WEST INDIES GENERA *COLUMNITIS, TECTITETHYA* AND *NUCLEOTETHYA* NEW GENUS WITH DESCRIPTION OF NEW SPECIES (PORIFERA, TETHYIDAE)

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ABSTRACT

This study treats three genera of West-Indian shallow water Tethyidae (Porifera Demospongiae). The poorly known genus *Columnitis* Schmidt 1870 has been redescribed by re-examination of its type species *C. squamata* and the description of a new species *C. anomala.* This genus is characterized by a skeleton made from parallel bundles of subtylostyles crossed in the inner part by a layer of thinner subtylostyles and by three kinds of asters. A new genus, *Nucleotethya,* and a new species, *N. bifida* have been erected to harbor specimens bearing a large spicular core. The knowledge of the genus *Tectitethya* Sarà 1994 has been increased by the description of three new species, *T. keyensis, T. macrostella* and *T. raphyroides.*

Recent taxonomic changes to the family Tethyidae have been made for the genus *Tethya* (Sarà, 1987; Bergquist and Kelly-Borges, 1991). Successively, the genera *Columnitis* and *Tectitethya* have been discussed in the light of a rearrangement of the family Tethyidae (Porifera: Demospongiae) (Sarà, 1994) and investigated by cladistic analysis demonstrating their relationship (Sarà and Burlando, 1994).

The genus *Columnitis* was erected by Schmidt (1870). Its description lacked some important details, even if it was sufficient for recognizing the existence of a new tethyid genus. No other information was added until now to the original description of its type species, *C. squamata.*

The genus *Tectitethya* refers to *Criptotethya crypta* (de Laubenfels, 1949) which was later named *Tethya cripta* by Reiswig (1970). This name has been confirmed also by Wiedenmayer (1977) because (p. 171): ". . . the cortical structure and the content and morphology of astrose microscleres vary within the genus *Tethya* so that *crypta* is best assigned to it at present." Oddly Wiedenmayer does not considered in that sentence the peculiar skeletal arrangement of *crypta* which he described and photographed. This architecture is very different for any *Tethya* species and thus *crypta* pertains to a different genus, which cannot be named *Cryptotethya* because this name is preoccupied.

Rich, new material collected along the Florida coasts, including living specimens, and a careful study of British Natural History Museum specimens until now ignored or unpublished show that the West Indian Tethyidae are more heterogeneous than hitherto known. These Tethyidae include, in addition to *Tethya,* different species of *Columnitis* and *Tectitethya* and a new genus (*Nucleotethya*). The Caribbean area contains a peculiar clade, composed of a group of shallow-water massive forms, which merits further investigation.

MATERIAL AND METHODS

The geographical location of the material considered in this study is indicated in Figure 1. The examined material is as follows:

Columnitis squamata—Slide (paratype) from the Museum für Naturkunde, Berlin (ZMB). Three specimens stored in the United States National Museum, Washington (USNM) and collected from the Gulf of Mexico, off the south-western Florida coast at 30–31 m by the Continental Shelf Association for the United States Mineral Management Service (hereafter indicated as CSA).

Figure 1. Geographical distribution of the species: Cs, *Columnitis squamata*; Ca, *C. anomala*; Nb, *Nucleotethya bifida*; Tc, *Tectitethya cripta*; Tk, *T. keyensis*; Tm, *T. macrostella.*

Columnitis anomala—One specimen, preserved in ethanol in the British Museum of Natural History (BMNH), labelled by Burton as *Tethya anomala,* collected off Gorda Bay, Mosquito Bank, West Indies, near the Nicaragua coast, 34 m by the ROSAURA Atlantic Expedition.

Tectitethya crypta—type and paratype (dry specimens) from the American Museum of Natural History, New York (AMNH). One dry specimen from the USNM. Two specimens (spicular slides) respectively from San Domingo and Bimini from the Pulitzer-Finali's collection at the Museo di Storia Naturale di Genova (MSNG). One specimen (in ethanol) from Pansini's collection at the Istituto di Zoologia dell'Università di Genova (IZUG), from San Salvador, Little Bahamas, 0.5 m, on a mangrove root. One specimen from the BMNH, from Arawshei (West Indies), labelled by Burton *Columnitis squamata* (in ethanol).

Tectitethya keyensis—Several specimens we collected in Florida Keys (Vaca Key), Florida Bay, near the Institution of Marine Science, on the Gulf of Mexico shore at 0.5–2 m. Individuals were photographed in situ and preserved in ethanol.

Tectitethya macrostella—Several ethanol preserved specimens, collected at 20–52 m in the Gulf of Mexico, off the south western Florida coast and stored in the USNM.

Tectitethya raphyroides—One specimen from the BMNH (in ethanol), collected at South Sound, sand shoal off Red Bay, 1.5–2 m, Cayman Islands (West Indies) by the Oxford University Expedition. Labelled by Burton as *Tethya raphyroides* and described by him in an unpublished manuscript (pers. comm.).

Nucleotethya bifida—Three specimens collected by CSA at 85 m, Gulf of Mexico off the south western coast of Florida by triangular dredge and stored in the USNM.

Spicule preparations were made by dissolving small fragments of the sponges in 65% nitric acid, rinsing with water, dehydrating in ethanol and mounting with Canada balsam. Thick sections perpendicular to the surface were made by hand or microtome on the unembedded or paraffin-embedded, ethanol fixed samples to study skeletal architecture and aquiferous system general organization. Thin sections were also made on paraffin-embedded samples and stained with haematoxylin-eosin for the purpose of studying histological details. The morphology of megasters and microasters was studied through a 115 Philips SEM. For the terminology of spicular traits here adopted see Sarà (1994). The

Table 1. Morphological and spicular characters of the four species of *Tectitethya*

