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Rosemarie C. Baron-Szabo and Stephen D. Cairns

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PART F, REVISED, VOLUME 2, CHAPTER 11: SYSTEMATIC DESCRIPTIONS OF THE SCLERACTINIA FAMILY MICRABACIIDAE

ROSEMARIE C. BARON-SZABO[1,2] and STEPHEN D. CAIRNS[1]

[[1]Department of Invertebrate Zoology, Smithsonian Institution, Washington, DC, USA, rosemarie_baronszabo@yahoo.com and CAIRNSS@si.edu; [2]Senckenberg Research Institute, Frankfurt/Main, Germany, Rosemarie.Baron-Szabo@senckenberg.de]

INTRODUCTION

The Micrabaciidae is one of the smallest and least diverse scleractinian families, consisting of the five genera: *Micrabacia* MILNE EDWARDS & HAIME (20 fossil species), *Leptopenus* MOSELEY (four extant species), *Letepsammia* YABE & EGUCHI (four extant species), *Rhombopsammia* OWENS (two extant species), and *Stephanophyllia* MICHELIN (three extant and ten fossil species). Thus, nearly 40 valid species pertain to this family (CAIRNS, 1989, p. 13–24; BARON-SZABO, 2002, p. 130–131; 2008, p. 147–153), most of which (30) are known exclusively as fossils. Only the two genera, *Leptopenus* MOSELEY, 1881 and *Rhombopsammia* OWENS, 1986 are as yet known exclusively from the Holocene.

The monophyly of the family is supported by macromorphological, microstructural, and molecular evidence. The macromorphological evidence includes a unique pattern of septal and costal insertion, alternating septa and costae, and the frequent presence of a marginal shelf. These characters are best illustrated and discussed by CAIRNS (1989), who also supplied a key to four (those with living species) of the five genera. The unique pattern of septal insertion, once thought to be a repeated bifurcation of the third cycle septa (CAIRNS, 1989), was shown by JANISZEWSKA, JAROSZEWICZ, and STOLARSKI (2013) to be accomplished by unequal-length invaginations of the wall between septa at the peripheral edge of the calice, and thus could not originate from bifurcation. Nonetheless, the result in adult corals resembles bifurcation and was even called pseudo-bifurcate by JANISZEWSKA, JAROSZEWICZ, and STOLARSKI (2013). The unique microstructural skeletal composition was first described by JANISZEWSKA and others (2011) and later elaborated by JANISZEWSKA and others (2015). The molecular monophyly, based exclusively on the mitochondrial gene CO1, was discussed by KITAHARA and others (2010), and based on four genes, both mitochondrial and nuclear, by STOLARSKI and others (2011). According to KITAHARA and others (2010) and STOLARSKI and others (2011), the Micrabaciidae, along with the Gardineriidae, form a deeply diverging basal clade, equivalent to the robust and complex clades that encompass all other Scleractinia.

This chapter gives an overview of the taxonomy, stratigraphy, and geography of the genera currently included in the family Micrabaciidae. The diagnosis of the family is followed by the description of its nominate genus, and then descriptions of the other genera in alphabetical order. Table 1 (p. 7) provides a synopsis of micrabaciid genera, including key characteristics and stratigraphic ranges.

Family MICRABACIIDAE Vaughan, 1905, p. 386

[Micrabaciidae VAUGHAN, 1905, p. 386] [=Stephanophylliidae YABE & EGUCHI, 1934, p. 281]

Simple, free, cupolate, ahermatypic, azooxanthellate, non-epithecate *sensu lato;* wall solid in earliest juvenile stages, becoming porous in later ontogenetical stages; porosity of wall achieved by development of concentric

