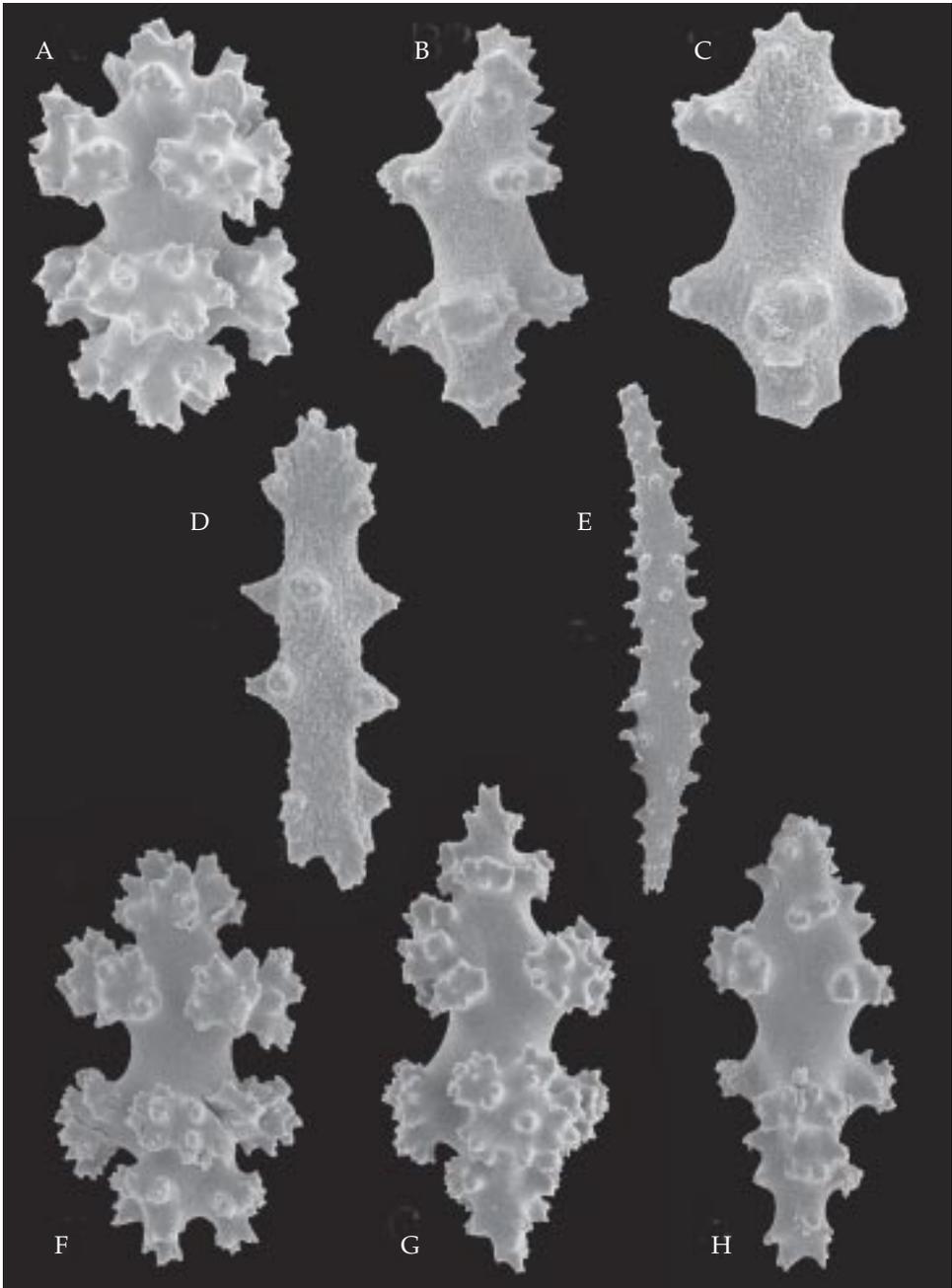


Fig. 10. *Eleutherobia variabile* (SAM-H3167). Scanning electron micrographs of sclerites from the surface of the capitulum. A. 0.07 mm. B. 0.06 mm. C. 0.05 mm. D. 0.10 mm. E. 0.20 mm. F. 0.07 mm. G. 0.10 mm. H. 0.08 mm.

