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AZOOXANTHELLATE SCLERACTINIA (HEXACORALLIA, ANTHOZOA, CNIDARIA) COLLECTED FROM OTSUKI, KOCHI PREFECTURE, JAPAN

by

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Abstract

Specimens representing 35 species of azooxanthellate scleractinian coral collected from Otsuki Town, Kochi Prefecture, Japan, are described and illustrated. Thirteen of the species were collected by hand with SCUBA to depths of 45 m. The remaining 22 species were collected by boat while dragging traditional precious coral tangle-nets at depths of 83-134 m. Twenty-seven species are new records for this region. Eight families are represented in the collection, but more than half of the taxa (20 species) belong to the family Dendrophylliidae. For several species with taxonomic problems, type specimens are also redescribed and figured.

Introduction

The Pacific coast of southwestern Japan enjoys the strong influence of the warm Kuroshio current, which allows it to display an abundant subtropical flora and fauna in spite of the relatively high latitude. The southwestern part of Kochi Prefecture, where the Biological Institution on Kuroshio is located, is a typical Kuroshio-influenced region well known for its excellent subtropical underwater scenery. In this region, several Marine Park zones have been designated as part of the Ashizuri-Uwakai National Park, due mainly to their well developed coral communities (Iwase, 2005). Many zooxanthellate scleractinian corals, which are tropical to subtropical components of the marine fauna, are known to flourish in this region: Veron (1992) and Nishihira and Veron (1995) reported 147 species of zooxanthellate Scleractinia from Tosashimizu City, where some of the Marine Park zones are located. However, the azooxanthellate Scleractinia of this region have seldom been studied except by Yabe and Eguchi (1942), who reported on rather deep-water species (see "Previous Studies" below).

In October, 2004, the author had the opportunity to visit the Biological Institution on Kuroshio in Otsuki Town, Kochi Prefecture, to study the azooxanthellate scleractinian corals of this region. In this report, the specimens collected are identified, described, and figured, and taxonomic problems concerning several species are discussed. Type specimens

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of some species are also redescribed and illustrated for the purpose of comparison.

Material and Methods

Specimens of azooxanthellate scleractinian corals were collected either by hand using SCUBA or by tangle-nets. Four series of SCUBA dives were undertaken to a depth of 45 m around Komo, southwards off Tachibanaura, Otsuki, on 5 and 6 October 2004 (Fig. 1).

Alternatively, specimens were collected on board a coral-fishing vessel, which used a traditional coral tangle-net to catch precious corals, *Corallium* spp. Such a net is composed of a thick log, large stone sinkers attached to it at regular intervals, and tufts of fishing net attached as streamers to the sinkers (see Kitahara, 1903 for traditional precious coral fishing). The vessel drags the net along the sea bottom to entangle the precious corals, and many other bottom animals are caught at the same time. In this study, a locally operated vessel was hired to drag a coral tangle-net at 4 stations off Nishidomari, Otsuki, on 7 October 2004. In both methods, all coral specimens were collected with the permission of the Governor of Kochi Prefecture.

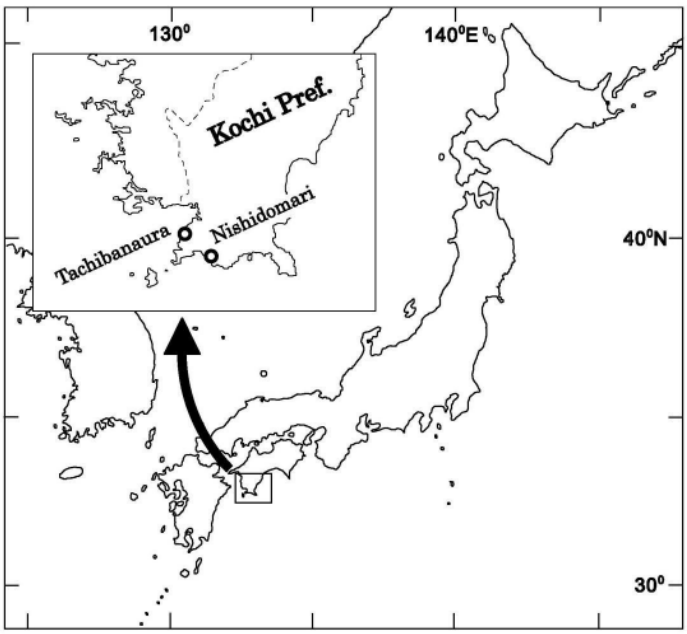

Fig. 1. Sampling stations of the present study.

The sampling stations are abbreviated as follows:

Komo: Off Komo, southwards off Tachibanaura, collected by H. Tachikawa, F. Iwase, and T. Hayashi using SCUBA, to a depth of 45 m.

CN1: Coral tangle-net station 1, off Nishidomari, Otsuki, Kochi Pref., from 32 ° 37.66 ′ N, 132 ° 50.44 ′ E, 114 m to 32 ° 37.56 ′ N, 132 ° 47.88 ′ E. The depth at the end of the operation was not recorded.

CN2: Coral tangle-net station 2, off Nishidomari, Otsuki, Kochi Pref., from 32 ° 34.14 ′ N, 132 ° 48.59 ′ E, 117 m to 32 ° 34.18 ′ N, 132 ° 47.59 ′ E, 125 m.

CN3: Coral tangle-net station 3, off Nishidomari, Otsuki, Kochi Pref., from 32 ° 43.08 ′ N, 132 ° 48.06 ′ E, 85 m to 32 ° 43.12 ′ N, 132 ° 47.68 ′ E, 83 m.

CN4: Coral tangle net station 4, off Nishidomari, Otsuki, Kochi Pref., from 32 ° 40.68 ′ N, 132 ° 47.57 ′ E, 130 m to 32 ° 40.68 ′ N, 132 ° 46.99 ′ E, 134 m.

Institutional abbreviations are as follows:

BIK: Biological Institution on Kuroshio, Kuroshio Biological Research Foundation, Otsuki.

CMNH: Coastal Branch of Natural History Museum and Institute, Chiba, Katsuura.

IGPS: Institute of Geology and Paleontology, Tohoku University, Sendai.

NSMT: National Science Museum, Tokyo (Showa Memorial Institute), Tsukuba.

Morphological terminology follows Cairns (1989, 1994, 2004), including the following abbreviations: GCD, greater calicular diameter; GCD:LCD, ratio of gretaer to lesser calicular diameter; PD:GCD, ratio of pedicel diameter to greater calicular diameter; Sx, septa of cycle designated by numerical subscript.

Collected specimens were cleaned using sodium hypochlorite solution and stored as dry specimens. To enhance the contrast in conventional black-and-white photographs, some of the specimens were stained dark using cyanine blue solution and coated with ammonium chloride prior to photography. SEM photographs were made using a JEOL JSM-5310LV at CMNH in low vacuum mode. All the conventional and SEM photographs were made by the author. Plate citations below each species heading pertain only to specimens from the present collection; photographs of other material are cited separately in the text. Specimens are deposited at CMNH (with a code of ZG) and BIK (with a code of C). Reference specimens were studied in IGPS and NSMT.

Previous Studies

In this section, species are divided into two categories for the sake of convenience. Species encountered by SCUBA divers are treated as shallow-water species, and species from much deeper areas that are only accessible using fishing gear or research apparatus are treated as deep-water species.

Shallow-water species. – Many field surveys have been conducted in the Marine Park zones in Ashizuri-Uwakai National Park, and a number of reports have been published up to now. Some of them include faunal lists of the region that mention many scleractinian corals. Almost all of these have been zooxanthellate species, with azooxanthellate species recorded only sporadically (Nature Conservation Society of Japan, 1965; Kochi Prefectural Government and Marine Parks Center of Japan, 1971; Nature Conservation Bureau, Environment Agency and Marine Parks Center of Japan, 1995). Shallow-water azooxanthellates previously reported from the Ashizuri-Uwakai region are *Rhizotrochus typus* (as *Monomyces uchiuraensis*), *Tubastraea coccinea*, *Tubastraea micranthus* (commonly as *Dendrophyllia micrantha*), and *Flabellum pavoninum* var. *paripavoninum*. Of these, the former three species were recorded also in the present study. The last one is cited by Nature Conservation Society of Japan (1965), but in a quote from a previously published preliminary report on the establishment of Ashizuri National Park. Unfortunately, the original report could not be accessed by the author and the occurrence of this species in shallow water was not confirmed by the present study.

Deep-water species. – In the significant work on Japanese azooxanthellate Scleractinia of

Yabe and Eguchi (1942), a majority of the materials examined was collected by R/V *Soyo-maru* of the Imperial Fisheries Experimental Station, which dredged extensively around Japan during the years 1922-1930. Fourteen *Soyo-maru* stations (Sts. 231, 322-333, and 336), ranging from 88 to 684 m in depth, were located off Okinoshima Island and off Cape Ashizuri, Kochi Prefecture, the region including the sampling stations of the present study. From these stations, 27 species and subspecies of azooxanthellate Scleractinia were recorded by Yabe and Eguchi (1942), although the names of some of the species in their report should be amended to fit the present-day taxonomy (see Cairns, 1994; Cairns and Zibrowius, 1997). Five of Yabe and Eguchi's species were recorded again in the present study: *Bathyactis palifera* (*Fungiacyathus paliferus* herein), *Premocyathus compressus* (*P. dentiformis* herein), *Citharocyathus conicus* (*Notocyathus conicus* herein), *Flabellum distinctum* (*Flabellum pavoninum* herein), and *Balanophyllia fistula* (*Eguchipsammia wellsi* herein). In these cases, Yabe and Eguchi's records were confirmed by reexamination of their specimens deposited at IGPS. Regarding two other of their species records, *Stephanophyllia formosissima* and *Balanophyllia* cf. *rediviva*, results of this reexamination are discussed in the accounts of *Letepsammia superstes* and *Balanophyllia* sp. cf. *B. rediviva*, respectively.

Result and Discussions

The specimens collected from the field survey included 35 species of azooxanthellate Scleractinia. Thirteen of these were collected by SCUBA diving and 22 were collected by coral tangle-net. As mentioned above, 8 (3 shallow-water and 5 deep-water) species were previously known from the Ashizuri-Uwakai region: the other 27 species are regarded as new records for this region. Eight families are represented, but more than half (20) of the species belong to the family Dendrophylliidae. Especially, the overwhelming majority (11 of 13) of species collected by SCUBA are dendrophylliids, which indicates a high diversity of this family in the shallow waters of this region. Among the species collected by tangle-net, the proportion of Dendrophylliidae is also relatively high (9 of 22). This can be attributed to the method of collection employed in this study. Many species of this family have a colonial, branched growth form and a rough exterior, and are apt to be entangled by the net. This method is less suitable for collecting relatively small, solitary, free-living species that are not easily entangled. In fact, all 5 species of Fungiacyathidae, Micrabaciidae, and Turbinoliidae collected in this study were each represented by just one or two dead coralla adhering to dead gastropod shells or to dead colonies of *Dendrophyllia* brought up together with bottom sediment. Field surveys by dredging aimed mainly at the free-living soft-bottom species are needed to supplement the results of the present study. In addition, in light of the rather narrow depth range of this study, researches extending to much greater depths are necessary to fully clarify the azooxanthellate scleractinian fauna of this region.

List of Species

Family POCILLOPORIDAE

1. *Madracis* sp.

(Pl. 1, Figs. A-E)

Material examined. – Komo, 37 m, part of a colony and several branch fragments (CMNH-ZG 03761; BIK-C-0150).

Description. – Colonial: colony attached to substrate, consisting of irregularly arborescent, slender, attenuate branches; diameter of branch 3.5-4.0 mm at 10 mm from tip. Collected specimen (part of a colony) 80 mm high and 115 mm across. Corallites 2.2-3.0 mm in GCD; corallites near branch tips polygonal and closely spaced, separated by thin ridges bearing unilinear row of conical teeth up to 0.5 mm high; corallites on middle and proximal parts of branches elliptical and separated by 1-2.5 mm of coenosteum. Coenosteum distinctly striated longitudinally and sparsely covered with pointed granules. Septa decamerally arranged in 1 cycle (10 septa), but 12 or 14 septa in occasional corallites; each septum bearing septal lobe as tall as intercalicular teeth. Columella a large, solid mass forming circular platform of about half calicular diameter, with slightly protruding conical central portion and laterally compressed apex. Living colony purplish brown; corallum white.

Remarks. – The present specimen has uniquely striated coenosteum and appears to belog to an undescribed species. In Japan, branching species of *Madracis* found in shallow waters have been identified customarily as *Madracis asanoi* Yabe and Sugiyama, 1936 (e.g., Eguchi, 1968; Uchida, 1994; Nishihira and Veron, 1995). Living colonies figured as *M. asanoi* in Uchida (1994) and Nishihira and Veron (1995) have growth forms similar to the present specimen; however, it is necessary to compare skeletal characters before concluding whether they are conspecific. The present specimen differs from *M. asanoi* not only in the striated coenosteum but also in the finer, attenuate branches. From Japan, another unidentified branching *Madracis* with two cycles of septa and a crown of distinct paliform lobes was recorded by Cairns (1994). It seems that the *Madracis* of Japan, and those of the Indo-Pacific region as well, are in need of revision.

The holotype of *M. asanoi*, collected from 100 fathoms (i.e., 183 m) off the Palao Islands (currently Republic of Palau, or Belau), is deposited at IGPS (Pl. 1, Figs. F-H). It is part of a sparsely branching colony with a maximum dimension of 62 mm. Its branch tips are rounded, the diameter of the terminal branches is 4-5.5 mm, and the diameter of the basal branch is 6.5 mm. The corallites are almost circular even at the tips of the branches and are characteristically variable in size. Larger corallites attain 2.5 mm in GCD. Each corallite has 10 (in some large corallites 12) lobed septa, which protrude up to 0.7 mm from the coenosteum, and no pali. The columella is a widely conical, solid mass of about half the calicular diameter, with a laterally compressed, blunt apex. Adjacent calices are separated by 0.5-1.0 mm of granular coenosteum.

Another branching species, *Madracis palauensis* Yabe and Sugiyama, 1936, was also described from the Palao Islands, at 80 fathoms (i.e., 146 m: Pl. 1, Figs. I-J). Yabe and Sugiyama (1936) distinguished it from *M. asanoi* by the broader, compressed branches, larger calices, and relatively narrow columella. Reexamination of the holotype has revealed that the colony was originally overgrowing an elongate substratum, presumably the axis of a dead gorgonian colony, and consequently the proximal branch was widened. Characteristics of the calices, including the variable calicular diameter, are very similar in

both species. *Madracis palauensis* has a slightly less protruded columella and, in a few corallites, rudimentary second order septa, in which 1 or 2 very small spines comprise each septum. These differences are not a sufficient basis enough for separating species, and I agree with Cairns and Zibrowius (1997) in synonymizing *M. asanoi* and *M. palauensis* under the former name.