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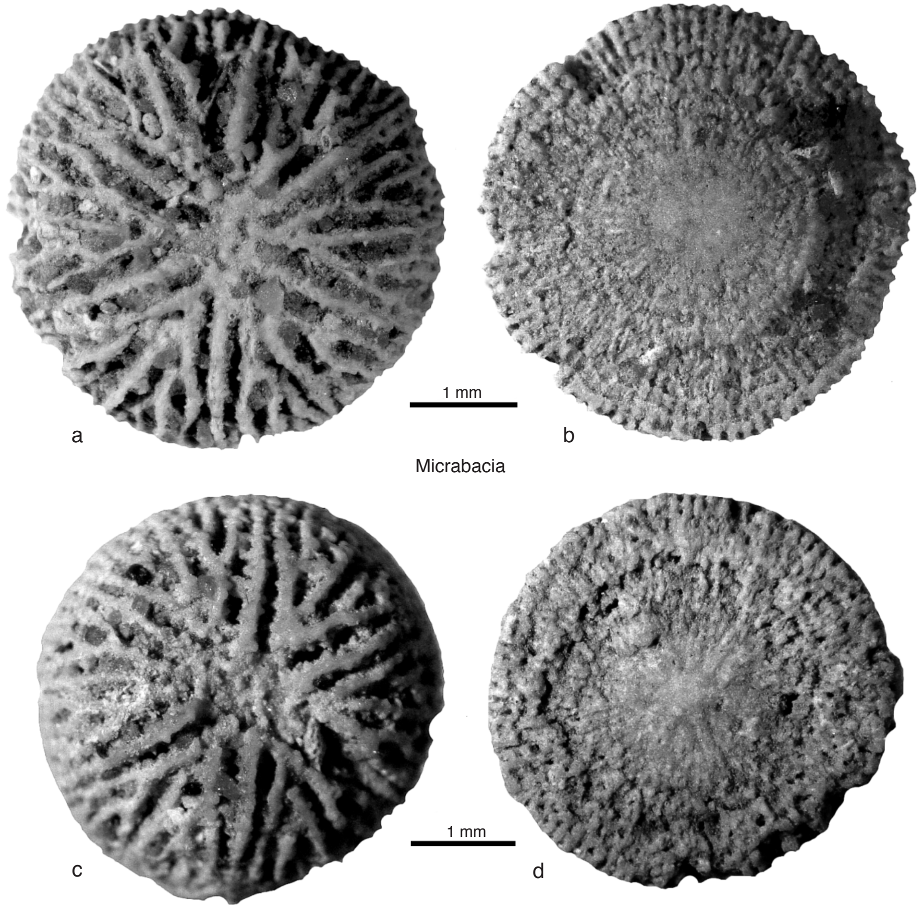

FIG. 1. Micrabaciidae (p. 2–3).

rows of pillars that are part of invaginated wall (*sensu* JANISZEWSKA, JAROSZEWICZ, & STOLARSKI, 2013), which occurs between septa of preceding cycles; septa represent vertical continuations of wall invaginations; septa of all cycles fused with nearest ones of former cycle, resulting in pseudo-bifurcation pattern; septa of fourth cycle and higher do not appear simultaneously but are inserted in pairs whereby the septum adjacent to older septa arises first; septa composed of thickening deposits unique to this group; not in crystallographic continuation with Rapid Accretion Deposits (RAD) or traditional calcification centers; costae beaded or smooth, alternate in position with septa by successive bifurcation, and match number of septa; septa perforate or compact, margins highly or slightly dentate; dissepiments absent; synapticulae present or absent; wall probably marginotheca; columella composed of processes of thickening deposits, loose, spongy, or compact, often elongate; pali absent; microstructure in thickening deposits composed of thin (around 100–300 nm) and short (1–2 µm) fibers arranged in chip-like bundles; polyp completely invests corallum. *Lower Cretaceous (Aptian)–Holocene*.