	External shape	Tubercles diameter (mm)	Megascleres kind	Megasclers size (mean ± SD) (μm)	Megasters size (mean ± SD) (μm)	Megasters R/C (mean ± SD)	Microsters kind	Microsters size (mean ± SD) (μm)
T. crypta	amorphous	2–3	anisostrongyles to strongyles	912.8 ± 87.5 × 22.6 ± 1.9	26.5 ± 4.7	1.1 ± 0.3	strongylasters	10.7 ± 1.8
T. macrostella	irregularly massive, lobate	2–5	anisostrongyles with subtylote heads	1,223 ± 117.5 × 38.4 ± 2.1	65.3 ± 5.8	2.6 ± 0.5	strongylasters to tylasters	15.1 ± 3.4
T. keyensis	roughly conical	3–5	anisostrongyles with subtylote heads	1,106.4 ± 119.4 × 18.5 ± 2.8	44.5 ± 6.8	1.4 ± 0.3	strongylasters to tylasters	12.3 ± 2.4
T. raphyroides	roughly pyramidal	2–5	anisostrongyles	865.4 ± 77.6 × 12.8 ± 2.4	14.7 ± 4.2	0.6 ± 0.2	strongylasters	10.5 ± 2.7

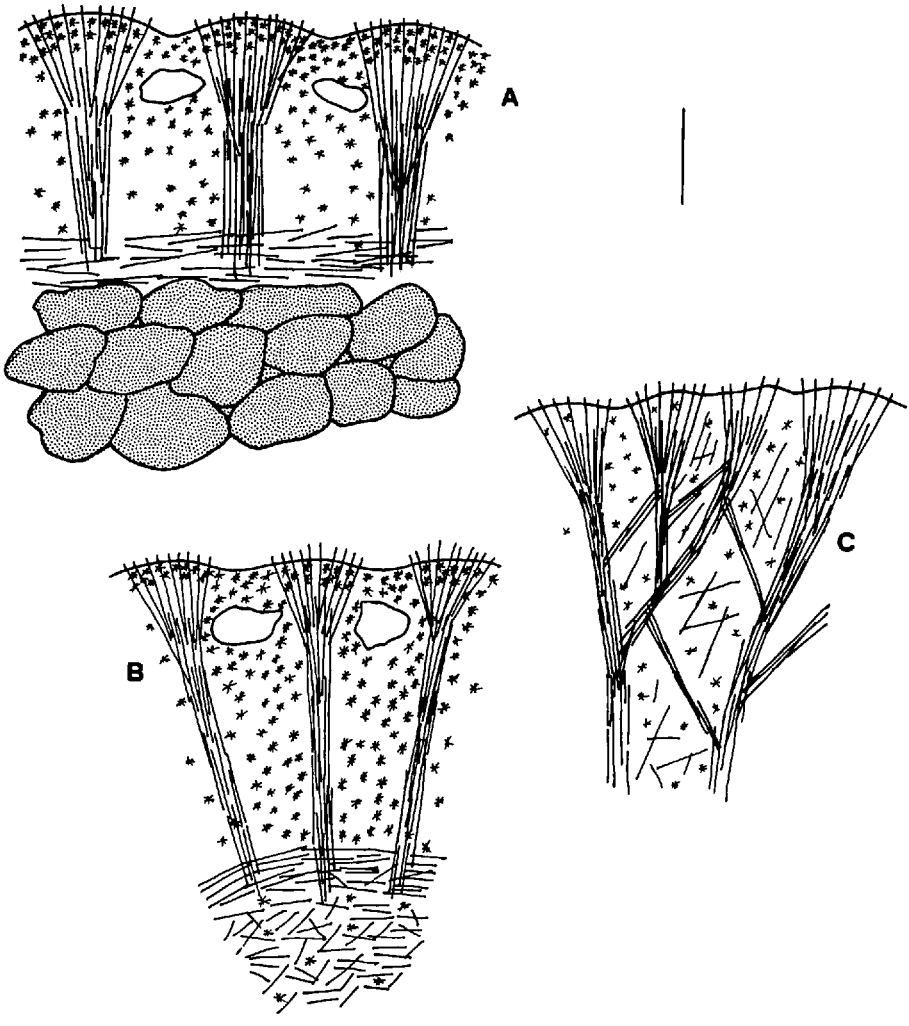

Figure 2. Skeletal arrangement in the genera: A, *Columnitis*; B, *Nucleotethya*; C, *Tectitethya*. Bar: 1 mm.

mean size of the *Tectitethya* spicules (Table 1) has been obtained by measuring 50 spicules for each specimen.

Taxonomic Study

Genus *Columnitis* Schmidt 1870

Diagnosis.—Tethyidae with a thick incrusting or massive body horizontally developed into winding branches and lobes. Surface with flattened, roughly hexagonal tubercles, above contiguous and below separated by grooves. Cortex indistinct but a thickening of asters under the sponge surface is always present. Large subdermal lacunes. Skeleton made by parallel bundles of megascleres ending in the tubercles and crossed in the inner part of the sponge by thinner megascleres isolated or in bundles (Fig. 2A). Megascleres are subtylostyles, sometimes styles. Megasters are oxyspherasters. Microsters of two sizes. The larger

category is represented by oxyasters and strongylasters with rays almost completely covered by spines: this spicule kind is typical of the genus *Columnitis*. The smaller category, particularly abundant on the sponge surface are tylasters. They are among the smaller micrasters known in Tethyidae. A large amount of sand inside the sponge, also in masses.

Type Species.—*C. squamata.*

Remarks.—The genus was erected by Schmidt (1870: 25) for the species *C. squamata.* To date this species was only represented by a spicular slide from the paratype stored in the ZMB. Based on the reexamination of this slide, we have identified three specimens from the CSA collection as belonging to *C. squamata.* One of these specimens has been choosen as neotype of the species. On the basis of a more precise characterization of *Columnitis,* it has been possible to attribute to this genus the BMNH specimen (1938:b: 30:38) labelled by Burton as *Tethya anomala* but never described. It is here described as a second species of *Columnitis,* i.e., *C. anomala.* Furthermore the specimen from Arawshey (West Indies), labelled by Burton as *C. squamata* (BMNH 1928:5:12:167), does not belong to this species, but to *Tectitethya crypta.*

Columnitis squamata Schmidt 1870

Material.—USNM 34537 (neotype), USNM 34548, BA 831 (paratypes) collected by CSA through a triangular dredge at Gulf of Mexico, off south western Florida coast: USNM 34537 at Stat. 15, 31.5 m, 25°45′53″N and 82°31′37″W, 11.9.80; USNM 34538 and BA 831 at Stat. 7, 30.4 m, 26°16′49″N and 82°44′01″W, 19.7.81.