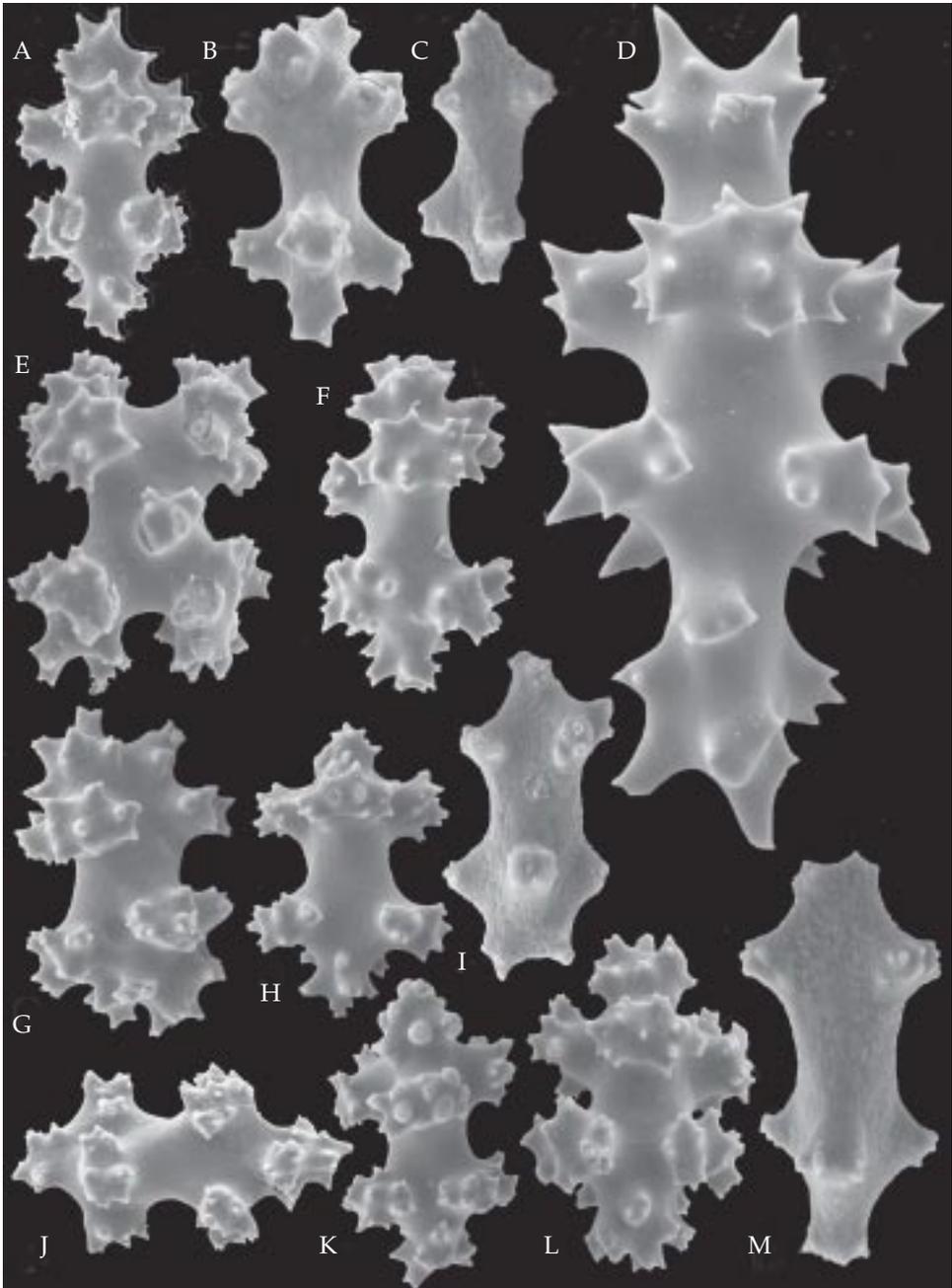


Fig. 11. *Eleutherobia variabile* (SAM-H3167). Scanning electron micrographs of sclerites from the surface of the stalk. A. 0.10 mm. B. 0.05 mm. C. 0.04 mm. D. 0.12 mm. E. 0.07 mm. F. 0.07 mm. G. 0.07 mm. H. 0.06 mm. I. 0.06 mm. J. 0.09 mm. K. 0.08 mm. L. 0.07 mm. M. 0.06 mm.