Micrabacia MILNE EDWARDS & HAIME, 1849, p. 71 [**Fungia coronula* GOLDFUSS, 1826–1827, p. 50; SD MILNE EDWARDS & HAIME, 1849, p. 71] [=*Cyclabacia* BÖLSCHE, 1866, p. 474 (type, *C. stellifera;* SD VAUGHAN, 1905, p. 409); =*Discopsammia* D'ORBIGNY, 1850, p. 180 (type, *Stephanophyllia bowerbankii* MILNE EDWARDS & HAIME, 1848, p.

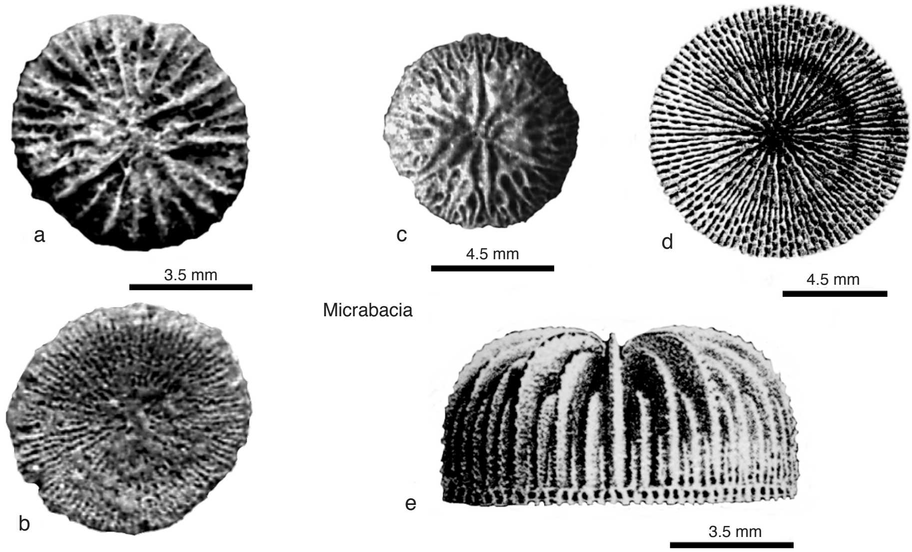

FIG. 2. Micrabaciidae (p. 2–3).

94; M)]. Solitary, cupolate to discoidal with flat to slightly concave base; marginal shelf narrow; corallum free, small, usually less than 15 mm in diameter; septa lamellar and perforate; septal margins nearly vertical peripherally, finely granulated laterally; synapticulae present; columella trabecular, papillose, or composed of lamellar segments; thecal pillars often not aligned in continuous concentric rings but in an alternating fashion. [The holotype is assumed to be lost; type material is presumably housed at the IPB (Bonn), but repeated attempts by BARON-SZABO to trace the specimens have failed. Genus is well described and discussed in WELLS, 1933, p. 153–171; CAIRNS, 1989, p. 13; BARON-SZABO, 2008, p. 147–153; and JANISZEWSKA, JAROSZEWICZ, & STOLARSKI, 2013, p. 244–256.] *Lower Cretaceous (Aptian)–Eocene:* western Europe, *Aptian–Paleocene;* South Asia, *Albian;* Central Asia, *Cenomanian;* West Asia, *Turonian;* eastern Europe, *Upper Cretaceous;* Central America, *Santonian;* northern Europe, *Campanian;* North America, *Campanian–Maastrichtian;* North Africa, *Paleocene–Eocene*.——FIG. 1*a–d*. **M. coronula* (GOLDFUSS, 1826–1827), Cenomanian (Essen Greensand), Germany (North-Rhine Westphalia); *a–b,* topotype, GPIH–4842, upper surface (*a*) and base (*b*) of corallum; *c–d,* topotype, GPIH–4843, upper surface (*c*) and base (*d*) of corallum (new, images by Baron-Szabo).——FIG. 2*a–e*. **M. coronula* (GOLDFUSS, 1826–1827), Cenomanian (Essen Greensand), Germany (North-Rhine Westphalia); *a–c,* topotype, MB K.2990–1, upper surface (*a*) and base (*b*) of corallum; *c,* topotype, MB K.2990–3, upper surface of corallum (new, from Münster collection, possibly original type collection, images by Baron-Szabo); *d–e,* sketch of holotype (specimen missing, presumably housed at IPB), base (*d*) and lateral view (*e*) of corallum. (Milne Edwards & Haime, 1850, pl. 10,*4a,c*).