Shape and Size.—USNM 34537 (7.5 × 5 × 2.5 cm) and BA 831 (3.5 × 3 × 2 cm) have an irregular massive body horizontally developed with winding branches and rounded lobes (Fig. 3A), USNM 34548 (cm 3 × 3 × 0.5–0.8) is a thick incrusting plate. All the specimens, collected by a triangular dredge, seem to be incomplete. The sponges incorporate fragments of shells and other detritus.

Color.—Pale brownish (in ethanol).

Consistency.—Hard, nearly incompressible.

Surface.—Smooth, entirely covered by flattened, roughly hexagonal tubercles, above contiguous and below separated by narrow grooves. The surface is not covered by sand in spite of the large amount inside the sponge.

Aquiferous System.—Oscules not visible in the preserved material. Large subdermal lacunes.

Skeleton.—Parallel bundles of megascleres ending with a fan in the tubercles. These main bundles are crossed in the inner part of the sponge by thinner megascleres generally in smaller transversal bundles or also scattered. Megasters and micrasters are densely distributed in the whole sponge but more concentrated under the sponge surface in a pseudocortical layer.

Spicules.—Megascleres (Fig. 4)—Subtylostyles with a well distinct swelling in the bases, sometimes styles: 300–2,000 × 3–30 μm. The vertical megascleres are generally 20–25 μm thick while the transversal ones are only 5–10 μm. Megasters (Figs. 4, 5)—Oxyspherasters with often apically bent or swollen rays: 50–80 μm, R/C (ratio between ray lenght and centrum diameter) = 1–2. Micrasters (Figs. 4, 5)—Two categories: strongylasters, sometimes oxyasters with 12 spined rays, 15–25 μm, without centrum; very small tylasters, 3–5 μm.

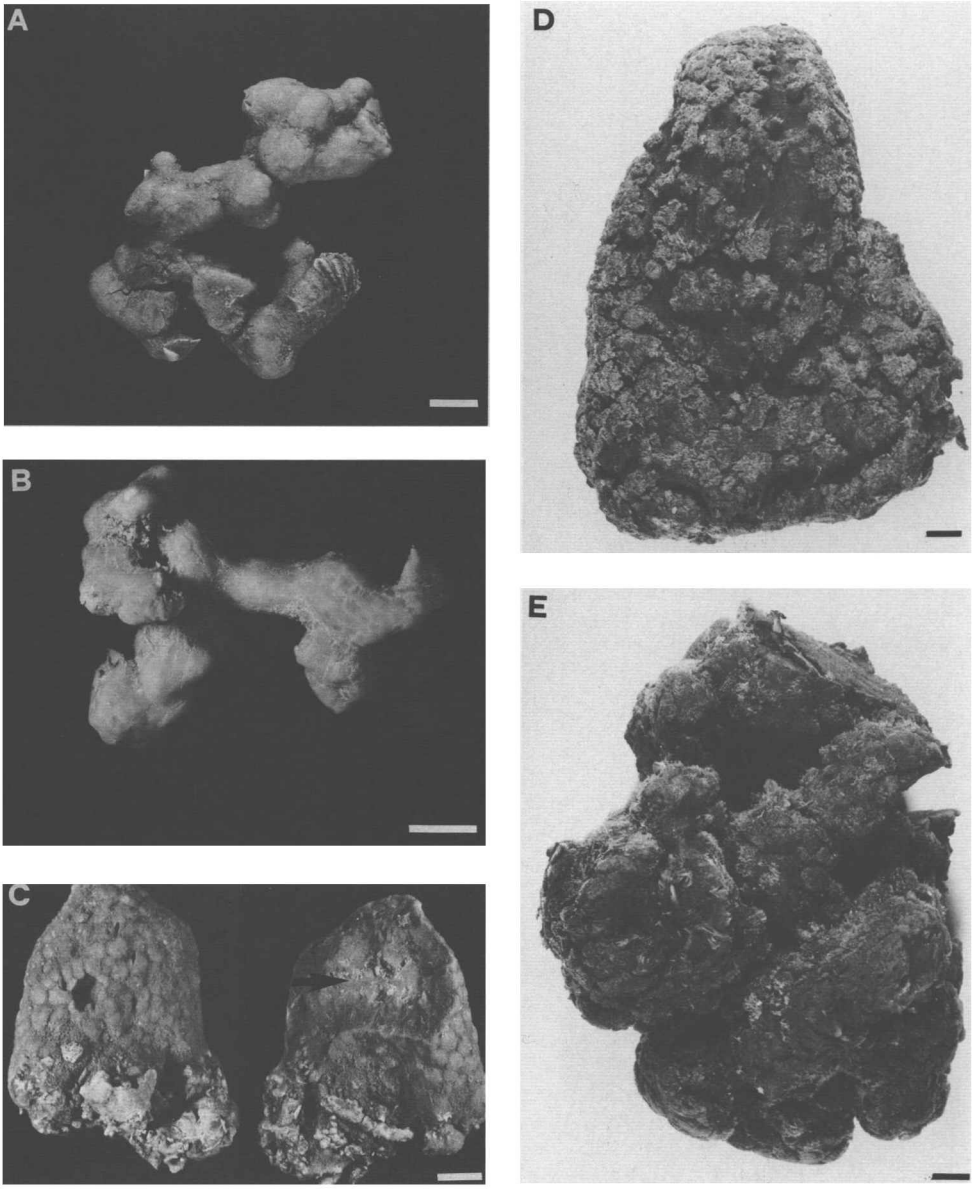

Figure 3. External morphology of the holotypes of the described new species. A, *Columnitis squamata*; B, *Columnitis anomala*; C, *Nucleotethya bifida* showing its spicular nucleus (arrow); D, *Tectitethya keyensis*; E, *Tectitethya macrostella*. Bars: 1 cm.