Family FUNGIACYATHIDAE

2. *Fungiacyathus* (*Fungiacyathus*) *paliferus* (Alcock, 1902)

(Pl. 2, Figs. A-B)

Material examined. – CN2, 1 (BIK-C-0151).

Description. – Corallum solitary and unattached, flat and semicircular, 4.4 mm in calicular diameter. Costae round, covered with low granules. Oral side worn but about 25 septa present in 2 systems flanked by 2 half systems, in 4 cycles. Adjacent septa united by solid synapticular plates. Columellar region broken.

Remarks. – This species is known to have two growth forms: a relatively large, circular corallum and a small, semicircular to wedge-shaped corallum, the latter being a result of longitudinal division. The present specimen is a long-dead, semicircular corallum, considered to be a juvenile specimen of the latter growth form. The adult corallum of *F. paliferus* has 5 cycles of septa hexamerally arranged, although coralla between 1.8 and 4.5 mm in calicular diameter have only 4 cycles of septa (Cairns, 1989), which is consistent with the septal number of this specimen.

Family MICRABACIIDAE

3. *Letepsammia superstes* Ortmann, 1888

(Pl. 2, Figs. C-D)

Material examined. – CN2, 1 (BIK-C-0152).

Description. – Corallum solitary, discoid and unattached, 9.3 mm in GCD. Costae thin, separated by widely open intercostal spaces and regularly connected by thin synapticulae, forming a mesh-like appearance. Septa hexamerally arranged in micrabaciid fashion (ca. 80 septa). Septa and costae alternating in position. Columella worn, formed of entangled trabeculae.

Remarks. – Most corals from Japan referred to *Stephanophyllia formosissima* Moseley, 1876, or *Letepsammia formosissima*, are actually this species; an exceptional case is a paper by Ogawa and Takahashi (2004), who figured true *L. formosissima*. *Letepsammia superstes* differs from *L. formosissima* in having a papillose (vs. flat-topped and spongy) columella, fewer septa (usually 96 vs. up to 144), and a smaller but relatively robust corallum. The present specimen is a considerably worn corallum with a GCD of 9.3 mm but generally agrees with the characteristics of *L. superstes*.

Specimens reported as *Stephanophyllia formosissima* from *Soyo-maru* St. 242 by Yabe and Eguchi (1942) were reexamined and found to be several small specimens of *Letepsammia fissilis* Cairns, 1995.

Family CARYOPHYLLIIDAE

4. *Caryophyllia* (*Caryophyllia*) *rugosa* Moseley, 1881
(Pl. 2, Figs. E-F)

Material examined. – CN1, 8 (CMNH-ZG 03798); CN2, 9 (5, CMNH-ZG 03802; 4, BIK-C-0153).
Description. – Corallum solitary, trochoid, attached by thick pedicel, PD:GCD = 0.42-0.87. Calice circular to slightly elliptical, GCD:LCD = 1.00-1.16; largest corallum 6.7 mm in GCD; height of corallum 4.2-11.7 mm. Costae low and indistinct, covered with fine transverse sculpture. Septa octamerally arranged in 3 cycles (32 septa). All septa with sinuous inner edges. Crown of 8 sinuous pali before S2. Columella fascicular, with a few twisted elements. Corallum light brown to white.

5. *Caryophyllia* (*Caryophyllia*) *hawaiiensis* Vaughan, 1907
(Pl. 2, Figs. G-H)

Material examined. – CN1, 1 (BIK-C-0154).
Description. – Corallum solitary, ceratoid, attached by narrow (4.2 mm in diameter) pedicel, PD:GCD = 0.44. Calice slightly elliptical, 9.5 x 7.7 mm in diameter; height of corallum 18.6 mm. Costae indistinct, covered with low granules. Septa pentamerally arranged in 4 cycles (40 septa). S1 and S2 exsert, forming calicular lancets. Crown of 10 pali before S3. Columella fascicular.

6. *Caryophyllia* (*Caryophyllia*) sp. cf. *C.* (*C.*) *japonica* Marenzeller, 1888
(Pl. 2, Figs. I-J)

Material examined. – CN2, 1 (CMNH-ZG 03803); CN3, 1 (CMNH-ZG 03813).
Description. – Corallum solitary, trochoid, and attached by thick pedicel, PD:GCD = 0.46-0.49. Calice slightly elliptical, 4.6 x 4.1 to 5.3 x 4.6 mm in diameter; height of corallum 6.9-8.5 mm. Costae low, rounded, covered with low granules. Septa octamerally arranged in 3 cycles (32 septa). Inner edges of S2 highly sinuous. Crown of 8 pali before S2. Columella fascicular.
Remarks. – These small specimens resemble *C. japonica* in corallum shape, costal ornamentation, and the highly sinuous inner edges of the penultimate cycle of septa (in this case S2), although the septal arrangement is not hexameral but octameral. More specimens should be examined to clarify the identification.

7. *Premocyathus dentiformis* (Alcock, 1902)
(Pl. 2, Figs. K-L)

Material examined. – CN2, 1 (BIK-C-0155).
Description. – Corallum solitary, free, ceratoid, compressed. Corallum curved in plane of GCD; base open, 2.5 x 2.0 mm in diameter, revealing 7 large and 7 small protosepta.

Calice elliptical, 3.4 x 2.7 mm in diameter; height of corallum 5.2 mm. Costae low, rounded. Twelve large septa alternating with 12 small septa (24 septa in all); pali absent. Columella a fascicular mass.

Remarks. – Only a small, dead specimen was collected. Mori (1987) demonstrated in a Pleistocene fossil of *Caryophyllia* (*Premocyathus*) *compressa* (Yabe and Eguchi, 1942) (= *Premocyathus dentiformis*; see Cairns and Zibrowius, 1997 for the synonymy) that the septal plan is intrinsic and the number of pali is related to the insertion of the third-cycle septa. The present specimen is considered to be a dodecameral specimen with the third cycle of septa yet to be developed, and consequently, lacking pali.

8. *Paracyathus* sp.

(Pl. 3, Figs. A-B)

Material examined. – CN2, 1 (CMNH-ZG 03804); CN3, 1 (CMNH-ZG 03814).

Description. – Corallum solitary, trochoid to subcylindrical, attached by thick pedicel, PD:GCD = 0.66-0.94. Calice slightly elliptical, 5.8 x 4.9 to 6.3 x 5.9 mm in diameter; height of corallum 4.1-7.6 mm. Costae as low, rounded ridges covered with granules; most of theca covered with calcareous deposits. Septa hexamerally arranged in 5 incomplete cycles, with 3 to 5 pairs of S4 lacking (38-42 septa in all). Paliform lobes as twisted papillae; 1 to 2 paliform lobes before each septum of all but last cycle in the half system; in other words, in half system with S4, paliform lobes present before S1-S3, whereas in half system without S4, before S1 and S2 only. Columella papillose, indistinguishable from paliform lobes. Septa and upper theca mottled dark brown.

Remarks. – There are many "obscure" species of *Paracyathus* described from the Indo-West Pacific region (see Cairns, 2004). At present I cannot convincingly identify the two small specimens of *Paracyathus* collected in this study.

Family TURBINOLIIDAE

9. *Notocyathus conicus* (Alcock, 1902)

(Pl. 3, Figs. C-D)

Material examined. – CN2, 1 (BIK-C-0156).

Description. – Corallum solitary, free, conical; base pointed, thecal angle in plane of GCD 45 °. Calice slightly elliptical, 4.8 mm in GCD, GCD:LCD = ca. 1.20; corallum 5.4 mm high. Theca covered with worn costae; intercostal furrows deep. Septa hexamerally arranged in 4 cycles (48 septa). Twelve pali before S3: pair of pali in each system joined before common S2, forming V-shaped structure. Columella papillose.

10. *Deltocyathoides*? sp.

(Pl. 3, Figs. E-F)

Material examined. – CN2, 1 (BIK-C-0157).

Description. – Corallum solitary, free, cylindrical, with rounded base. Calice circular, 3.0 mm in GCD, GCD:LCD = 1.05; corallum 2.7 mm high. Theca covered with rounded

costae, intercostal furrows moderately deep. Septa hexamerally arranged in 3 cycles (24 septa). Six pali before S2. Columella papillose.

Remarks. – This small specimen has the same corallum size and calicular structure as *Peponocyathus minimus* (Yabe and Eguchi, 1937), although it has a rather rounded base, which is one of the generic characteristics of *Deltocyathoides* (see Cairns, 1997), instead of the truncate base of *Peponocyathus*. However, in a large series of the specimens of *P. minimus* collected from Japan, basal morphology is rather variable, ranging from transversely flat to slightly rounded (personal observation of the author), and some specimens in the series are hardly to be distinguished from the present specimen. This variation in basal morphology is quite the same as that of a Miocene congener, *Truncatocyathus* (=*Peponocyathus*) *duncani* (Reuss, 1871), as has been shown by Stolarski (1992; see Cairns, 1997 for the synonymy). Further study is needed to clarify the status of the present specimen.

11. *Idiotrochus kikutii* (Yabe & Eguchi, 1941)

(Pl. 3, Figs. G-H)

Material examined. – CN2, 2 (BIK-C-0158).

Description. – Corallum solitary, free, compressed-cylindrical; base transversely flat or with "pinched" basal edge. Calice elliptical, 3.0-3.1 mm in GCD, GCD:LCD = 1.50-1.55; corallum 1.9-2.8 mm high. Costae wide and smooth, intercostal striae narrow. Septa hexamerally arranged in 3 cycles (24 septa). Costae and septa alternating in position. In one specimen, 10 pali present before S1 and S2 except S1 in GCD, and columella fascicular; in other specimen, calicular structure worn and obscure.

Remarks. – The condition of the base in the present specimens is related to the time after division: the specimen with a transversely flat base has divided recently, whereas the "pinched" basal edge of the other specimen represents a healed scar.

Family GUYNIIDAE

12. *Truncatoguynia irregularis* Cairns, 1989

(Pl. 3, Figs. I-K)

Material examined. – CN2, 5 (3, CMNH-ZG 03805; 2, BIK-C-0159).

Description. – Corallum solitary, free, compressed-cylindrical; thecal edge rounded, sides parallel to one another or slightly tapered toward base; transverse division present. Pairs of thecal spines sometimes present near base of corallum on rounded thecal edges. Calice elliptical, 3.5-5.8 mm in GCD, GCD:LCD = 1.08-1.35; largest specimen 71 mm high. Theca smooth, porcellaneous; internal thecal pits occuring in lines, one line corresponding to each interseptal space; position of internal pits visible externally as chalky white markings. Septa basically hexamerally arranged in 3 to 4 cycles (24 to 32 septa in all). Columella absent; usually 12 septa reaching center of calice and firmly connected to each other. Corallum white.

Remarks. – This species is known to reproduce asexually by transverse division, although the fixed stage (anthocaulus) is yet to be found. Two of the present specimens, those of

3.3 and 3.7 mm in GCD, have an elongate-conical corallum with a small, open base of, respectively, 2.4 x 1.6 and 1.5 x 1.5 mm in diameter. The small basal diameter of these coralla (anthocyathi) suggests that the unknown anthocauli of this species have narrow pedicel. Two of the other specimens have thecal spines of quite the same form as those in species of *Truncatoflabellum*. The spines attain 3.4 mm in length and 0.8 mm in basal diameter. The largest specimen (Pl.3, Fig. K) has 4 pairs of spines in the lower half of the theca, although most of them are broken and only their scars are visible. Thecal spines have not been known in this species previously; however, I have collected several "spined" specimens of *Truncatoguynia* from various stations around Japan together with many "unspined" specimens. These two forms cannot be distinguished except by the presence or absence of the thecal spines, and this character is considered here to exhibit intraspecific variation.

Family FLABELLIDAE

13. *Flabellum pavoninum* Lesson, 1831
(Pl. 4, Figs. A-B)

Material examined. – CN2, 1 (CMNH-ZG 03806); CN4, 2 (BIK-C-0160).
Description. – Corallum solitary, with narrow pedicel but free when collected. Corallum compressed, its fan-shaped planar faces meeting at acute edges, and edges bearing low, discontinuous crests; edge angle (excluding crests) 90 °-106 °, face angle 41 °-43 °. Calicular edge smooth. Calice elongate, 15.7-27.0 mm in GCD; corallum 10.7-22.3 mm high. Septa hexamerally arranged in 6 incomplete cycles (108-110 septa in larger two specimens). Columella rudimentary.
Remarks. – These specimens pertain to the "*coalitum*" form of the species, which is distinguished from the typical form by having a smaller corallum, a lower edge angle, and fewer septa (Cairns, 1994, 1999; Cairns and Zibrowius, 1997).

14. *Javania insignis* Duncan, 1876
(Pl. 4, Figs. C-D)

Material examined. – CN1, 1 (BIK-C-0161).
Description. – Corallum solitary, ceratoid, attached by tectura-reinforced pedicel, PD:GCD = 0.27. Calicular edge weakly serrated. Calice elliptical, GCD:LCD = 1.50, 22.5 mm in GCD, height of corallum 29.5 mm. Theca smooth. Septa hexamerally arranged in 5 cycles (96 septa); lower-order septa moderately exsert. Fossa deep; columella absent.

15. *Rhizotrochus typus* Milne Edwards & Haime, 1848
(Pl. 4, Figs. E-H)

Material examined. – Komo, 42-45 m, 5 (2, CMNH-ZG 03762; 1, CMNH-ZG 03763; 1, CMNH-ZG 03764; 1, BIK-C-0162).
Description. – Corallum solitary, turbinate to fan-shaped, fixed by narrow pedicel as well as many rootlets. Calice elliptical to elongate, GCD:LCD = 1.21-2.33, largest corallum 105

mm in GCD and 70 mm high. Theca thin, usually encrusted by various epifauna and/or calcareous algae; calicular edge smooth. Many hollow rootlets connecting lower part of theca and substrate; number of rootlets uncountable in most coralla due to encrusting organisms. Septa hexamerally arranged in 6 cycles, with some additional S7 pairs in large corallum (202 septa in a corallum of GCD 98 mm). Upper 4-6 mm of septa very narrow, with each S1-3 forming large septal lobe below. Fossa deep; columella an elongate, connected mass of thick trabeculae. Living polyps extending brilliantly colored tentacles, usually orange, reddish orange, or pink.

Remarks. – Around Tachibanaura, this species is known only from several restricted areas (M. Nakano, personal communication). In one of these areas, Komo, several large individuals are attached to the rocky bottom at about 45 m depth. One of the specimens collected has a rather flabellate corallum with an elongate, slightly S-shaped calice 105 x 45 mm in diameter, presumably the largest corallum ever reported for this species.