Leptopenus MOSELEY, 1881, p. 204 [**L. discus* MOSELEY, 1881, p. 205; SD WELLS, 1936, p. 115, syntypes, NHMUK 1880.11.25.158–159]. Solitary, discoidal with flat base; corallum extremely fragile and highly porous; costae composed of thin dentate ridges that extend far beyond calice to form a delicate marginal shelf; septa rudimentary, porous, composed primarily of a series of tall spines; synapticulae absent; columella large, spongy or variable in shape, composed of loose mass of spines. [Genus is well described and discussed by CAIRNS, 1989, p. 13–15.] *Holocene:* worldwide, including Antarctic, 221–5000 m depth.——FIG. 3,*1a–b*. **L. discus*, syntype, NHMUK 1880.11.25.159, Holocene, southwestern Atlantic Ocean, Challenger Station 323, 3473 m depth; *a,* skeleton surface, cross-section view; *b,* close-up view of *a* (new, images courtesy of Ken Johnson).

Letepsammia YABE & EGUCHI, 1932, p. 58 [**Stephanophyllia formosissima* MOSELEY, 1876, p 561; OD; syntype, NHMUK 1880.11.25.156]. Solitary, cupolate with flat, highly porous base; corallum porous but sturdy; costae consist of thin, delicate ridges; intercostal spaces broader than costae and penetrated by large pores; thin marginal shelf present; septa lamellar and highly porous, with complex dentition; small synapticulae present, uniting lower, outer edges of all septa; columella spongy, well developed. [Type and original material are well described by CAIRNS, 1989, p. 15–18, pl. 6,*j, 7,g–i,* and *8,a–d*]. *Pliocene–Holocene:* East Asia, *Pliocene–Pleistocene;* Indian and Pacific Oceans, 97–710 m depth, *Holocene*.——FIG. 3,*2a–b. L.*