Fig. 12. Map of the Indo-West Pacific showing the distribution of the genus *Eleutherobia*; ■ = collecting stations; arrow shows type locality of *Eleutherobia flammicerebra* spec. nov.

Eleutherobia variabile (Thomson, 1910) comb. nov.
(figs. 1D-G, 9-12)

For synonymy see Williams, 1992: 295.

Material examined.— SAM-H3167, non-type material, South Africa, Cape Province, Atlantic side of Cape Peninsula, Hottentots Huisie, 33° 59'S; 18° 21'E, 13-16 m depth, 18.viii.1983, collected by Gary C. Williams with use of SCUBA, eight whole colonies.

Remarks.— For a description see Williams (1986, 1992). For comparison with *E. flammicerebra* the growth form (figs. 1D-G, 9A-C), internal anatomy (fig. 3B), polyps (figs. 1D, 1G, 3B), and sclerites (figs. 9D-K, 10-11) are presented here as well.

The distinctly capitata shape of the colonies of *Eleutherobia variabile* comb. nov. is very similar to that of *Eleutherobia flammicerebra* spec. nov. In addition, *Eleutherobia studeri* is clavate to capitata, and therefore has a similar colony shape to these two species. In addition, the two taxa treated here can be allocated to the genus *Eleutherobia* based on sclerite shape as well.

Distribution (fig. 12).— The species is endemic to South Africa (Atlantic coast of Cape Peninsula to the Tugela River mouth off Natal); 13 to at least 168 meters in depth (Williams, 1986: fig. 13).

Table 1. Valid species in the genus *Eleutherobia*

Species	Colony Shape	Distribution
1. <i>E. albiflora</i> (Utinomi, 1957)	digitiform	Japan
2. <i>E. aurea</i> Benayahu & Schleyer, 1995	digitiform to lobular	South Africa
3. <i>E. dofleini</i> (Kükenthal, 1906)	digitiform to digitate	Japan
4. <i>E. duriuscula</i> (Thomson & Dean, 1931)	digitiform	Indonesia
5. <i>E. flammicerebra</i> spec. nov.	capitate	Palau
6. <i>E. flava</i> (Nutting, 1912)	digitiform	Japan
7. <i>E. grandiflora</i> (Kükenthal, 1906)	digitiform to clavate	Japan
8. <i>E. grayi</i> (Thomson & Dean, 1931)	digitiform to lobular	Indonesia; Solomon Islands; ?Ryukyus
9. <i>E. rigida</i> (Pütter, 1900)	digitiform	Japan
10. <i>E. rotifera</i> (Thomson, 1910)	digitate	South Africa
11. <i>E. rubra</i> (Brundin, 1896)	digitiform	Japan; NW Australia
12. <i>E. somaliensis</i> Verseveldt & Bayer, 1988	digitate to lobate	Somalia
13. <i>E. splendens</i> (Thomson & Dean, 1931)	digitiform	Indonesia; Philippines
14. <i>E. studeri</i> (Thomson, 1910)	clavate to capitate	South Africa
15. <i>E. sumbawaensis</i> Verseveldt & Bayer, 1988	digitiform	Indonesia
16. <i>E. unicolor</i> (Kükenthal, 1906)	digitiform to clavate	Japan
17. <i>E. variabile</i> (Thomson, 1921) comb. nov.	capitate	South Africa
18. <i>E. vinadigitaria</i> Williams & Little, 2001	digitiform	South Africa
19. <i>E. zanahoria</i> Williams, 2000	digitiform to lobate	Tonga; NE Australia

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