DENDROPHYLLIIDAE

16. *Balanophyllia* (*Balanophyllia*) *vanderhorsti* Cairns, 2001

(Pl. 4, Figs. I-J)

Material examined. – Komo, 15-20 m, 4 coralla and 1 pseudocolony of 7 corallites (3, CMNH-ZG 03765; 1, ZG 03766; 1, BIK-C-0163).

Description. – Corallum solitary or pseudocolonial; trochoid, attached by thick pedicel, PD:GCD = 0.54-0.67. Calice elliptical, GCD:LCD = 1.19-1.76; largest specimen 25.1 mm in GCD and 36.5 mm high. Costae narrow, each bearing unilinear row of acute teeth and separated by porous intercostal striae. Lower half of corallum epithecate. Septa crowded, hexamerally arranged in 5 cycles in weak Pourtalès plan; with some pairs of S6 in large corallum (up to 108 septa in all). Columella an elongate mass of twisted lamellae. Coenosarc of living corallum orange.

Remarks. – This species has been known as *Balanophyllia ponderosa* van der Horst, 1926, but because this specific name is preoccupied by *B.* (*Eupsammia*) *ponderosa* Vaughan, 1900, a replacement name was proposed by Cairns (2001).

17. *Balanophyllia* (*Balanophyllia*) sp. cf. *B.* (*B.*) *rediviva* Moseley, 1881

(Pl. 4, Figs. K-L; Pl. 5, Fig. A)

Material examined. – CN2, 1 (CMNH-ZG 03807); CN4, 1 (CMNH-ZG 03820).

Description. – Corallum solitary, elongate-cylindrical, attached by thick pedicel. Larger corallum 8.4 x 7.8 mm in calicular diameter, 5.6 mm in pedicel diameter, 37 mm high; showing one episode of rejuvenescence. Costae flat, indistinct, covered with conical granules and separated by porous intercostal striae. Epitheca extending up to 9 mm below calicular edge. Septa hexamerally arranged in 4 cycles in Pourtalès plan, 1 to 4 half systems lacking pairs of S4 (40-46 septa in all). Columella discrete, spongy.

Remarks. – Two coralla examined agree fairly well with the description of *B. redivida*, but they differ in having non-ridged lower-order costae (C1-C3) and less exsert S1 (see Cairns and Zibrowius, 1997). In consideration of these differences, the identification of

these specimens is provisional.

The specimen reported as *B.* cf. *rediviva* by Yabe and Eguchi (1942) from *Soyo-maru* St. 325 (210 m depth) was reexamined. This specimen is an elongate-conical corallum of 12.1 x 10.6 mm calicular diameter and 44.0 mm high, attached to the substrate by a narrow pedicel only 2.9 mm thick. Although it has similar calicular and costal characters to the specimens collected in this study, I cannot positively identify them all as the same species for the present.

18. *Eguchipsammia wellsi* (Eguchi, 1968)

(Pl. 5, Fig. E; Pl. 6, Figs. A-C)

Material examined. – CN2, 21 (15, CMNH-ZG 03810; 6, BIK-C-0164).

Description. – Colonial, unattached and recumbent. Colony consisting of elongate axial corallite and perpendicularly budded secondary corallites at sparse and irregular intervals, with occurrence of tertiary and occasionally quaternary corallites. All corallites irregularly bent. Corallum up to 72 mm high. Calice circular to elliptical, often slightly hexagonal, GCD:LCD = 1.01-1.22, axial corallite up to 7.0 mm in GCD. Costae as low, porous ridges covered with blunt to conical granules and separated by porous intercostal furrows. Epitheca extending up to 2 mm from calicular edge. Septa hexamerally arranged in 3 to 4 cycles in Pourtalès plan. Septal face covered with sparse, minute granules; inner edges of all septa entire, separated from columella by distinct fossa. Columella discrete, composed of interconnected vertical lamellae. Coenosarc of living colony orange.

Remarks. – It seems that 4 morphologically very similar species are included in the abundant material of *Eguchipsammia* collected from CN2. *Eguchipsammia wellsi* is distinguished from its congeners by its almost flat septal faces, entire septal margins, and discrete columella composed of interconnected lamellae. This species was previously reported as lacking an epitheca (e.g., Cairns, 1994; Cairns and Zibrowius, 1997); however, the present specimens have a thin epitheca, as do the other three congeners in the present material.

The lectotype of *E. wellsi* designated by Cairns (1994) is deposited at IGPS (Pl. 5, Figs. B-D). Characters of the present specimens generally agree well with the lectotype.

19. *Eguchipsammia gaditata* (Duncan, 1873)

(Pl. 5, Fig. F; Pl. 6, Figs. D-F)

Material examined. – CN2, ca. 80 (ca. 70, CMNH-ZG 03809; 10, BIK-C-0165).

Description. – Colonial, unattached and recumbent. Growth form similar to that of *E. wellsi*. Intratentacular budding rarely occurring. Corallum up to 56 mm high. Calice circular to elliptical, often slightly hexagonal, GCD:LCD = 1.01-1.24, axial corallite up to 4.2 mm in GCD. Costae as low, porous ridges covered with blunt to conical granules and separated by porous intercostal furrows. Epitheca extending up to 1 mm from calicular edge. Septa hexamerally arranged in 3 cycles in weak Pourtalès plan. Septal face densely covered with coarse, conical granules; interseptal region narrow. Inner edges of septa laciniate and intermingled with the small, indistinct columella. Coenosarc of living colony orange.

Remarks. – *Eguchipsammia gaditata* is characterized by the coarse septal granulations and

the laciniate inner edges of the septa that intermingle with the indistinct, nondiscrete columella. The differences from *E.* sp. 2 are noted in the account of that species.

20. *Eguchipsammia* sp. 1

(Pl. 5, Fig. G; Pl. 6, Figs. G-I)

Material examined. – CN1, 4 (CMNH-ZG 03799); CN2, 10 (8, CMNH-ZG 03811; 2, BIK-C-0166); CN4, 1 (CMNH-ZG 03821).

Description. – Colonial, unattached and recumbent. Growth form similar to that of *E. wellsi*. Largest corallum 52 mm high. Calice circular to elliptical, GCD:LCD = 1.00-1.23, axial corallite up to 7.0 mm in GCD. Costae as narrow, relatively high, irregular ridges covered with conical granules; intercostal furrows wide and irregularly porous. Epitheca extending up to calicular edge. Septa thin, hexamerally arranged in 3-4 cycles in Pourtalès plan; septal face covered with sparse, conical granules; septal edges irregularly curled. Inner edges of septa laciniate and continuous with columella composed of loosely connected lamellae. Coenosarc of living colony orange.

Remarks. – *Eguchipsammia* sp. 1 is distinguished from its 3 congeners in the present material by the widely spaced, irregularly curled septa, the nondeiscrete columella of loosely connected lamellae, and the extremely coarse theca.

21. *Eguchipsammia* sp. 2

(Pl. 5, Fig. H; Pl. 6, Figs. J-L)

Material examined. – CN2, 12 (10, CMNH-ZG 03812; 2, BIK-C-0167).

Description. – Colonial, unattached and recumbent. Growth form similar to that of *E. wellsi*. Largest corallum 67 mm high. Calice circular to elliptical, GCD:LCD = 1.01-1.24, axial corallite up to 5.5 mm in GCD. Costae as low, porous ridges covered with conical granules; lower order costae often slightly higher and narrower than others, each with unilinear row of conical teeth; intercostal furrows porous. Epitheca extending up to 1.5 mm below calicular edge. Septa hexamerally arranged in 3 to 4 cycles in weak Pourtalès plan; septal face covered with sparse, conical granules; inner edges of septa laciniate. Columella relatively large, composed of interconnected lamellae or a spongy mass, intermingled with inner septal lace. Coenosarc of living colony orange.

Remarks. – *Eguchipsammia* sp. 2 is very similar to *E. gaditata*; however, it has less granular, more widely spaced septa and a large columella of interconnected lamellae and is here considered to be a discrete species.

22. *Rhizopsammia* sp. cf. *R. verrilli* van der Horst, 1922

(Pl. 7, Figs. A-J)

Material examined. – Komo, 15-25 m, 10 colonies (9, CMNH-ZG 03767-03775; 1, BIK-C-0168).

Description. – Colonial; colony bushy, consisting of cylindrical corallites budded from common coenosteum or theca of other corallites as well as from spreading stolons. Stolons costate, flat to semicircular in cross-section, up to 7 mm thick. Largest colony 60 mm high

and 105 mm across. Calices large, almost circular, sometimes slightly scalloped, GCD:LCD = 1.00-1.17, largest corallite 16.8 mm in GCD, and corallites exceeding 14 mm in GCD common; individual corallites up to 42 mm high. Costae porous, covered with blunt granules and separated by porous intercostal furrows. Septa hexamerally arranged in 5 cycles in pronounced Pourtalès plan; 5th cycle never complete but pairs of 6th cycles developed in larger corallites (up to 102 septa altogether). Columella an elliptical, spongy mass. Coenosarc of living colony orange.

Remarks. – Although the present specimens have a growth form similar to that of *Cladopsammia*, they always have more or less distinct stolons near the base of the colony and must be included in *Rhizopsammia*. They most closely resemble *R. verrilli*; however, the corallites of the present specimens are considerably larger. The identification of these specimens is only tentative at present.

23. *Cladopsammia* sp. cf. *C. gracilis* (Milne Edwards & Haime, 1848)

(Pl. 8, Figs. A-E)

Material examined. – Komo, 20 m, 1 colony (CMNH-ZG 03776).

Description. – Colonial; colony phaceloid, consisting of cylindrical corallites budded from common coenosteum or lower theca of larger corallites. Colony 55 mm high and 70 mm across. Calice elliptical, GCD:LCD = 1.08-1.33, largest corallite 13.6 mm in GCD. Costae narrow but distinct, covered with pointed granules and separated by porous intercostal furrows. Septa thin, hexamerally arranged in 5 cycles in Pourtalès plan. Columella elliptical, coarsely spongy. Coenosarc of living colony orange.

Remarks. – The present specimen has a growth form similar to that of *C. gracilis*, although differing slightly in septal configuration. In *C. gracilis*, the septa are arranged in a "pronounced" Pourtalès Plan (see Cairns, 1994: pl. 38e), whereas in the Pourtalès plan of the present specimens, S2 to S4 are not distinctly independent and S2 are wide and reach the columella. Considering these differences, the identification of this specimen remains tentative.

24. *Cladopsammia eguchii* (Wells, 1982)

(Pl. 8, Figs. F-H)

Material examined. – Komo, 10 m, 4 fragments from 1 colony (CMNH-ZG 03783).

Description. – Colonial, colony phaceloid, consisting of compressed corallites budded from common coenosteum or lower theca of larger corallites. Calice elliptical to elongate, GCD:LCD = 1.32-2.01, largest corallite 13.7 mm in GCD; height of corallite up to 28 mm. Costae narrow and distinct, each bearing unilinear row of conical granules, and separated by sparsely porous intercostal striae. Septa closely packed, hexamerally arranged in 4 to 5 cycles in weak Pourtalès plan, with additional S6 pairs in larger corallites (up to 104 septa in largest corallite). Columella an elongate, spongy mass. Coenosarc of living colony reddish pink.

Remarks. – The taxonomic relationship between this species and "*Dendrophyllia compressa*" is discussed in the account of the next species.

25. *Cladopsammia*? sp. cf. "*Dendrophyllia compressa* Ogawa & Takahashi, 1995"

(Pl. 8, Figs. I-K)

Material examined. – Komo, 15 m, 2 branches from one colony (CMNH-ZG 03785).

Description. – Colonial; colony bushy, consisting of slender corallites budded from common base or theca of larger corallites. Calice elliptical, GCD:LCD = 1.20-1.22, largest corallite 6.1 mm in GCD; height of corallite up to 28.5 mm. Costae narrow, covered with minute granules; intercostal furrows wide and irregularly porous. Epitheca extending to 3.5-4.5 mm below calicular edge. Septa thin, crowded, hexamerally arranged in 4 cycles in Pourtalès plan; 4 to 6 pairs of S5 as well in 2 larger corallites (56-60 septa altogether). Columella spongy, continuous with inner septal lobes. Coenosarc of living colony pale orange.

Remarks. – Only two fragments of a small colony were collected: each fragment consists of a rather slender axial corallite and 2 to 3 secondary corallites budded from the theca of the axial corallite. Although these fragments resemble species of *Eguchipsammia*, the whole colony is bushy and firmly attached to the substratum (*in situ* observation), so the generic placement should be *Dendrophyllia* or, with considerable likelihood, *Cladopsammia*. The present specimens are presumably conspecific with *Dendrophyllia compressa* described by Ogawa and Takahashi (1995). In 1973, Eguchi described *Dendrophyllia arbuscula* var. *compressa* Eguchi and Sasaki in Eguchi, however, according to the International Code of Zoological Nomenclature (ICZN) Article 15.2, Eguchi's variation name, published after 1960, is excluded from zoological nomenclature (International Commission on Zoological Nomenclature, 2000). Later, Ogawa and Takahashi (1995) briefly described *D. compressa* based on 41 variously shaped colonies. Although they attributed the authorship of *D. compressa* to Eguchi and Sasaki, the author of this species must be Ogawa and Takahashi, who elevated the variation name to the rank of specific name (International Commission on Zoological Nomenclature, 2000: ICZN Article 45.5.1). The 41 specimens mentioned by Ogawa and Takahashi (1995) should be considered as syntypes and reexamination of these specimens is urgently needed.

When Wells (1982) described *Balanophyllia eguchii*, he regarded "*D. arbuscula* var. *compressa* Eguchi and Sasaki, 1973" as a synonym of his species, but he proposed a new name presumably because he considered *D. arbuscula* var. *compressa* as a junior secondary homonym of *Balanophyllia compressa* Seguenza, 1880. Cairns (1991, 1994) followed Wells in treating Eguchi and Sasaki's "*compressa*" as a junior synonym of *Balanophyllia* (or *Cladopsammia*) *eguchii*. On the other hand, Ogawa and Takahashi (1995) and Ogawa *et al*. (1998) considered two species to have been included in what had been called *B. eguchii,* namely "*B. eguchii*" *sensu stricto* and "*D. compressa*". Although I suspect that "*compressa*" of Eguchi and Sasaki in Eguchi (1973) and that of Ogawa and Takahashi (1995) are conspecific, I agree with Ogawa and Takahashi in recognizing the existence of two similar but distinct species. These two species differ in corallite size and growth form of the colony, and they often occur together *in situ* where they can readily be distinguished.