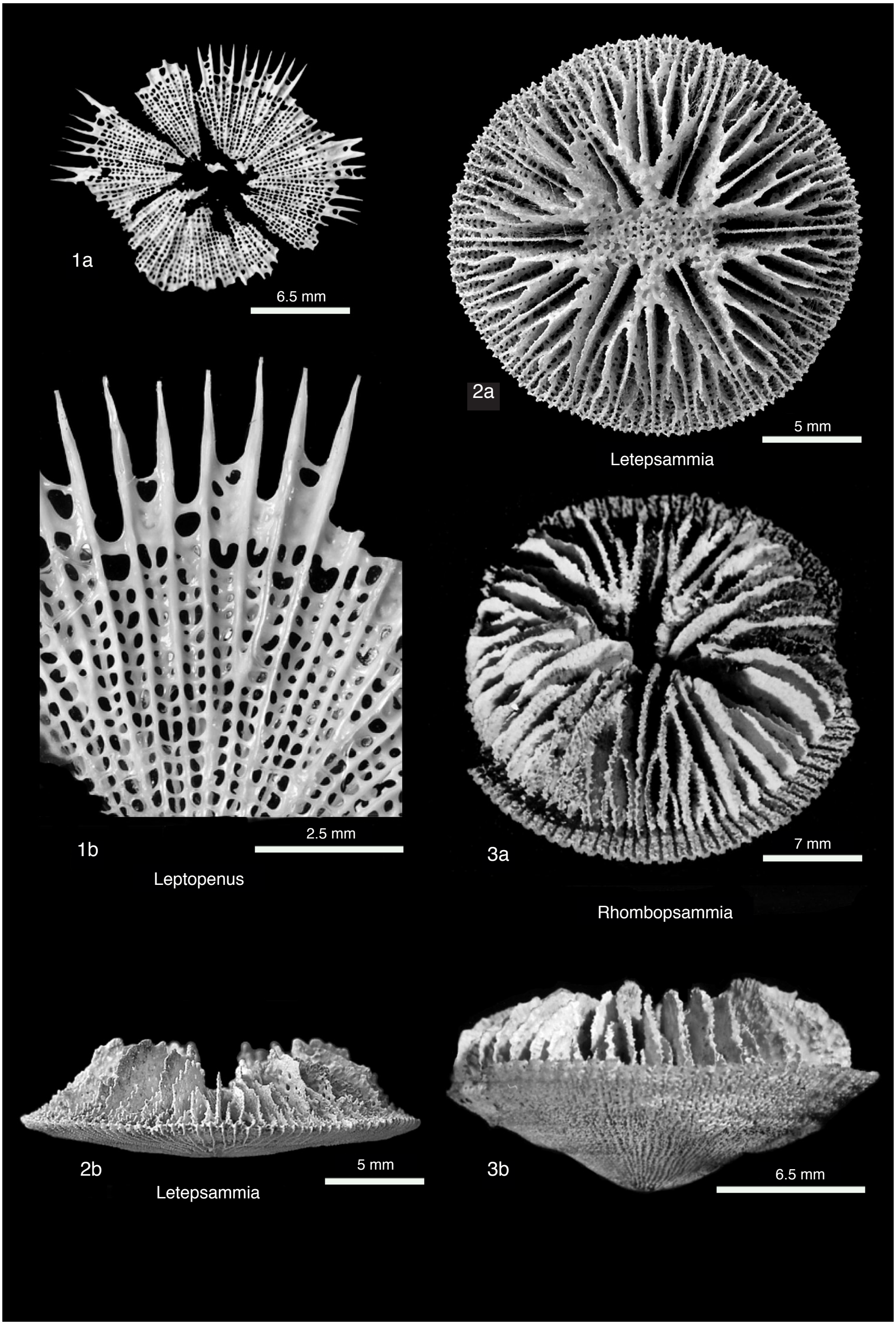

FIG. 3. Micrabaciidae (p. 3–5).

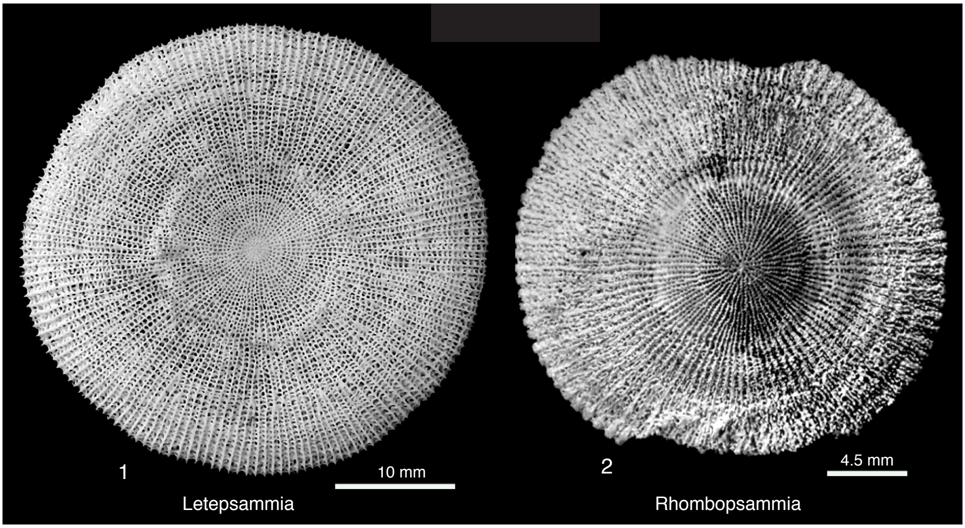

FIG. 4. Micrabaciidae (p. 3–6).