Columnitis anomala new species

Material.—BMNH 1938 b:30:39 (holotype), labelled by Burton *Tethya anomala*. Collected off Gronda Bay, Mosquitoes Bank, St. 31, 16-1-1937, 15°54′N and 82°13′W, 34 m, by dredge, ROSAURA Atlantic Expedition. Caribbean Sea, off the Nicaragua coasts.

Shape and Size.—Irregularly massive, horizontally developed with winding cy-

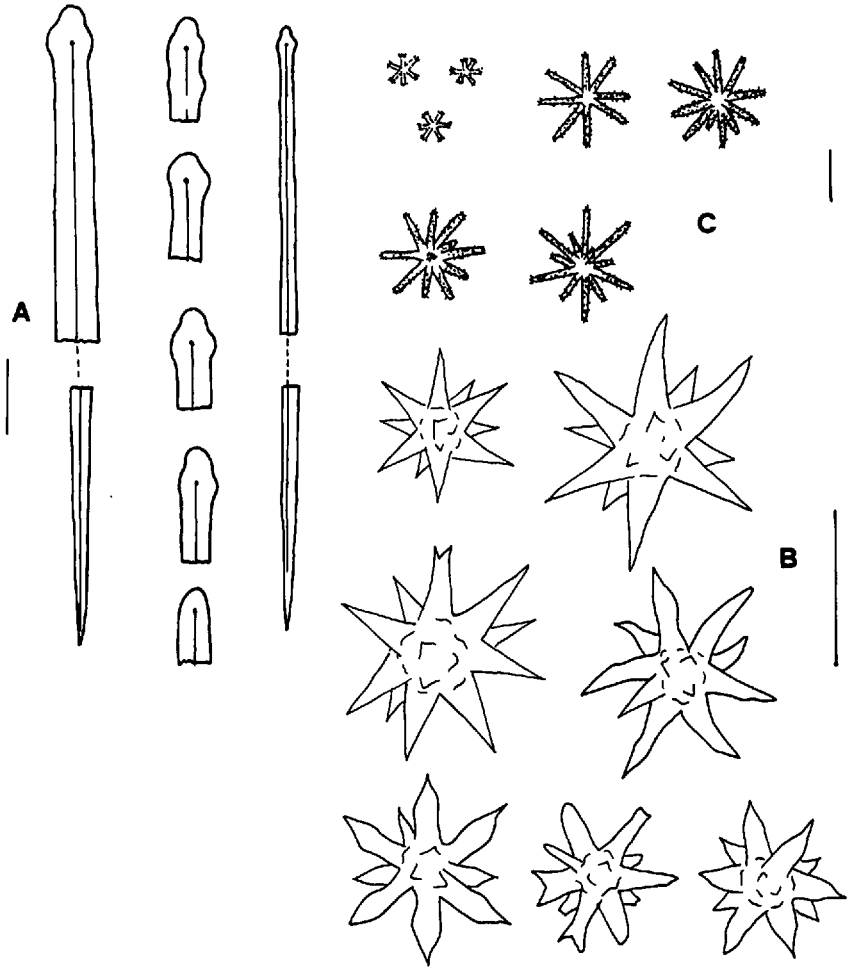

Figure 4. *Columnitis squamata:* A, Subtylostyles; B, megasters; C, microsters. Bars: A–B, 50 μm; C, 10 μm.

lindrical branches and rounded lobes (Fig. 3B), cm 5 × 3 × 1 (height). The specimen, collected by dredge may be incomplete.

Color.—Pale brownish (in ethanol).

Consistency.—Hard, nearly incompressible.

Surface.—Smooth, entirely covered by flattened roughly hexagonal tubercles, above contiguous and below separated by narrow grooves. Surface not covered by sand in spite of its large amount inside the sponge.

Aquiferous System.—No oscules visible in the preserved material.

Skeleton.—Parallel bundles of megascleres originate inside the branches, also from the sand core and end in fan-like expansions in the tubercles. These main bundles are crossed in the inner regions of the sponge by thinner megascleres joined in transversal smaller bundles or also scattered. Megasters and microsters