26. "*Cladopsammia coccinea* (Ehrenberg, 1834)"

(Pl. 9, Figs. A-E)

Material examined. – Komo, 10-15 m, 2 colonies (1, CMNH-ZG 03779; 1, BIK-C-0169).
Description. – Colonial; colony phaceloid, consisting of bushy cluster of relatively long, cylindrical corallites, these budded from common coenosteum or from theca of larger corallites. Pairs of lateral corallites tending to bud simultaneously from opposite sides of lower theca of parent corallite, with next lateral pair budding from both axils between parent corallite and proximal lateral corallites; consecutive pairs of lateral corallites directed alternately forward and backward. Largest colony 54 mm high and 87 mm across. Calice circular to elliptical, GCD:LCD = 1.07-1.23, largest corallite 15.3 mm in GCD. Costae as low ridges covered with irregular granules and separated by porous intercostal furrows. Septa hexamerally arranged in 5 cycles in Pourtalès plan. Fossa very deep, depth to top of columella up to 18.5 mm. Columella usually a small, loosely connected, fascicular mass. Coenosarc of living colony orange.
Remarks. – This characteristic species was illustrated as *Tubastraea coccinea* (Ehrenberg) by Eguchi (1968; in part: pl. C14, figs. 8-9; see remarks of next species) and as *Dendrophyllia coccinea* by Ogawa and Takahashi (1995). Because *Oculina coccinea* Ehrenberg, 1834 was once placed in *Tubastraea* by Eguchi (1968), it should be considered as a junior secondary homonym of *Tubastraea coccinea* Lesson, 1829 and must be replaced by the oldest available junior synonym. It is necessary first to investigate carefully the synonymy and identity of *O. coccinea* Ehrenberg. The new generic combination of the name *Cladopsammia coccinea* was proposed by Ogawa and Takahashi (2000: 15).

27. "*Cladopsammia coarctata* (Duncan, 1889)" *sensu* Ogawa and Takahashi (1995)

(Pl. 9, Figs. F-J)

Material examined. – Komo, 10-25 m, 3 colonies (2, CMNH-ZG 03777-03778; 1, BIK-C-0170).
Description. – Colonial; colony basically plocoid, consisting of cylindrical corallites budded from broad coenosteum; individual corallites protruding up to 20 mm. Largest colony 44 mm high and 70 mm across. Calice elliptical, GCD:LCD = 1.19-1.33, largest corallite 18.7 mm in GCD. Costae as coarse, low ridges, each with unilinear row of conical teeth and separated by porous intercostal furrows. Septa hexamerally arranged in 5 cycles in Pourtalès plan. Columella a large, elongate, spongy mass. Coenosarc of living colony orange.
Remarks. – This is a well-defined species with a plocoid growth form similar to that of *Tubastraea coccinea* Lesson, large and elliptical corallites with septa arranged in the Pourtalès plan, and characteristically coarse costae. Variations of the growth form of this species have been illustrated by Ogawa and Takahashi (1995) as *Dendrophyllia coarctata*. I consider some of the specimens of *Tubastraea coccinea* of Eguchi (1968) to be this species as well (e.g., pl. C14, figs. 4-5 and pl. C26, fig. 1). Ogawa and Takahashi (1995) identified this species as "*Dendrophyllia coarctata* Duncan, 1876"; however, illustrations in the original description of *D. coarctata* by Duncan (1889: pl. 1, figs. 27-28; *not* Duncan, 1876) indicate a phaceloid colony in which several cylindrical or slightly conical corallites are budded from a rather small base, quite unlike the plocoid colony form of the present species. The appropriate scientific name for this species seems to be in need of reconsideration. The generic placement of this species in *Cladopsammia* was proposed by

Ogawa and Takahashi (2000: 15).

28. *Dendrophyllia* sp. cf. *D. ijimai* Eguchi, 1965

(Pl. 10, Figs. A-E)

Material examined. – CN3, 4 colonies (3, CMNH-ZG 03815; 1, CMNH-ZG 03816).

Description. – Colonial; colony arborescent and attached by massive base, consisting of main branch comprising long, tapered axial corallite and sparse lateral branches of similar form. Lateral corallites on main and lateral branches aligned in 4 somewhat irregular rows on each branch and protruding up to 6.5 mm. Largest colony 96 mm high. Calice circular, axial coralllites 4.2-5.4 mm in GCD, lateral corallites 3.6-5.2 mm in GCD. Costae rounded, each with unilinear row of blunt teeth or covered with pointed granules; intercostal striae narrow, not very porous. Septa hexamerally arranged in 4 cycles in Pourtalès plan; 4th cycle never complete. Columella small, consisting of tightly fused, thick trabeculae and covered with coarse granules. Coenosarc of living colony bright orange.

Remarks. – The name *D. ijimai* was proposed by Eguchi (1935) for the unidentified species of *Dendrophyllia* cited and illustrated in Ijima (1918), but he did not describe the species at that time. This taxon was first described briefly by Eguchi (1965) in Japanese, and three years later Eguchi (1968) described it again in both English and Japanese; in both cases, the authorship was attributed to Yabe and Eguchi. According to the ICZN, Eguchi (1965) satisfies the requirements to be available (Article 13.1.1) although the authorship should be Eguchi instead of Yabe and Eguchi in Eguchi, because no indication of Yabe's involvement in the production of the description is present (Article 50.1; International Commission on Zoological Nomenclature, 2000). As a result, the author and published date of *D. ijimai* should be Eguchi (1965). The illustrated specimen in Eguchi (1965), which is also figured in Eguchi (1968), is considered to be one of the syntypes, and deposited at NSMT (Pl. 10, Figs. F-J). It is a branching colony 160 mm high with axial corallites of 6.3-7.6 mm in GCD and lateral corallites of up to 7.5 mm in GCD. The costae are irregularly porous and covered with sparse granules. The septa are hexamerally arranged in 4 cycles in Pourtalès plan. The columellae are relatively large, tightly connected, trabecular masses.

Although the specimens collected in the present study have a growth form similar to that of the illustrated syntype of *D. ijimai*, they have considerably smaller corallites and different costal ornamentation. These specimens agree well with the specimen described by van der Horst (1922) as *Dendrophyllia minuscula* Bourne, 1905, especially in the size of the corallites. Until the intraspecific variation of *D. ijimai* is better understood, the identification of these specimens remains tentative.

29. *Dendrophyllia subcornigera* Eguchi, 1968

(Pl. 11, Figs. A-E)

Material examined. – Komo, 15-35 m, 3 colonies (2, CMNH-ZG 03781-03782; 1, BIK-C-0171).

Description. – Colonial; colony bushy, consisting of several straight primary branches spreading from rather small base; each primary branch consisting of tall axial corallite and

elongate, conical, lateral corallites sparsely budded at angles of ca. 60 °; 3rd order corallites appearing on elongate lateral corallites. Largest colony 105 mm high and 160 mm across. Primary branches up to 95 mm high, lateral corallites attaining 32 mm high before start of 3rd-order budding. Calice elliptical; axial corallites 9.4-11.4 mm in GCD, GCD:LCD = 1.07-1.17, diameter of primary branches just above base 12.5-14 mm; lateral corallites up to 9.5 mm in GCD. Costae as narrow ridges, each bearing unilinear row of conical teeth, separated by porous intercostal furrows. Septa hexamerally arranged in 4 cycles in Pourtalès plan; pairs of S5 occuring in a few axial corallites. Columella elliptical, formed as interconnected trabeculae or spongy mass, often constricted at inner edges of lateral S1. Coenosarc of living colony orange.

Remarks. – The holotype of *D. subcornigera subcornigera* is deposited at IGPS, and a part of the colony (one branch) is deposited at NSMT (Pl. 11, Figs. F-H). Although the holotype has an abnormally widened axial corallite and thicker bases of the primary branches, the specimens of the present study generally agree well with it. The holotype of another subspecies, *D. subcornigera cylindrical* Eguchi, 1968, is also deposited at IGPS and one of its branch is deposited at NSMT (Pl. 11, Figs. I-J). Compared with the holotype of the nominate subspecies, it has lateral corallites budded at slightly wider intervals and less thickened primary branches; however, other characters are quite similar. Although Ogawa and Takahashi (1995) regarded them as discrete species, it seems more appropriate to consider the differences between these subspecies as intraspecific variation.

The year of publication of both *D. subcornigera subcornigera* and *D. subcornigera cylindrica* is sometimes referred to 1934. In fact, Eguchi (1934) only proposed the names of both *D. subcornigera* and *D. subcornigera cylindrica* in a distributional table of eupsammid (=dendrophylliid) corals. The formal descriptions of this species and its subspecies were not published until Eguchi (1968). The authorship of them should be Eguchi as in the case discussed for *D. ijimai*.

This species may be conspecific with *Dendrophyllia arbuscula* van der Horst, 1922, although the lectotype of *D. arbuscula*, designated by Cairns and Zibrowius (1997), has considerably smaller corallites (5-6 mm in GCD) and densely divided branches (van der Horst, 1922: pl. 8, fig. 6; Cairns and Zibrowius, 1997: fig. 29a). The differences between *D. arbuscula* and *D. subcornigera* should be evaluated more thoroughly in the future.

30. *Dendrophyllia boschmai* van der Horst, 1926

(Pl. 12, Figs. A-C)

Material examined. – CN3, 3 fragments of worn colonies (CMNH-ZG 03818).

Description. – Colonial; colony arborescent, consisting of upright branches; each branch composed of sympodially budded cylindrical corallites, in which terminal corallite replaced by successive corallite. Largest specimen (part of a colony) 90 mm high. Calice circular to elliptical, GCD:LCD = 1.00-1.30, largest corallite 9.0 mm in GCD; calicular margin not flared nor lanceted. Costae as low ridges, covered with relatively large, conical granules and separated by less porous, narrow striae. Septa hexamerally arranged in 4 cycles in Pourtalès plan. Columella a small, elongate mass of fused trabeculae.

Remarks. – This species belongs to the "sympodial" group of *Dendrophyllia* defined by Cairns (1994). It can be distinguished from other sympodial *Dendrophyllia* of Japan,

namely, *D. florulenta* Alcock, 1902, *D. cyathoheloides* Eguchi, 1965, and possibly *D.* sp. cf. *D. incisa* (Crossland, 1952), by having cylindrical corallites with generally smooth, not flared nor lanceted, calicular margins.

31. *Dendrophyllia* sp. cf. *Dendrophyllia incisa* (Crossland, 1952)

(Pl. 12, Figs. D-G)

Material examined. – CN1, 4 worn colonies (CMNH-ZG 03801); CN2, 5 worn colonies (CMNH- ZG 03808).

Description. – Colonial; colony small, clump of corallites budded in 1 plane, consisting of relatively large, sympodially budded, short corallites and smaller, elongate-conical corallites budded from axil or lower theca of larger corallites; larger corallites often immersed in thick coenosteum within axil of adjacent corallites; base of colony extremely thickened. Largest colony 70 mm high. Calice elliptical to compressed; GCD:LCD = 1.22-2.32, largest corallite 17.4 x 7.5 mm in calicular diameter. Costae distinct near calicular edge, each bearing unilinear row of conical teeth, separated by porous intercostal furrows. Septa hexamerally arranged in 5 cycles in Pourtalès plan. S1 and S2 moderately exert, forming short lancets. Columella distinctive, composed of interconnected trabeculae or vertical lamellae.

Remarks. – Although all of the present specimens are considerably worn, they have a distinctive growth form and are likely included in the sympodial group of the genus (see Cairns, 1994). These specimens are presumably conspecific with *D. incisa*, which is known only from its small holotype from unknown depth on the Great Barrier Reef, Australia (Crossland, 1952; Cairns, 2004). Additional, better preserved specimens and reexamination of the holotype of *D. incisa* are needed to confirm this identification.

Some of the specimens of *Dendrophyllia boschmai cyathohelioides* (sic!) of Eguchi (1968: e.g., pl. C15, figs. 1-3) seem to be similar to the present specimens. As in the case of *D. ijimai*, the authorship and date of publication of *D. boschmai cyathoheloides* should be Eguchi (1965). In the spelling of the subspecific name, Eguchi (1968) confused *cyathohelioides* and *cyathoheloides*, the former being used most often in that work, but the latter occurring once in the synonymy in the English part (p.C57) and again in the heading for this taxon in the Japanese part (p.*C35*); however, the correct original spelling, from Eguchi (1965), is *cyathoheloides*. Eguchi (1968) invalidly designated a specimen from Kowa, Mie Prefecture (Reg. No. 57443: depository was not given but the number coincides with a specimen at IGPS) as the holotype of this subspecies. Mie Prefecture was not one of the localities for this subspecies mentioned in Eguchi (1965), so the designation of the specimen from there as holotype is invalid in all respects; the specimen in question is not even a syntype eligible to be named as lectotype. The illustrated syntype in Eguchi (1965) could not be located either in IGPS or NSMT. Later, Ogawa and Takahashi (1995) elevated this subspecies to specific rank.

32. *Dendrophyllia* sp.

(Pl. 12, Figs. H-K)

Material examined. – CN3, 1 colony (CMNH-ZG 03818).

Description. – Colonial; colony consisting of gently bent, long axial corallite and sparsely branching lateral corallites, these latter being elongate-conical and also gently bent in irregular directions. Colony 80 mm high and 105 mm across, attached by pedicel 14.8 mm in diameter. Calice elliptical, axial corallite 14.0 x 10.8 mm in calicular diameter, largest lateral corallite 14.7 x 12.2 mm in calicular diameter. Costae flat and porous, separated by narrow, less porous, slit-like intercostal striae. Septa thin, hexamerally arranged in 5 cycles in Pourtalès plan, 5th cycle incomplete. Columella a discrete, spongy mass. Coenosarc of living colony light brown.
Remarks. – This specimen seems to belong to the "bush-like" group of *Dendrophyllia* (see Cairns, 1994). Although its growth form is unique, additional specimens are needed before discussing its identification further.

33. *Tubastraea coccinea* Lesson, 1829
(Pl. 13, Figs. A-C)

Material examined. – Komo, 10-25 m, 3 colonies (2, CMNH-ZG 03786-03787; 1, BIK-C-0172).
Description. – Colonial; colony plocoid, flat to hemispherical, consisting of cylindrical corallites budded from broad coenosteum, individual corallites protruding up to 11 mm. Largest colony 75 mm in maximum dimension. Calice circular to slightly elliptical, GCD:LCD = 1.04-1.22; largest corallite 15.5 mm in GCD. Costae as low ridges, covered with minute granules and separated by sparsely porous striae; coenosteum covered with irregularly curled, thin ridges separated by wide, highly porous furrows. Septa hexamerally arranged in 4 cycles; S1 and S2 having straight inner edges, S3 laciniate or as rows of long, irregular trabeculae; S4 rudimentary or as rows of irregular trabeculae often joined to adjacent S3; Pourtalès plan absent. Columella variable in size, a trabecular or fascicular mass. Coenosarc of living colony orange.