formosissima (MOSELEY, 1876), syntype, NHMUK 1880.11.25.156, Holocene, Indo-Pacific Ocean, 170 m depth, Challenger Station 209; upper surface (*a*) and lateral view (*b*) of corallum (new, images courtesy of Ken Johnson).——FIG. 4,*1. L. formosissima* (MOSELEY, 1876), syntype, NHMUK 1880.11.25.156, base of corallum, Holocene, Indo-Pacific Ocean, 170 m depth, Challenger Station 209 (new, image courtesy of Ken Johnson).

Rhombopsammia OWENS, 1986, p. 249 [**R. squiresi* OWENS, 1986, p. 250; OD]. Solitary, cupolate with convex, highly porous base; corallum porous but sturdy; costae consist of thin, dentate ridges; intercostal spaces broader than costae; marginal shelf present; septa lamellar and imperforate, with complex dentition; small synapticulae present; columella spongy. [Holotype USNM 72797, as well as five paratypes are deposited at the USNM. The genus was well described originally by OWENS and re-described by CAIRNS, 1989, p. 18–19, pl. 8,*e–j,* pl. 9,*a–d.*] *Holocene:* Pacific Ocean (off Philippines and Timor Sea), 68–1401 m depth.——FIG. 3,*3a–b. R. squiresi* OWENS, 1986, holotype, USNM 72797, Holocene, Indo-Pacific, 929 m depth; *a,* upper surface of corallum, oblique (Cairns, 1989, pl. 8,*e*); *b,* lateral view of corallum (Cairns, 1989, pl. 8,*g.*)——FIG. 4,*2. R. squiresi* OWENS, 1986, holotype, USNM 72797, Holocene, Indo-Pacific Ocean, 929 m depth, base of corallum (Cairns, 1989, pl. 8,*f*.——FIG. 5,*1. R. squiresi* OWENS, 1986, paratype, USNM 72800, costal granulation, Holocene, Indo-Pacific Ocean, 907 m depth, Albatross station 545425 (Cairns, 1989, pl. 9,*b*).

Stephanophyllia MICHELIN, 1841, p. 32 [**Fungia elegans* BRONN, 1838, p. 900; OD] [=*Stephanopsammia* YABE & EGUCHI, 1932, p. 58 (type, *S. discoides* MILNE EDWARDS & HAIME, 1848; OD]. Solitary, cupolate with flat base; corallum porous but sturdy; costae have two rows of aligned granules, granules equal to or thicker than intercostal spaces; marginal shelf narrow, developed regularly or irregularly, absent in some places; septa lamellar and perforate only near base; synapticulae present; columella solid and compact, lamellar or lenticular. [According to CHEVALIER (1962, p. 434), holotype is lost, and thus he designated a neotype, a specimen figured by MICHELIN, 1841, pl. 8,*2.* The type species was well described and illustrated by CHEVALIER, 1962, p. 433–435, fig. 155–157. Microstructural studies on various Miocene and Pliocene *Stephanophyllia* specimens were carried out by JANISZEWSKA and others, 2015. New data by Baron-Szabo (in press) identifies upper Aptian origins of *Stephanophyllia.*] *Lower Cretaceous (Aptian)–Holocene:* western Europe, *upper Aptian–Turonian;* Central America, *Santonian–Campanian;* North America, *Santonian–Maastrichtian;* ?eastern Europe, *Campanian;* eastern Africa, *Campanian–Maastrichtian;* eastern and western Europe, North Africa, South Asia, *Paleocene;* North America, South Asia, western Europe, *Eocene;* eastern and western Europe, *Oligocene–Miocene;* North Africa, southern Europe, *Miocene–Pliocene;* East Asia, *Pliocene–Pleistocene;* Melanesia, *Pleistocene;* Indo-Pacific Ocean, 15–700 m depth, *Holocene.*——FIG. 5,*2a–c. S. nysti* MILNE EDWARDS & HAIME, 1850, BSPG 2014/I/30, lower Miocene (Hemmor), The Netherlands (Miste at Winterwijk); lateral view (*a*), upper surface (*b*) of corallum, and oblique view (*c*) of upper surface, showing porosity of wall (new, images by Baron-Szabo).——FIG. 5,*2d–e. S. imperialis* (MICHELIN, 1841), NHMW 1846/0037/0980, Miocene (Badenian), Austria; upper surface (*d*) and base (*e*) of corallum (new, images by Baron-Szabo of original material used to figure specimen in Reuss, 1872, pl. 14,*1a* and 14,*2a*).