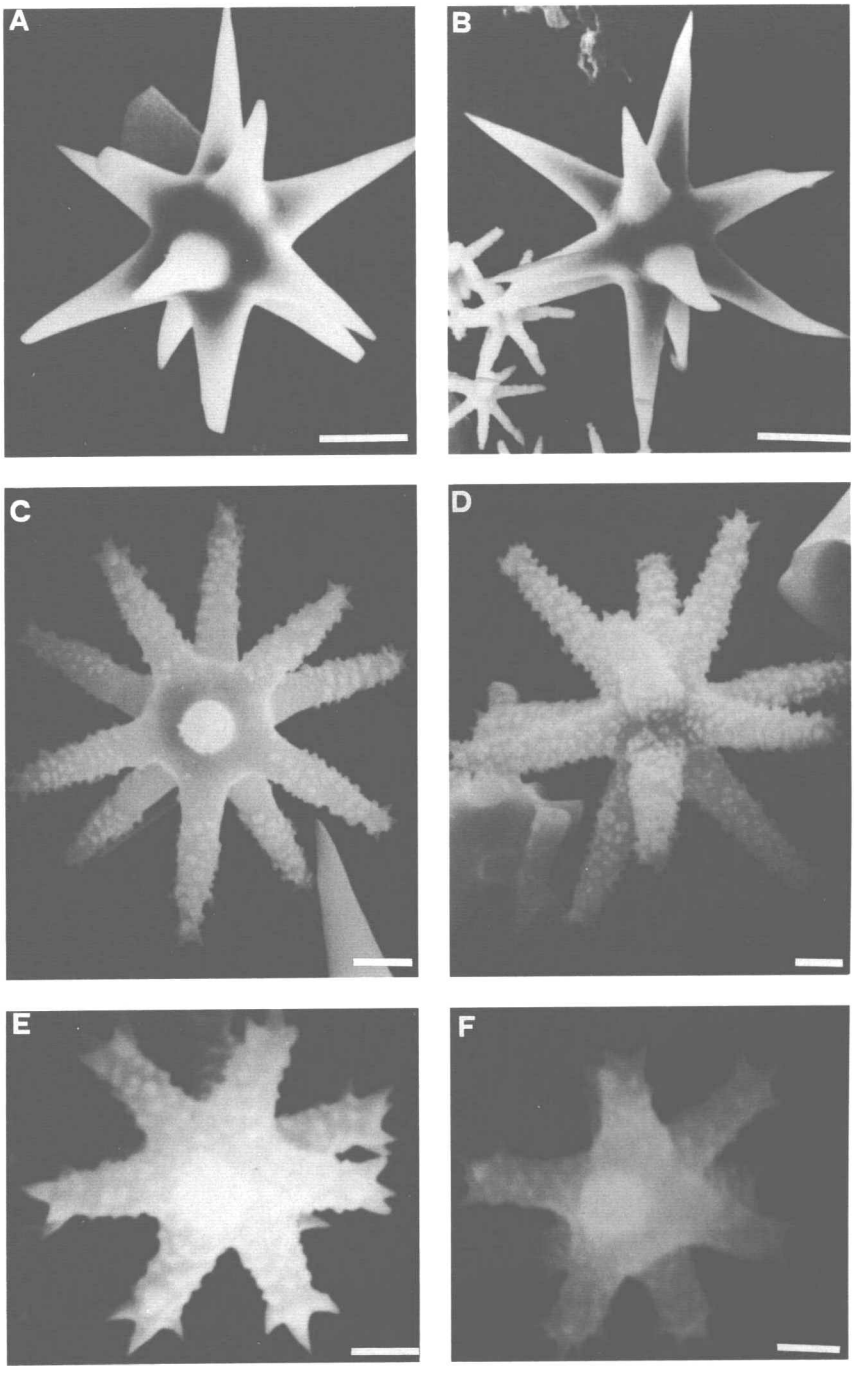

Figure 5. *Columnitis squamata*, SEM micrographs: A–B, megasters; C–D, large microsters; E–F, small microsters. Bars: A–B, 10 μm; C–D, 2 μm; E–F, 1 μm.

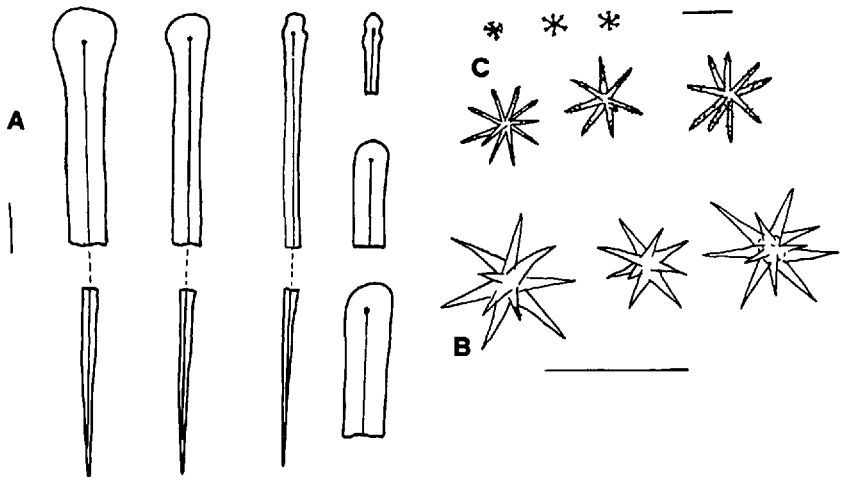

Figure 6. *Columnitis anomala:* A, Subtylostyles; B, megasters; C, micrasters. Bars: A, 10 μm; B, 50 μm; C, 10 μm.

densely packed into the whole sponge with thickening under the sponge surface (pseudocortex).

Spicules.—Megascleres (Fig. 6)—Subtylostyles with well swollen spicular bases 280–1,100 μm × 3–10 μm. Megasters (Figs. 6, 7)—Oxyspheraster, 20–50 μm, R/C = 3, with a very small centrum and, generally, with 12 rays. The number of rays may be reduced to 4 or 3. Micrasters (Figs. 6, 7)—Two distinct size categories: the larger is represented by oxyasters with about 12 slender spined rays, 15–20 μm; the smaller is represented by very thin tylasters 2–4 μm in diameter, particularly concentrated on the sponge surface, but present everywhere.

Etymology.—We conserve the name given by Burton which acknowledges the specific difference with *squamata.*

Remarks.—*C. anomala* is distinguished from *C. squamata* mainly for its megaster shape and size. The measures of the diameters and of the R/C of the oxyspheraster of the single specimen of *C. anomala* and of the three specimens of *C. squamata* show clearly that the two species are distinct in these traits. The oxyspheraster of *C. anomala* are smaller and have a reduced centrum. Other differential characters are the more pronounced oxyaster type of the larger category of micrasters with a slenderer shape and smaller size. These last features are also shown by the minute tylasters. Moreover the monaxonic megascleres of *C. anomala* are slenderer and shorter and among the thinnest in the whole family Tethyidae. Geographically *C. squamata* and *C. anomala* have been found in considerably distant, about 2,000 km apart, West Indies localities (Fig. 1).