34. *Tubastraea diaphna* (Dana, 1846)
(Pl. 13, Figs. D-F)

Material examined. – Komo, 10-25 m, 2 colonies (1, CMNH-ZG 03787; 1, BIK-C-0173).
Description. – Colonial; colony phaceloid, consisting of bushy cluster of cylindrical corallites budded from narrow common coenosteum or lower part of other corallites; height of colony up to 61 mm. Calice circular to elliptical, GCD:LCD = 1.05-1.53; largest corallite 16.3 mm in GCD. Costae as low ridges, covered with minute granules and separated by porous intercostal furrows. Septa hexamerally arranged in 4 cycles; S1 and S2 having straight inner edges, S3 and S4 rudimentary; deep in fossa, inner edges of a few S4 (rarely S3) produced into tall, vertical trabeculae as paliform lobes. Pourtalès plan absent. Columella usually as small, elongate, fascicular mass. Coenosarc of living colony black-green.

35. *Tubastraea micranthus* (Ehrenberg, 1834)
(Pl. 13, Figs. G-K)

Material examined. – Komo, 10-25 m, 7 colonies (6, CMNH-ZG 03789-03794, 1, BIK-C-0174).

Description. – Colonial; colony large, arborescent, attached by massive base; consisting of few stems of long, tapered axial corallites and sparse lateral branches. Lateral corallites of distal branches arranged in 2 rows on opposite sides of branch; corallites of each row directed alternately forward and backward. Corallites of mid to proximal branches gradually immersed in thick coenosteum and linear arrangement obscured. Largest specimen (part of a colony) 270 mm high. Calice circular to slightly elliptical; axial corallites 8.1-10.5 mm in GCD, GCD:LCD = 1.02-1.26; lateral corallites 6.2-7.8 mm in GCD. Costae as low ridges, covered with granules and separated by not very porous intercostal furrows. Septa hexamerally arranged in 4 cycles. S1 and S2 having straight inner edges, S3 and S4 rudimentary or as irregularly fused trabecular rows. Pourtalès plan absent. Columella various: fascicular, trabecular, or plate-like mass of fused trabeculae. Coenosarc of living colony either black-green or bright orange.

Remarks. – Cairns and Zibrowius (1997) noted that "most corals referred to this species (= *T. micranthus*) from Japan are *Dendrophyllia*." Although the specimen figured as *Dendrophyllia micranthus* by Eguchi (1968: pl. 24C, figs. 2-3) appears to be a species of *Dendrophyllia*, *T. micranthus* is a rather common shallow-water coral in southwestern Japan and occasionally observed by SCUBA divers. In growth form, *D. ijimai* is similar to *T. micranthus*; however, *D. ijimai* lives deeper and is rarely encountered by divers. *Tubastraea micranthus* has two distinct forms in respect to coenosarc coloration: black-green and orange. This species is common in shallow water at Otsuki, where both the black and orange color forms occur but black is dominant.

Acknowledgements

I am most grateful to Fumihito Iwase, Toru Hayashi, and staff of BIK for their cooperation and generosity during my stay in Otsuki. I also thank Masao Nakano (Diving Shop Seahorse) who guided and supported the SCUBA diving, and Harumi Tajima (captain of *Kiryo-maru*) who skillfully operated the coral tangle-net fishing vessel. Yukimitsu Imahara (Wakayama Prefectural Museum of Natural History) and Asako Matsumoto (University of Tokyo) helped to collect specimens on board *Kiryo-maru*. Hiroshi Namikawa (NSMT) and Jun Nemoto (IGPS) facilitated visits to their collections and loaned me specimens. I express special gratitude to Stephen D. Cairns (National Museum of Natural History, Smithsonian Institution) and Mark J. Grygier (Lake Biwa Museum), who reviewed the manuscript and provided valuable comments. The Kuroshio Biological Research Foundation supported this study financially.

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EXPLANATION OF PLATES

PLATE 1

***Madracis* sp.**

Figs. A-E. CMNH-ZG 03761, colony, branch, branch tip, mid branch, and proximal branch, x0.6, x1.7, x3.9, x4.0, and x4.0, respectively.

Madracis asanoi

Figs. F-H. Holotype from Belau, IGPS No. 60632, colony, branch, and branch tip, x1.1, x1.6, and x5.0, respectively; Figs. I-J. Holotype of *Madracis palauensis* from Belau, IGPS No. 60634, colony and branch tip, x0.67 and x5.0, respectively.

PLATE 2

Fungiacyathus paliferus

Figs. A-B. BIK-C-0151, calicular and basal views, both x10.0.

Letepsammia superstes

Figs. C-D. BIK-C-0152, calicular and basal views, both x4.6.

Caryophyllia* (*Caryophyllia*) *rugosa

Figs. E-F. CMNH-ZG 03798, calicular and side views, x7.9 and x5.8, respectively.

Caryophyllia* (*Caryophyllia*) *hawaiiensis

Figs. G-H. BIK-C-0154, calicular and side views, x5.1 and x2.4, respectively

Caryophyllia* (*Caryophyllia*) sp. cf. *C.* (*C.*) *japonica

Figs. I-J. CMNH-ZG 03803, calicular and side views, x8.5 and x5.9, respectively.

Premocyathus dentiformis

Figs. K-L. BIK-C-0155, calicular and side views, x12.3 and x9.5, respectively

PLATE3

***Paracyathus* sp.**

Figs. A-B. CMNH-ZG 03814, calicular and side views, x7.6 and x5.2, respectively.

Notocyathus conicus

Figs. C-D. BIK-C-0156, calicular and side views, x9.5 and x8.6, respectively.

***Deltocyathoides*? sp.**

Figs. E-F. BIK-C-0157, calicular and side views, both x13.0.

Idiotrochus kikutii

Figs. G-H. BIK-C-0158, calicular and side views, x15.0 and x14.0, respectively.

Truncatoguynia irregularis

Fig. I. CMNH-ZG 03805-2 (left) and BIK-C-0159 (right), spined and tapered coralla, x3.0; Fig. J. CMNH-ZG 03805-2, oblique calicular view showing internal thecal pits, x11.3; Fig. K. CMNH-ZG 03805-1, elongate corallum, x1.3.

PLATE 4

Flabellum pavoninum

Figs. A-B. CMNH-ZG 03806, calicular and side views, x1.7 and x1.6, respectively.

Javania insignis

Figs. C-D. BIK-C-0161, calicular and side views, x2.0 and x1.3, respectively.

Rhizotrochus typus

Figs. E-F. BIK-C-0162, oblique calicular and side views, x0.66 and x0.7, respectively; Figs. G-H. CMNH-ZG 03764, calicular and oblique calicular views, x0.5 and x0.9, respectively.

Balanophyllia* (*Balanophyllia*) *vanderhorsti

Figs. I-J. BIK-C-0163, calicular and side views, x2.0 and x1.3, respectively.

Balanophyllia* (*Balanophyllia*) sp. cf. *B.* (*B.*) *rediviva

Figs. K-L. CMNH-ZG 03820, calice and costae, x5.2 and x3.6, respectively.

PLATE 5

Balanophyllia* (*Balanophyllia*) sp. cf. *B.* (*B.*) *rediviva

Fig. A. CMNH-ZG 03820, side view, x2.5.

Eguchipsammia wellsi

Figs. B-D. Lectotype from off Shionomisaki, Wakayama Pref., IGPS No. 58969, side view, axial calice, and secondary calice, x2.0, x6.1, and x20.0 respectively; Fig. E. CMNH-ZG 03810, side views of five coralla, x0.67.

Eguchipsammia gaditata

Fig. F. CMNH-ZG 03809, side views of five coralla, x0.67.

***Eguchipsammia* sp. 1**.

Fig. G. CMNH-ZG 03811, side views of five coralla, x0.67.

***Eguchipsammia* sp. 2.**

Fig. H. CMNH-ZG 0312, side views of five coralla, x0.67.

PLATE 6

Eguchipsammia wellsi

Figs. A-C. CMNH-ZG03810, two calices and costae, x7.2, x8.0, and x5.5, respectively.

Eguchipsammia gaditata

Figs. D-F. CMNH-ZG03809, intratentacularly budding calice, calice and costae, x9.6, x9.1, and x6.8, respectively.

***Eguchipsammia* sp. 1.**

Figs. G-I. CMNH-ZG 03811, two calices and costae, x8.0, x8.0, x6.1 respectively.

***Eguchipsammia* sp. 2.**

Figs. J-L. CMNH-ZG 03812, two calices and costae, x10.6, x9.0, x7.6 respectively.

PLATE 7

Rhizopsammia* sp. cf. *R. verrilli

Figs. A, F, I. CMNH-ZG 03773, colony, stolons, and calice, x0.6, x1.2, and x3.1, respectively; Fig. B. CMNH-ZG 03768, colony, x0.5; Fig. C. CMNH-ZG 03775, colony, x0.9; Figs. D, E, J. CMNH-ZG 03767, stolons, colony, and calice, x1.4, x0.5, and x2.4, respectively; Figs. G, H. CMNH-ZG 03771, costae and calice, x2.3, x3.0 respectively.

PLATE 8

Cladopsammia* sp. cf. *C. gracilis

Figs. A-E. CMNH-ZG 03776, two views of colony, two calices, and costae, x0.9, x1.0, x4.0, x3.5, and x2.9, respectively.

Cladopsammia eguchii

Fig. F. CMNH-ZG 03783-1, colony fragment, x1.4; Figs. G-H. CMNH-ZG 03783-2, calice and costae, x3.0 and x2.5, respectively.

***Cladopsammia*? sp. cf. "*Dendrophyllia compressa*"**

Figs. I-K. CMNH-ZG 03785, side view of two colony fragments, calice, and costae, x1.4, x7.2, and x5.3, respectively.

PLATE 9

"*Cladopsammia coccinea*"

Fig. A. CMNH-ZG 03815, top view of colony, x0.7; Figs. B-E. BIK-C-0169, colony, two calices, and costae, x1.0, x3.0, x3.0, and x3.0, respectively.

"*Cladopsammia coarctata*" *sensu* Ogawa and Takahashi

Figs. F, H, J. CMNH-ZG 03815, colony, calice, and costae, x1.0, x2.6, and x2.5, respectively; Figs. G, I. BIK-C-0170, colony and calice, x1.2 and x2.9, respectively.

PLATE 10

Dendrophyllia* sp. cf. *D. ijimai

Figs. A. C-E. CMNH-ZG 03815, colony, calice, oblique calice, and costae, x0.8, x7.7, x6.7, and x6.7 respectively; Fig. B. CMNH-ZG 03816, colony with relatively long lateral corallites, x0.67.

Dendrophyllia ijimai

Figs. F-J. Figured syntype from Kamegiho, Sagami Bay, NSMT-Co R 842, colony, branch tip, lateral calice, axial calice, and costae, x0.45, x1.1, x5.8, x3.0, and x3.2 respectively.

PLATE 11

Dendrophyllia subcornigera

Fig. A. CMNH-ZG 03781, large colony, x0.5; Figs. B-E. BIK-C-0171, colony, two calices, and costae, x0.6, x4.0, x3.7, and x2.0 respectively; Figs. F-H. Holotype of *D. subcornigera subcornigera* from Numazu (Enoura Bay), Shizuoka Pref., IGPS No.40859 and NSMT-Co R 896 (dark-colored branch) conjoined, colony, calice, and abnormally widened axial calice, x0.5, x5.6, and x1.5 respectively; Figs. I-J. Holotype of *D. subcornigera cylindrica* from Shirahama (formerly Kanayama-mura), Wakayama Pref., IGPS No.39754 and NSMT-Co R897 (dark-colored branch) conjoined, colony and calice, x0.4 and x5.2, respectively.

PLATE 12

Dendrophyllia boschmai

Figs. A-C. CMNH-ZG 03817, colony, branch, and calice, x0.6, x1.3, and x5.4, respectively.

Dendrophyllia* sp. cf. *D. incisa

Figs. D-F. CMNH-ZG 03808-2, colony and two calices, x1.0, x3.2, and x3.3, respectively; Fig. G. CMNH-ZG 03808-1, side view of colony, x0.9.

***Dendrophyllia* sp.**

Figs. H-K. CMNH-ZG 03818, colony, two calices, and costae, x0.7, x3.5, x3.6, and x2.0, respectively.

PLATE 13

Tubastraea coccinea

Figs. A-C. BIK-C-0172, colony and two calices, x1.2, x3.8, and x3.4, respectively.