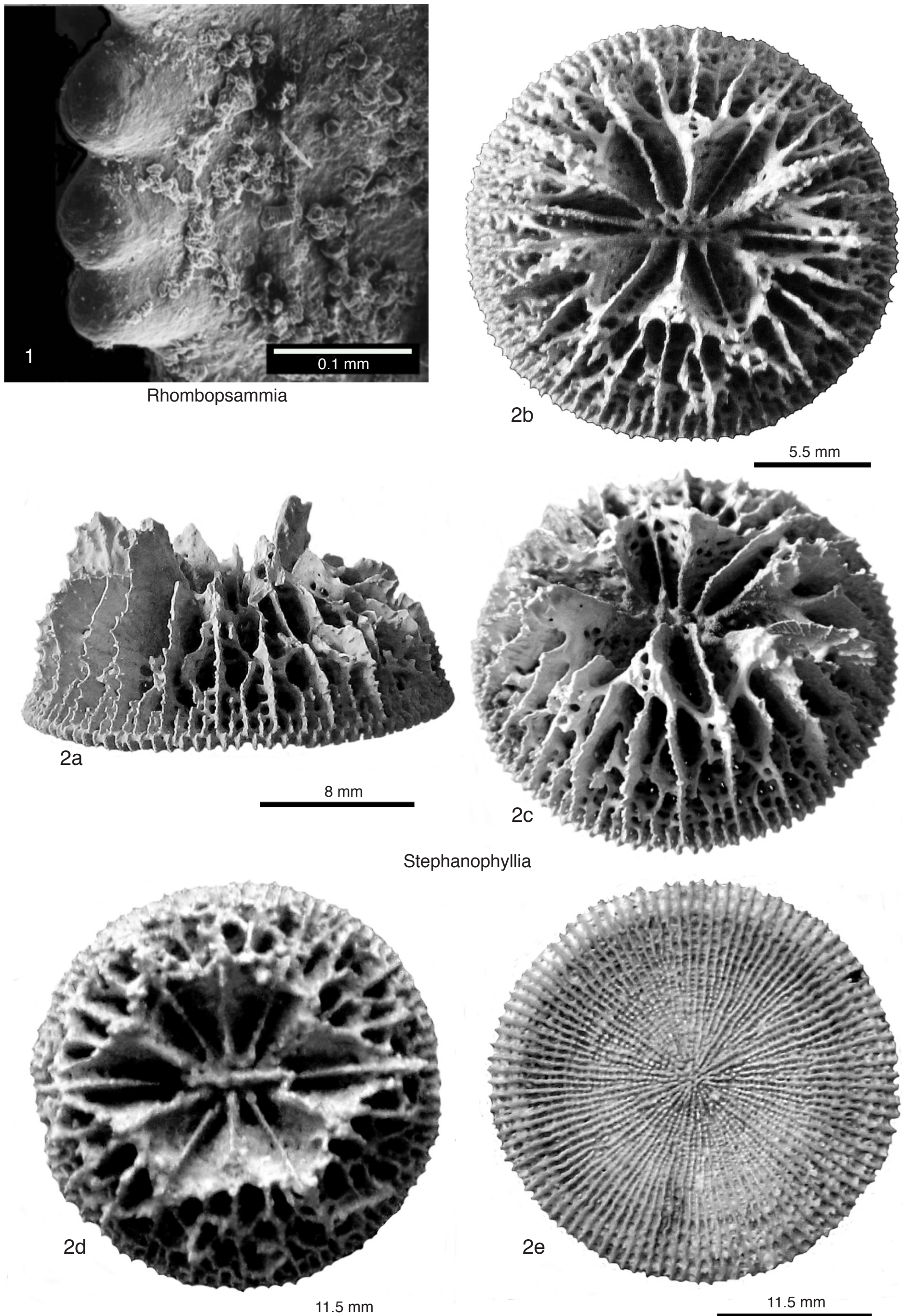

FIG. 5. Micrabaciidae (p. 5–7).

TABLE 1. Synopsis of micrabaciid genera, including key characteristics and stratigraphic ranges.

Micrabaciidae genus	Key characteristics	Stratigraphic ranges	Remarks
Micrabacia Milne Edwards & Haime, 1849, p. 71 [**Fungia coronula* Goldfuss, 1826–1827, p. 50; SD Milne Edwards & Haime, 1849, p. 71]	Corallum robust and relatively small (usually less than 15 mm in diameter); marginal shelf narrow; septa lamellar and perforate	Lower Cretaceous (upper Aptian)–Eocene	Together with *Stephanophyllia,* this genus has the largest stratigraphic range of the micrabaciid genera; contains the junior synonyms *Cyclabacia* Bölsche, 1866, and *Discopsammia* d'Orbigny, 1850.
Leptopenus Moseley, 1881, p. 204 [**L. discus* Moseley, 1881, p. 205; SD Wells, 1936, p. 115]	Corallum extremely fragile; marginal shelf spinose; intercostal spaces extremely porous; septa rudimentary, composed of a series of spines	Holocene	This genus was revised by Cairns (1989). Except for *Fungiacyathus,* this is the deepest living scleractinian coral.
Letepsammia Yabe & Eguchi, 1932, p. 58 [**Stephanophyllia formosissima* Moseley, 1876, p 561; OD]	Corallum delicate; thin marginal shelf present; intercostal spaces extremely porous; septa lamellar and highly porous	Pliocene–Holocene	Type and original material of the genus well described and partially revised by Cairns (1989). There are four valid species, one having a fossil record.