Genus ***Nucleotethya*** new genus

Diagnosis.—Tethyidae with a conical or ovoidal, massive body. Surface with flattened, rounded or polygonal tubercles. Cortex indistinct, marked only by the density of asters. Skeleton made by radial bundles of megascleres ending in the tubercles and, in the inner part of the sponge, by transversal bundles of thinner megascleres crossing the radial bundles and surrounding a large spicular core

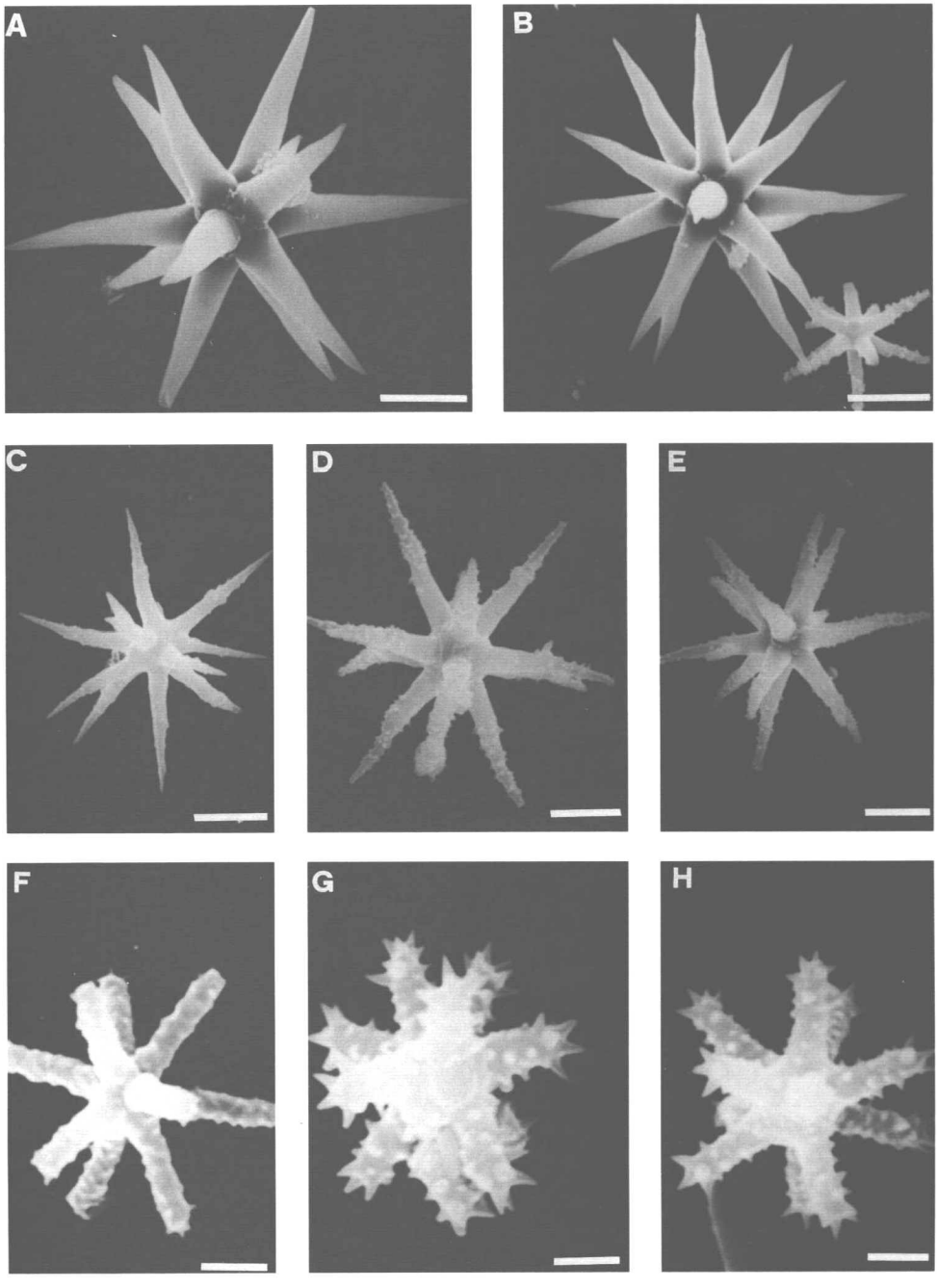

Figure 7. *Columnitis anomala,* SEM micrographs of: A–B, megasters; C–E, large microasters; F–H, small microasters. Bars: A–B, 10 μm; C–E, 5 μm; F–H, 1 μm

(about 0.5–0.66 of the sponge diameter). This is made by a confuse network of megascleres with megasters, microsters and sand.(Fig. 2B) Megascleres are styles and subtylostyles. Large megasters and only one type of microsters. Surface covered by sand, also abundant inside the sponge.

Type Species.—***Nucleotethya bifida*** new species

Remarks.—*Nucleotethya* has been established for samples with well developed and specially structured nucleius. The nucleus of *Nucleotethya* sharply differs for other nuclei occasionally occurring in Tethyidae. In *Tethya* a nucleus sometimes occurs but is small and built by the basal part of the megasclere bundles. In *Burtonitethya* (Sarà, 1994) there is a large nucleus at the insertion of the stalk in the body but is formed by clumps of thin strongyles and styles surrounding the base of the radiate bundles of megascleres. In *Tethycometes* (Sarà, 1994) microstrongyles occur around the base of the central strongyloxeas.

Some characters such as the massive irregular shape, the external appearance, the indistinct cortex and the occurrence of sand show that *Nucleotethya* belongs to the same clade of Tethyidae of *Columnitis* and *Tectitethya* (Sarà and Burlando, 1994). Nevertheless *Nucleotethya* is distinguished from *Columnitis* and *Tectitethya* by the development of the nucleus. Other distinctive characters are the large size of its megasters, the type of megasclere, chiefly a style-subtylostyle while in *Columnitis* it is a subtylostyle with swollen ends and in *Tectitethya* an anisostrongyle, and the microsters features. The name *Nucleotethya* is derived from the remarkable skeletal trait.

Nucleotethya bifida new species

Material.—USNM 34558 (holotype), USNM 34559, BA 477 (paratypes) collected by CSA by a triangular dredge, Gulf of Mexico, southwest Florida coast, at Stat. 11, 2-6-82, 85 m, 26°16′43″N, 83°46′49″W; BA 477, July 1990.

Shape and Size.—USNM 34558 and USNM 34559 are irregularly conical, respectively cm 6 × 3 × 5 (height) and cm 3 × 2 × 3 (height) (Fig. 3C); BA is ovoidal cm 2 × 2 × 3 (height).

Color.—(in ethanol) Brownish gray on the sandy surface, pink brown in the interior.

Consistency.—Hard, incompressible.

Aquiferous System.—With one small oscule at the top of the sponge (not demonstrable for USNM 34559 because this specimen is damaged at the top). Large subdermal lacunes at a depth inside the sponge of 0.5 cm, under the pseudocortex.