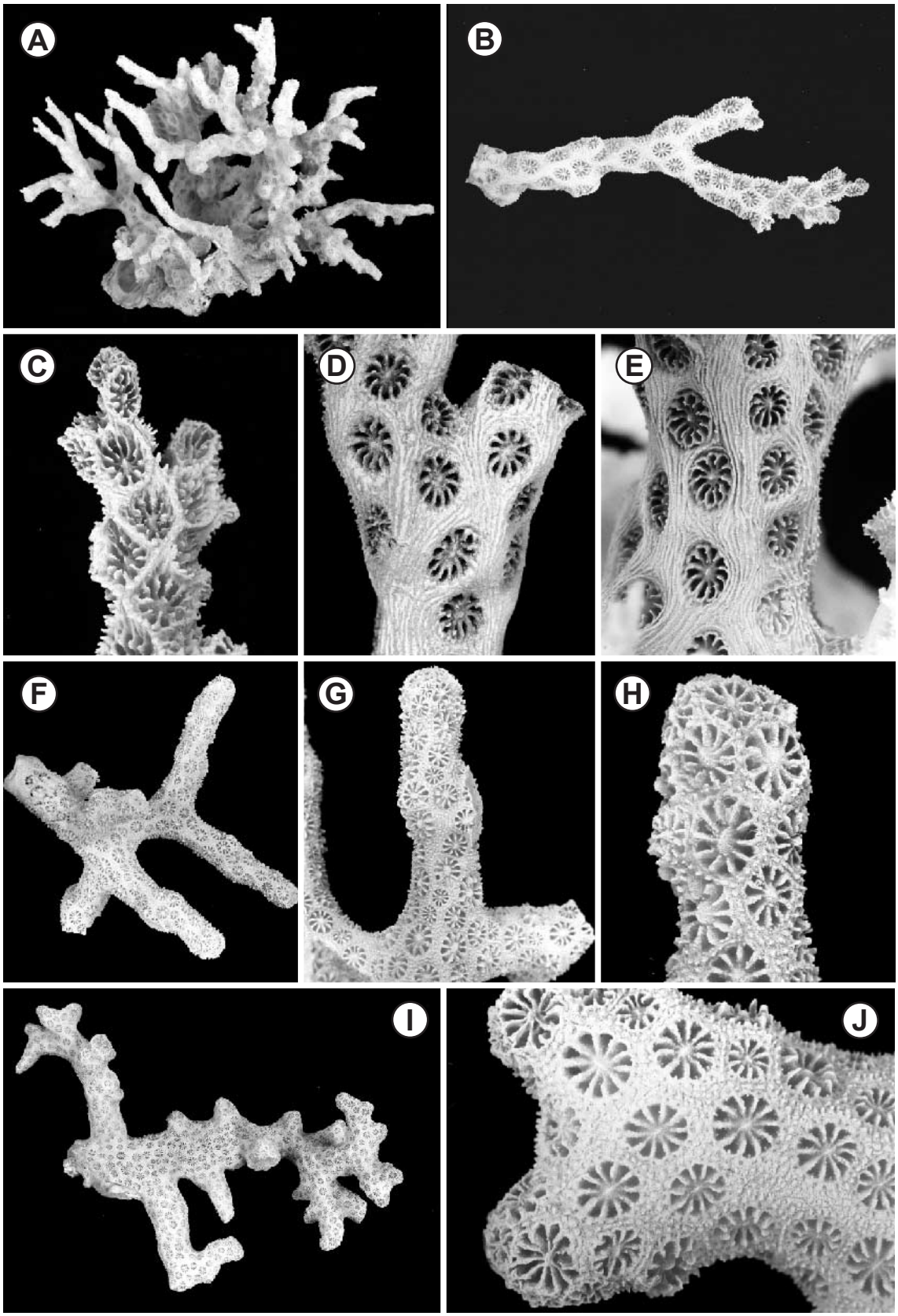
Tubastraea diaphna

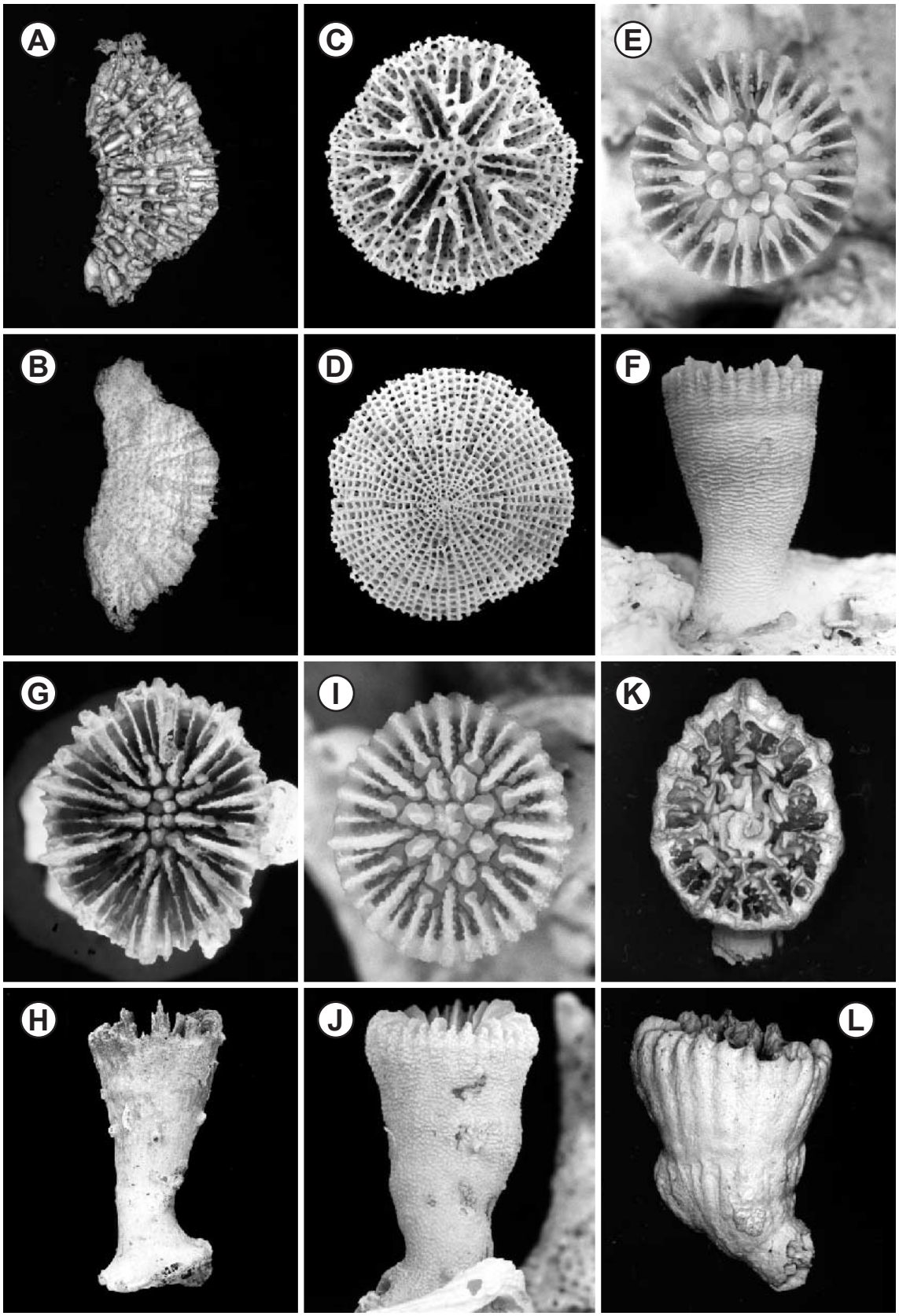
Figs. D-F. BIK-C-0173, colony and two calices, x0.9, x3.1, and x2.7, respectively.

Tubastraea micranthus

Fig. G. CMNH-ZG 03794, part of large colony, x0.22; Fig. H. CMNH-ZG 03791, colony with short branches, x0.56; Figs. I-K. CMNH-ZG 03793, two side views of distal branch and calice, x0.6, x1.1, and x5.0, respectively.

PLATE 1

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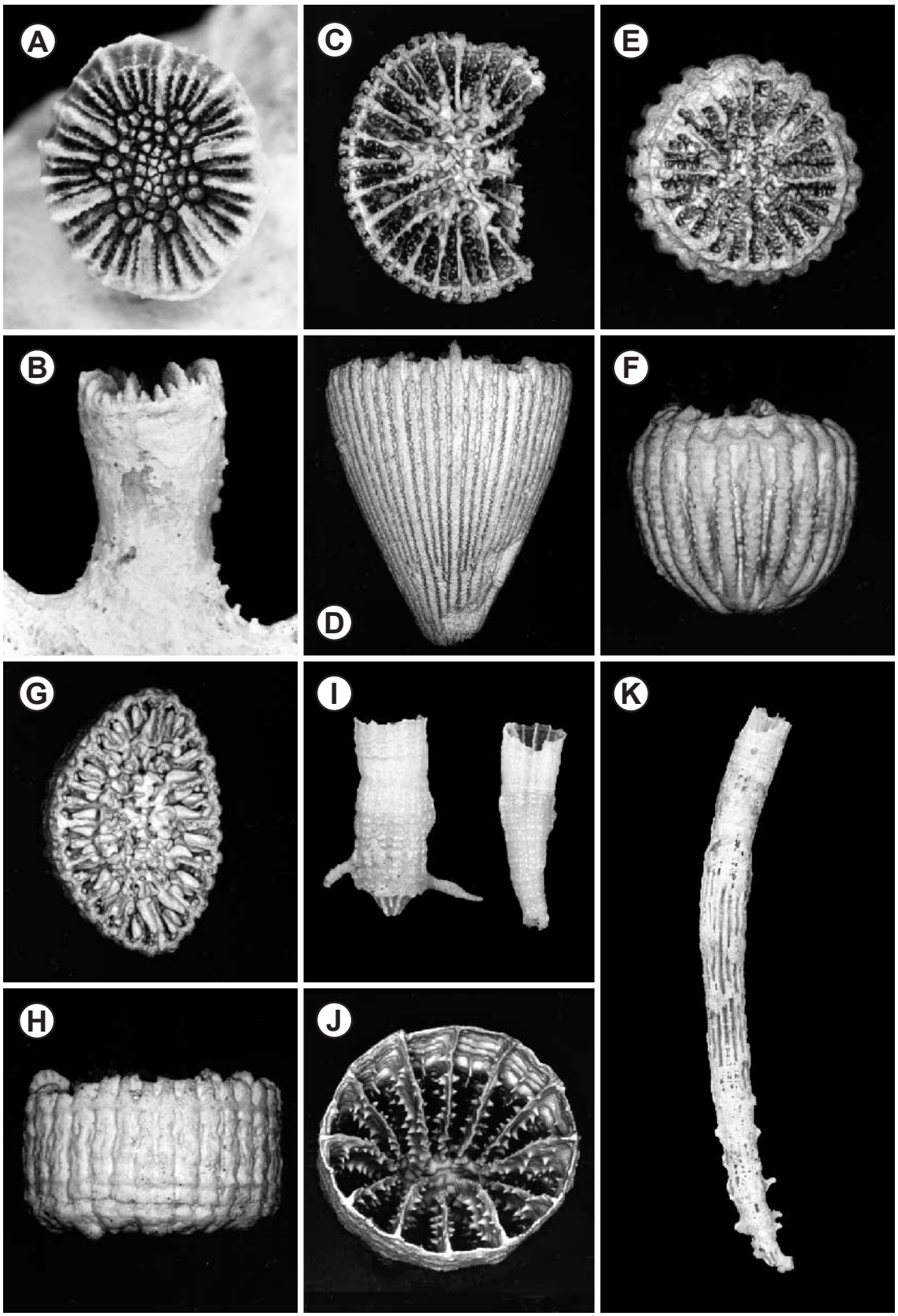

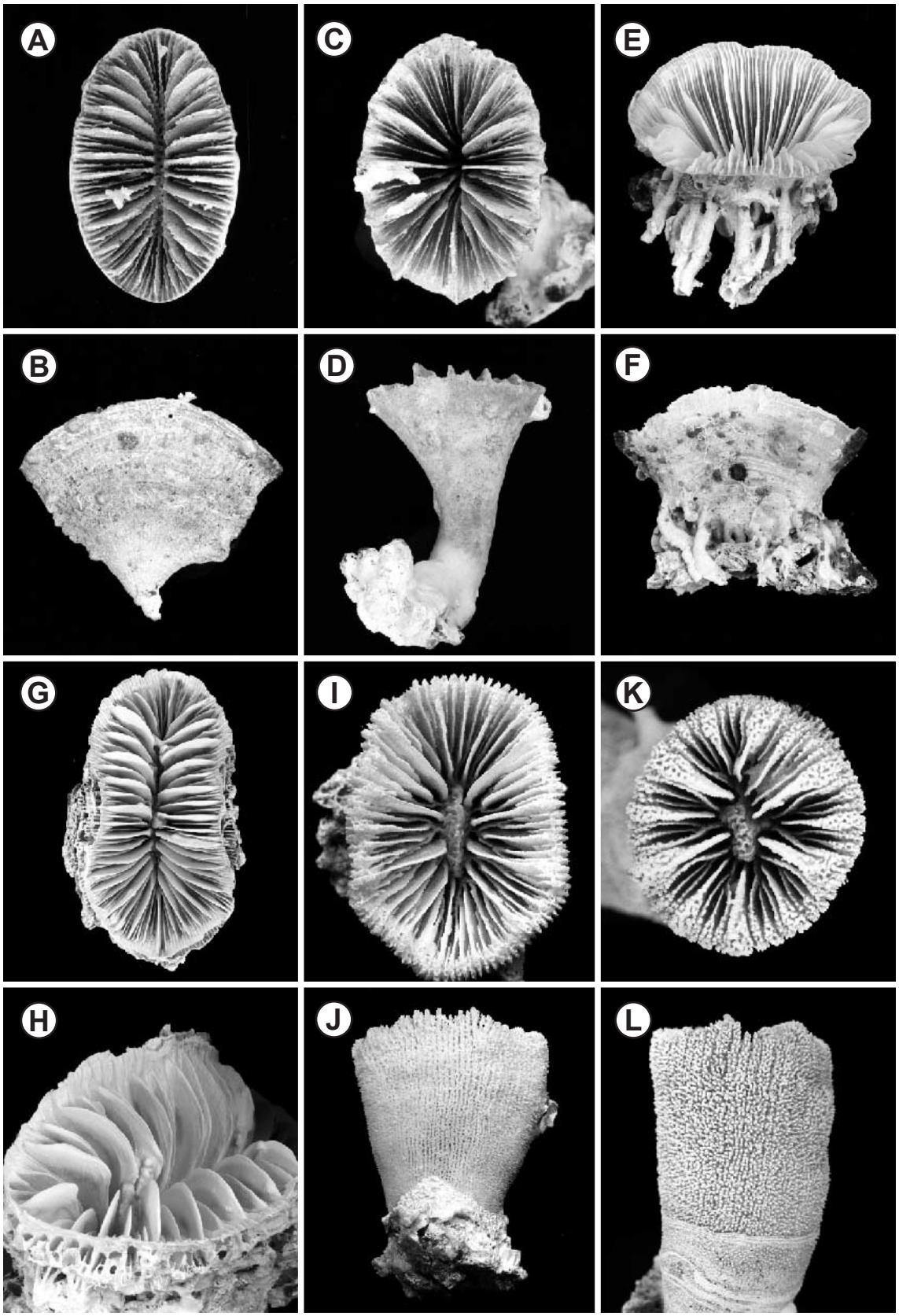
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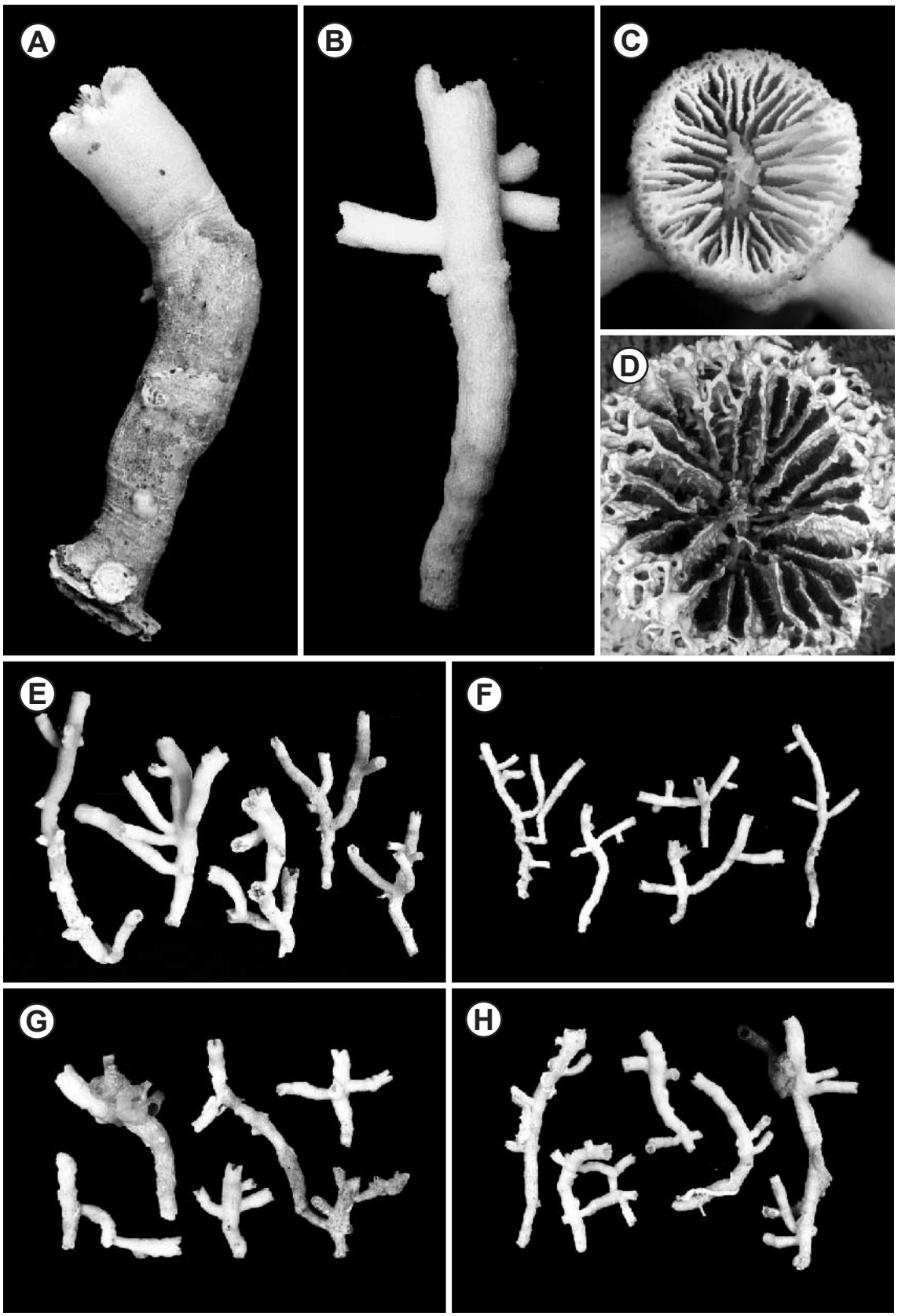