Rhombopsammia Owens, 1986, p. 249 [**R. squiresi* Owens, 1986, p. 250; OD]	Corallum robust; thick marginal shelf present; intercostal spaces extremely porous; septa lamellar and imperforate	Holocene	The genus, consisting of two exclusively extant species, was revised by Cairns (1989).
Stephanophyllia Michelin, 1841, p. 32 [**Fungia elegans* Bronn, 1838, p. 900; OD]	Corallum robust; marginal shelf narrow; septa lamellar and perforate; columella solid, often lamellar; generally no endotheca	Lower Cretaceous (upper Aptian)–Holocene	Type species well described and illustrated by Chevalier, 1962; additional microstructural information on the genus by Janiszewska & others, 2015; contains junior synonym *Stephanopsammia* Yabe & Eguchi, 1932.

ABBREVIATION FOR MUSEUM REPOSITORIES

BMNH: The Natural History Museum, London, UK
BSPG: Bayerische Staatssammlung für Paläontologie und historische Geologie, Munich, Germany
GPIH: Institut für Geologie, Universität Hamburg, Hamburg, Germany
IPB: Institut für Paläontologie der Universität Bonn, Bonn, Germany
MB: Museum für Naturkunde, Berlin, Germany
NHMUK: Natural History Museum, London, UK
NHMW: Naturhistorisches Museum, Vienna, Austria
USNM: United States National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (now NMNH)

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