Surface.—Finely hispid and covered by sand. Tubercles flattened, 2–4 mm in diameter, rounded or with a roughly polygonal outline.

Skeleton.—Radiate bundles of megascleres originating from nucleus and ending in the tubercles with fan-like expansions. Transversal rows of thinner megascleres around the nucleus crossing the radiate bundles. Megasters and microsters diffuse into the whole sponge but particularly concentrated in the pseudocortical layer, about 300 μm thick. The nucleus, about 0.5–0.66 of the whole sponge, macroscopically distinct for color and consistency from the sponge tissue, is made by a dense and confuse network of stylote megascleres of different size accompanied by megasters, microsters and sand.

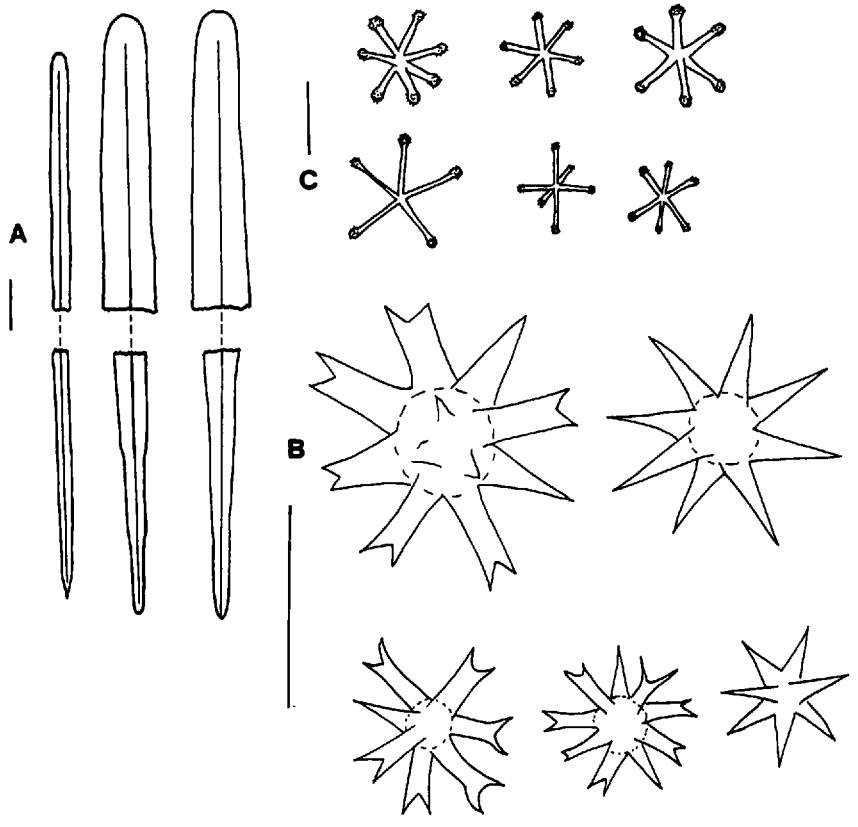

Figure 8. *Nucleotethya bifida:* A, styles; B, megasters; C, microasters. Bars: A, 30 μm; B, 100 μm; C, 5 μm.

Spicules.—Megascleres (Fig. 8)—Styles or subtylostyles, sometimes anisostrongyles in the radiate bundles: 800–2,300 × 20–30 μm. Styles of the transversal rows: 350–1,600 × 5–10 μm. Styles in the nucleus: 300–2,000 × 5–20 μm. Megasters (Figs. 8, 9)—Oxyspherasters: Diameter: 40–160 μm (in the nucleus 30–80 μm); R/C = 1–1.5. With rays generally apically trunked with forks and teeth. Microasters—Tylasters with slender rays and a small swollen tip. Diameter 7–12 μm. (sometimes 15–18 μm.)

Etymology.—*bifida* for the megasters forked rays.

Genus *Tectitethya* Sarà 1994

Diagnosis.—Tethyidae of large size with a massive, amorphous or irregularly conical, cylindrical, hemispherical or plurilobate body. The cortex is ill defined, nearly indistinct. Flattened and irregularly rounded tubercles of different size are present on the surface, which is covered by sand or sea weeds. Sediment occurs also inside the sponge. The megascleres form ascending, stout bundles ending in fan-like expansions in the tubercles and frequently branching and anastomosing; scattered megascleres lay in the interstices (Fig. 2C). The megascleres may be anisostrongyles or strongyles frequently with subtylote head. The megasters,