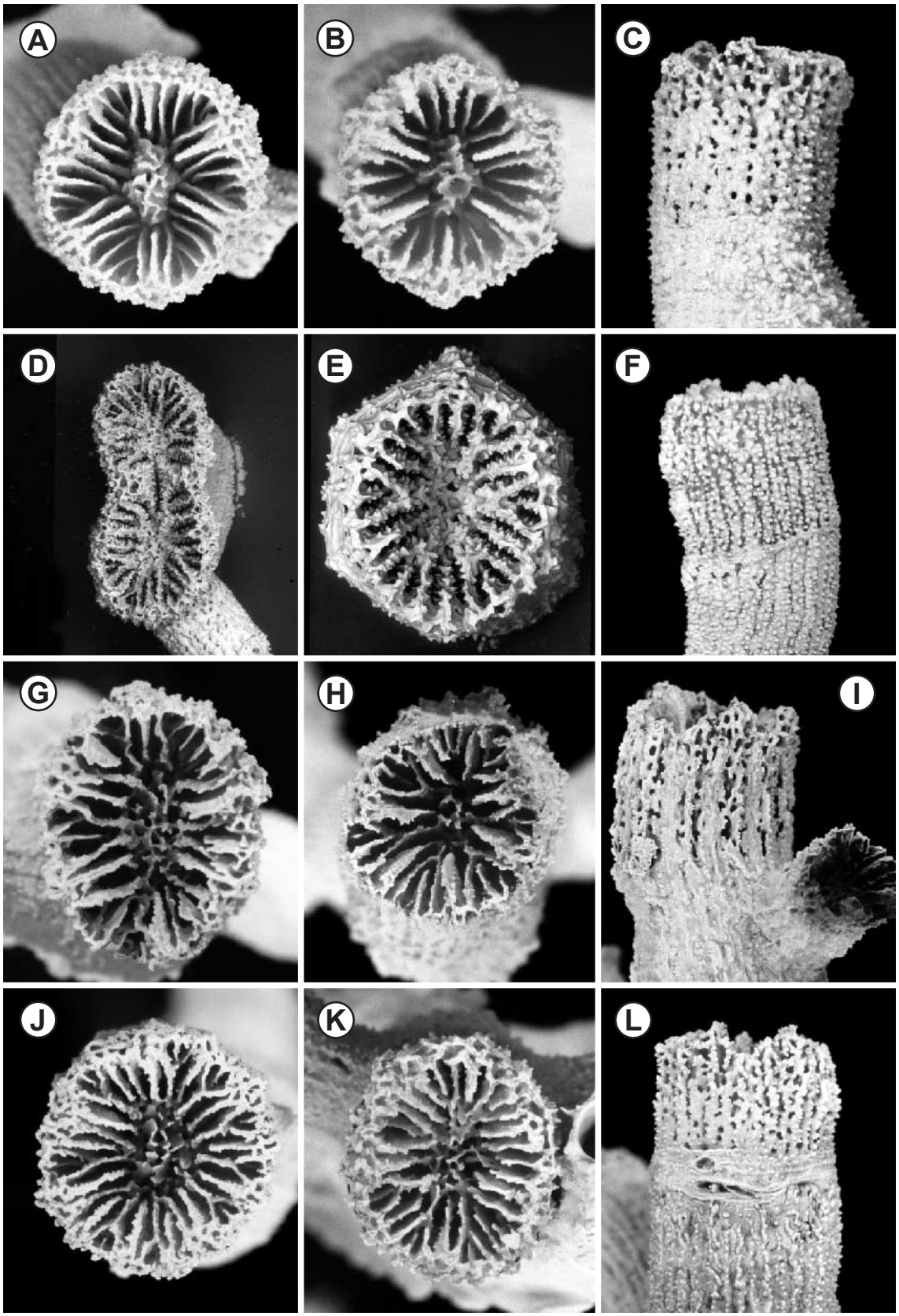
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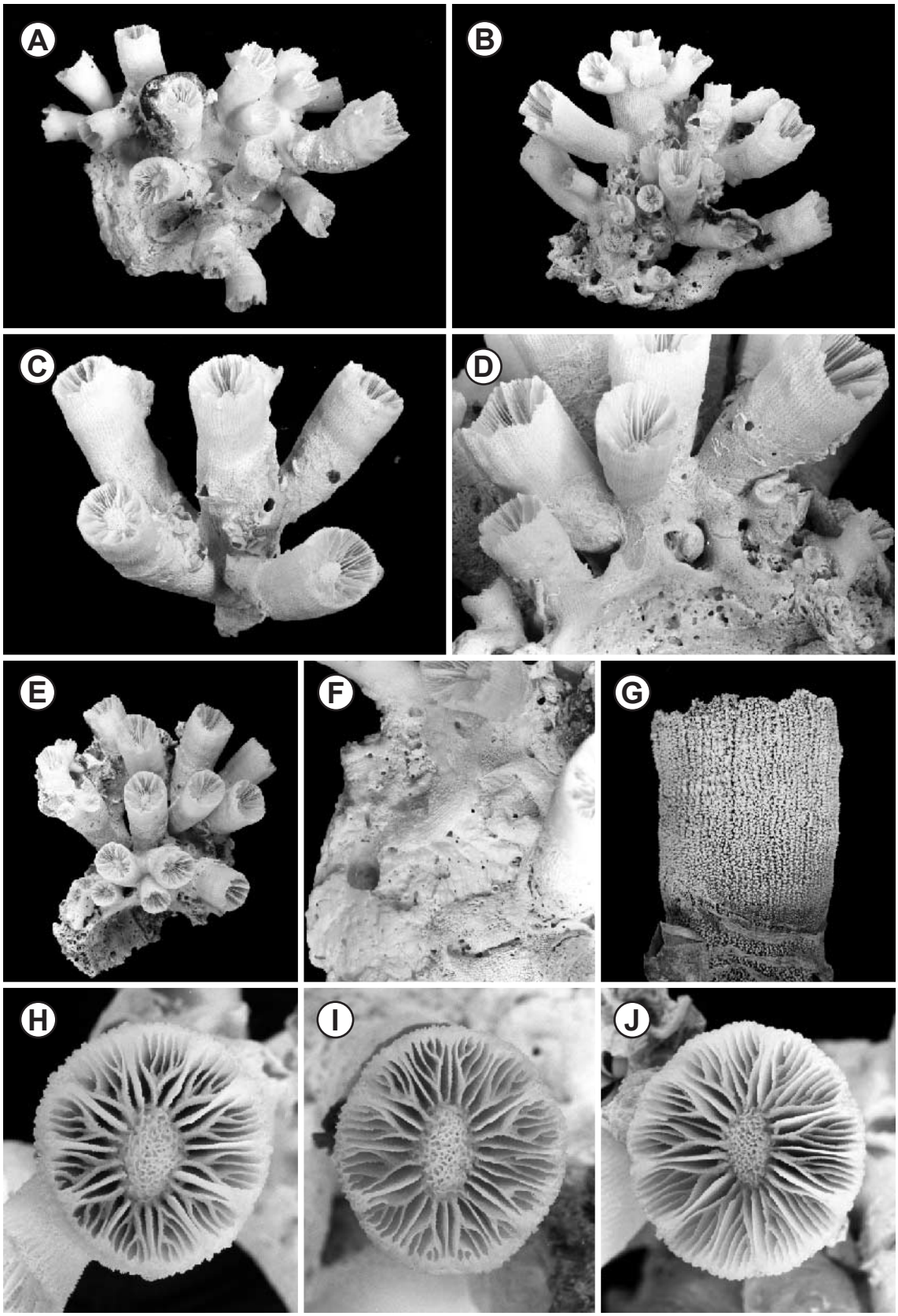
PLATE 7



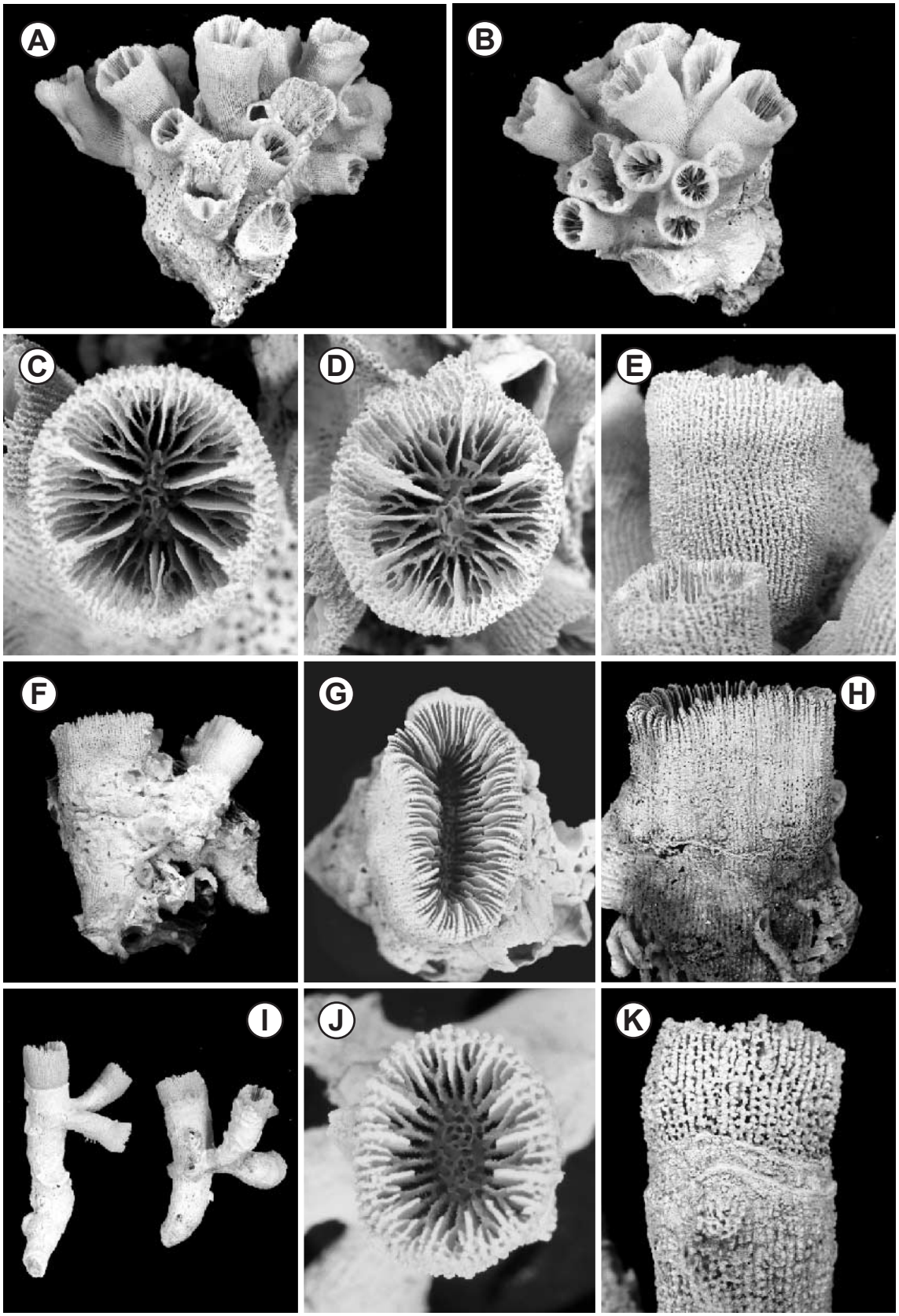

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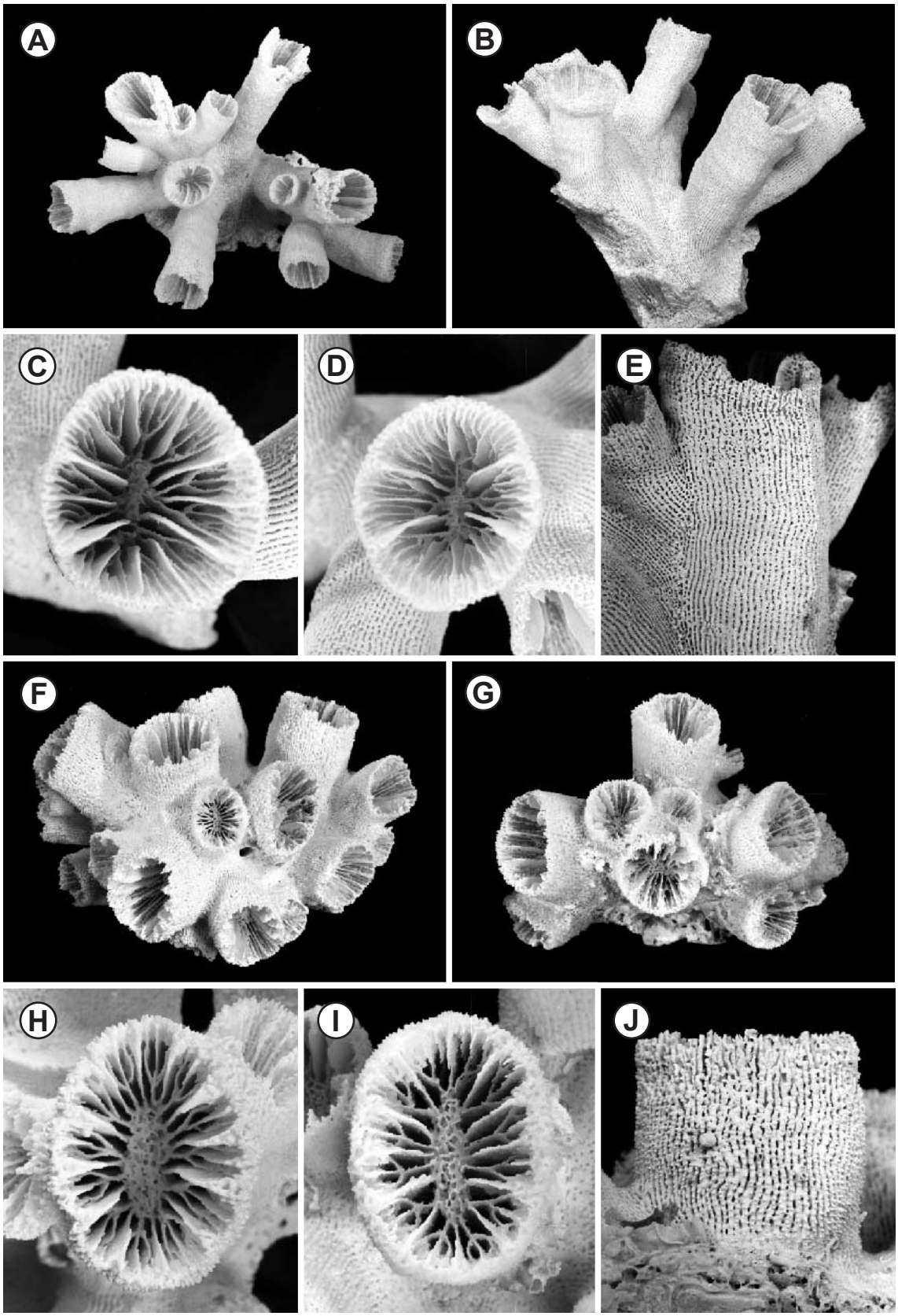
PLATE 9



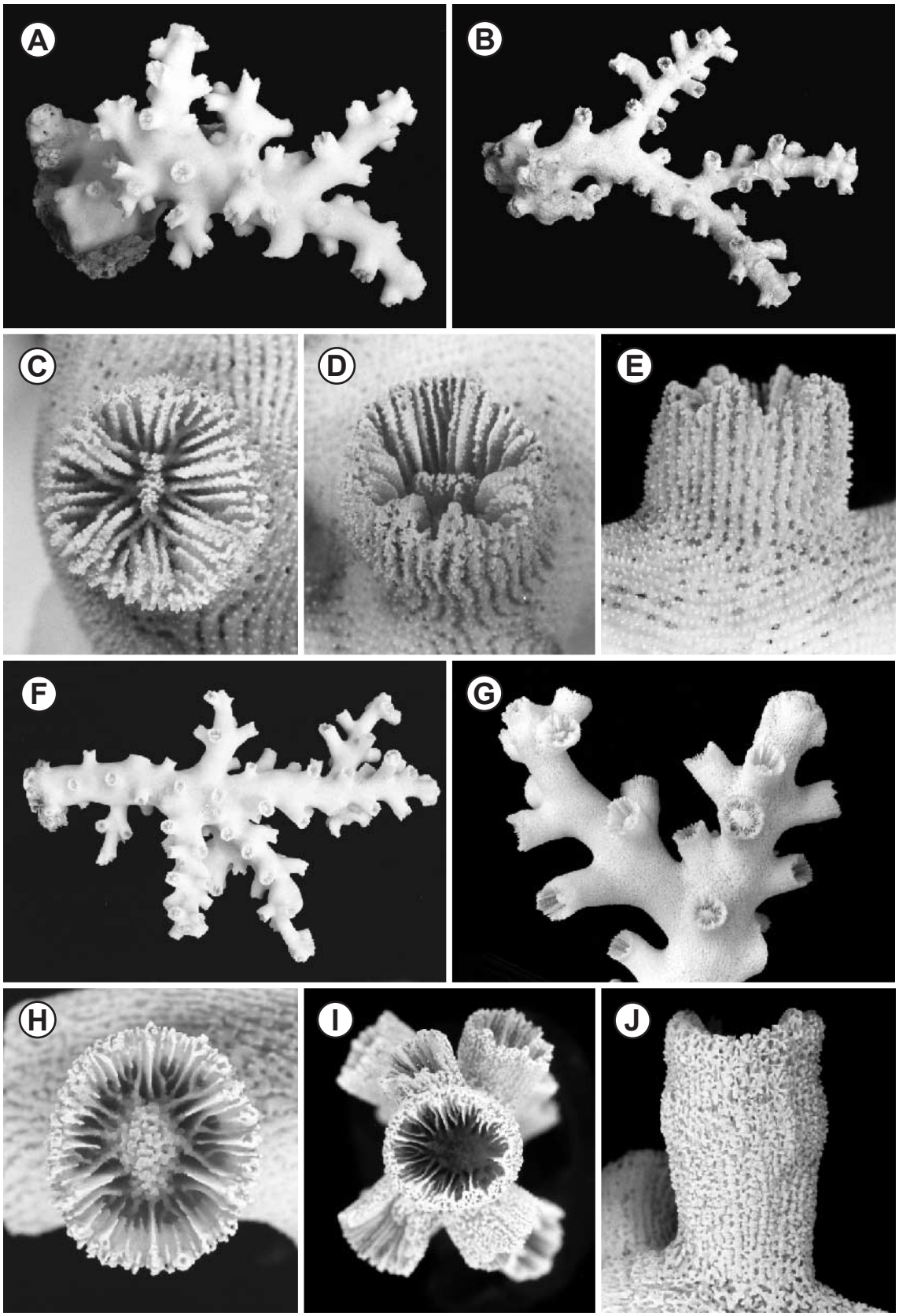

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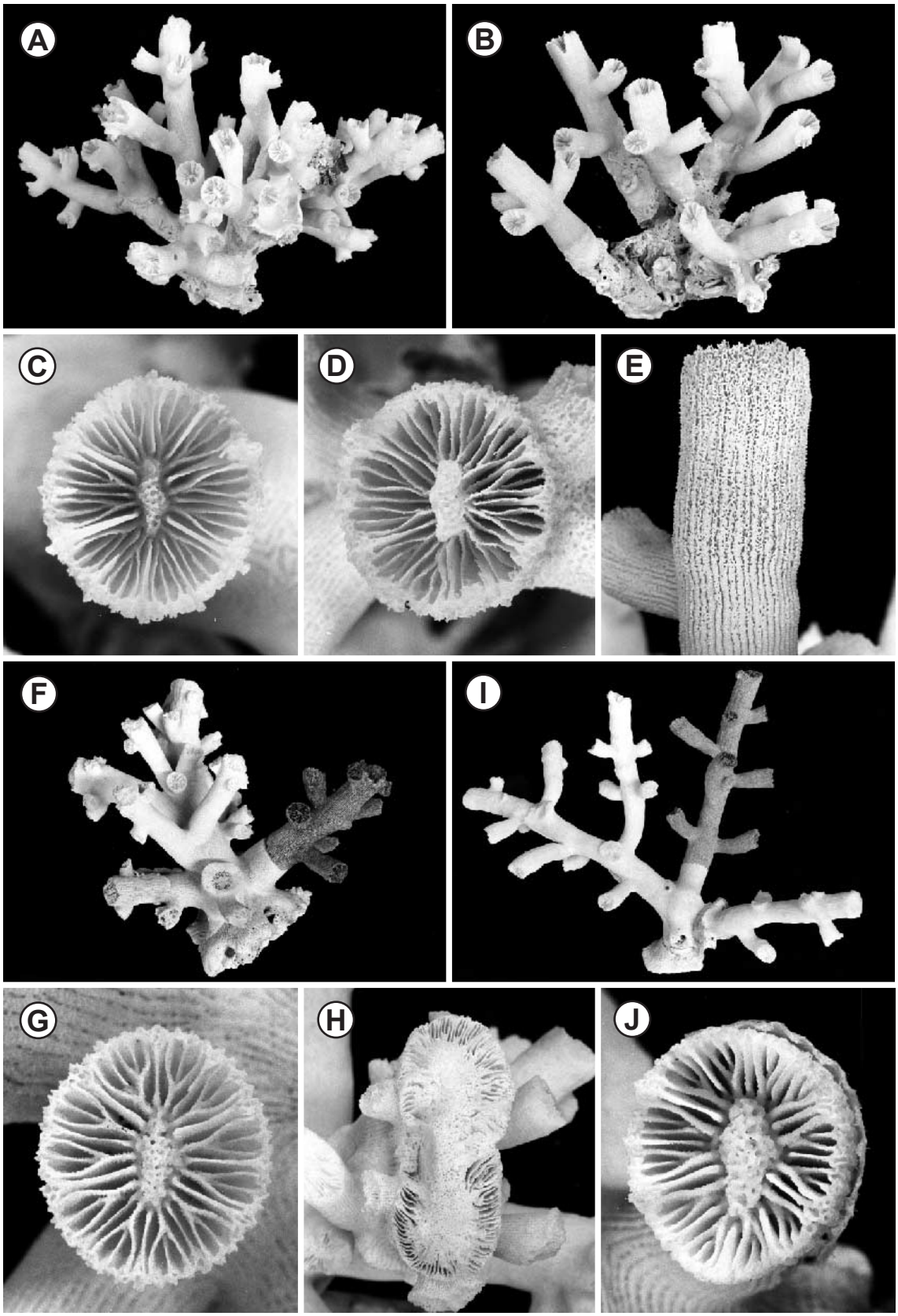
PLATE 11



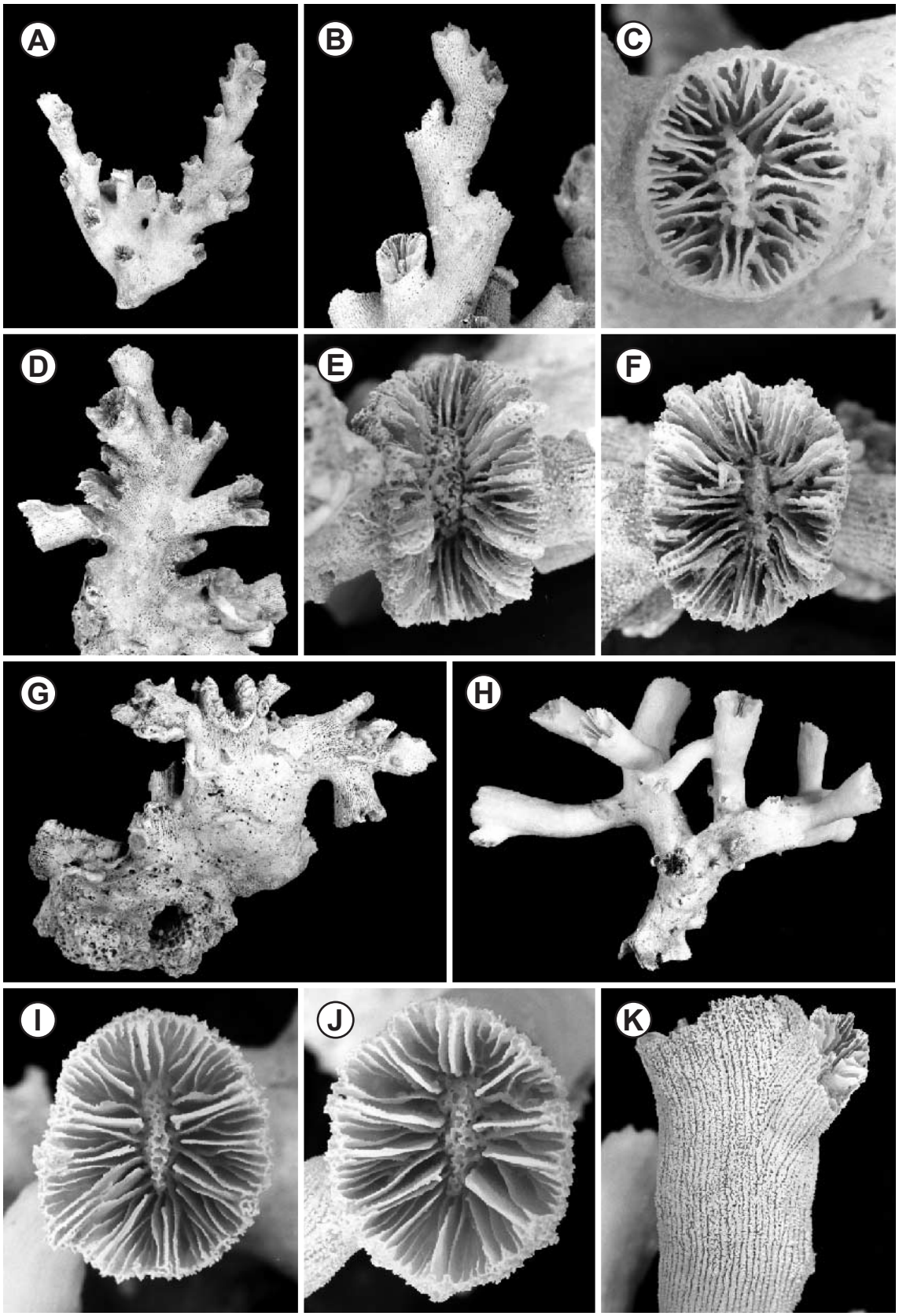

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PLATE 13