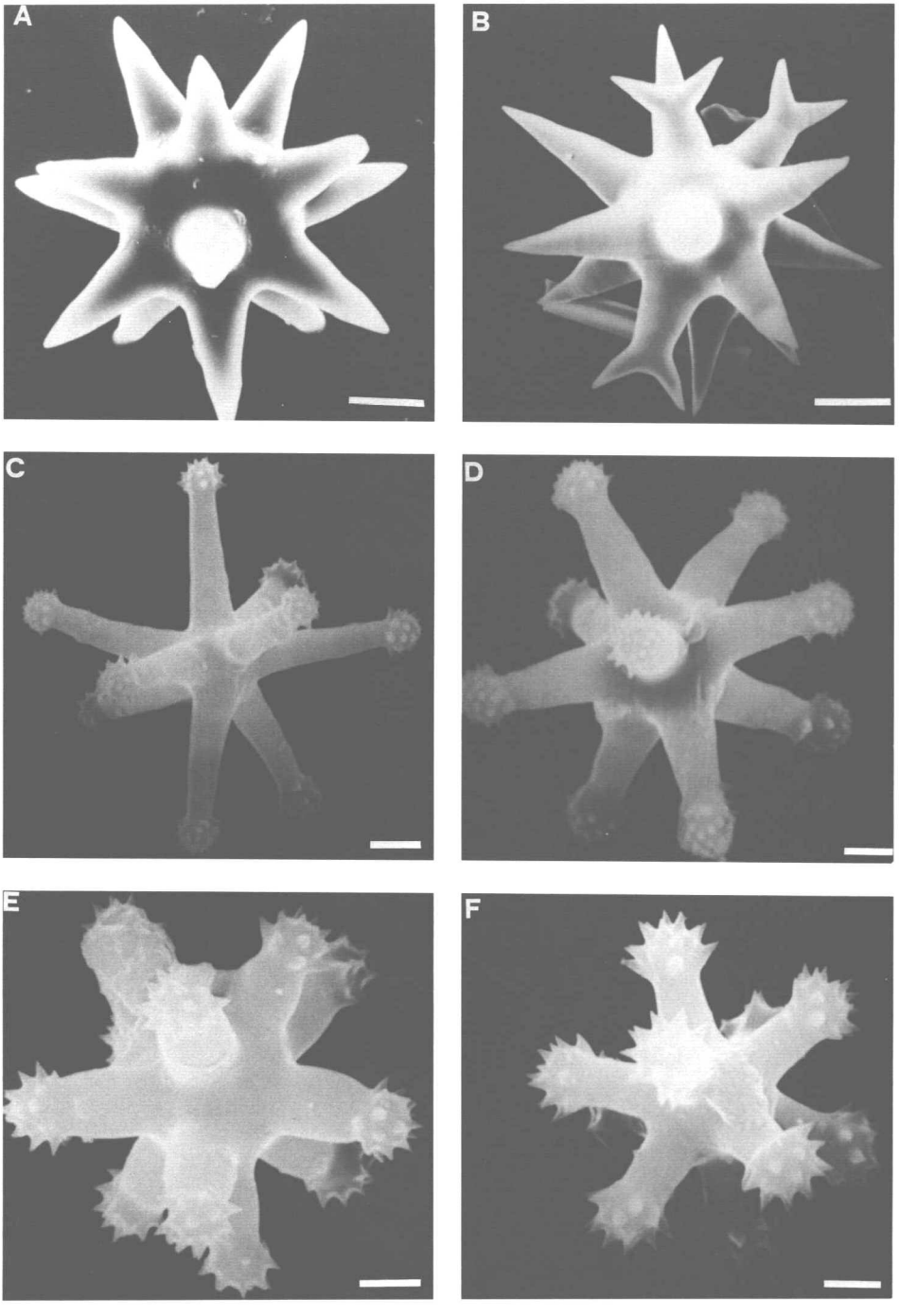

Figure 9. *Nucleotethya bifida,* SEM micrographs: A–B, megasters; C–F, micrasters. Bars: A–B, 10 μm; C–F, 2 μm.

sometimes rare, are oxyspherasters of small or medium size with frequent reductions and anomalies. The microsters are strongylasters or oxyasters.

Type Species.—Tectitethya crypta (de Laubenfels, 1949).

Remarks.—The name *Tectitethya* refers to the species described as *Cryptotethya crypta* by de Laubenfels (1949) and subsequently included in *Tethya* by Reiswig, 1971. This species has been carefully redescribed, as *Tethya crypta,* by Wiedenmayer (1977). The body and skeleton structure showed clearly (Sarà, 1994) that *T. crypta* was not a *Tethya* but representative of a new genus which however could not be called *Cryptotethya* because this name was previously utilized by Dendy (1905) for a species, *C. agglutinans,* which probably does not belong to the Tethyidae. We describe here three other species of *Tectitethya: T. keyensis, T. macrostella* and *T. raphyroides* (Table 1).

Tectitethya crypta (de Laubenfels 1949)

Material.—Cryptotethya crypta: holotype and paratype, AMNH 473, 500, Bimini, Bahamas; *Tethya crypta* USNM 30278, Bimini; Pulitzer Coll BW 4, Bimini; SDC 10, S. Domingo; Pansini coll. 2206, San Salvador, Little Bahamas; *Columnitis squamata* BMNH 1928. 1. 12. 167, Arawshei, West Indies.

Shape and Size.—Unfortunately the holotype of *T. cripta* is represented by a dry preserved fragment but de Laubenfels (1949) described the species as ". . . an amorphous sponge, often of fist size or slabs 4 by 7 by 12 cm." The specimen BMNH 1928.1.12.167, attributed by us to *T. cripta* collected at Arawshei (West Indies) and erroneously labelled by Burton as *Columnitis squamata* measures 10 × 6 × 15 cm and is black brownish in ethanol and perhaps incomplete.

Surface.—A trait, not reported by the previous description but observed by us on the holotype, is the regular cover of the surface with small, irregularly rounded and flattened tubercles, 2–3 mm in diameter.

Aquiferous System.—According with the original description, the oscule was not visible.

Skeleton.—Megasclere bundles frequently branched and anastomosed. Scattered megascleres and foreign body fill the interstices between the bundles.

Spicules.—Megascleres—Anisostrongyles to strongyles (Fig. 11A) 500–1400 (912.8 ± 87.5 in average) × 10–40 (22.6 ± 1.9 in average) μm. Megasters (Figs. 10A–C; 11B)—Oxyspherasters, diffuse into the whole sponge, generally in a reduced number, often with forked rays and other anomalies, 10–40 μm (26.5 ± 4.7 in average), R/C = 1–2 (1.1 ± 0.3 in average). Ray tips frequently rounded and ray base width half its length. Microsters (Figs. 10D–F; 11C)—Strongylasters, D = 8–12 μm (10.7 ± 1.8 in average).

Remarks.—The main characters distinguishing the different species of *Tectitethya* are the external shape and the size and shape of their megasters (Table 1). In addition *T. crypta* is distinguished from the other species by smaller tubercles, the kind of megascleres and, from *T. macrostella* and *T. keyensis* by the microsters shape and size.

It is likely that the redescription of *T. crypta* by Wiedenmayer (1977) mingles external aspects of *T. keyensis* and *T. crypta* and refers clearly to *T. crypta* only for the spicules. In fact, among the sources of its description he cites the papers of Tabb and Manning (1961) and of Storr (1964) which listed the presumed *T. crypta* as coming from the Florida Bay and west coast of Florida where we found *T. keyensis* and *T. macrostella* but not *T. crypta.* It should be also observed if the

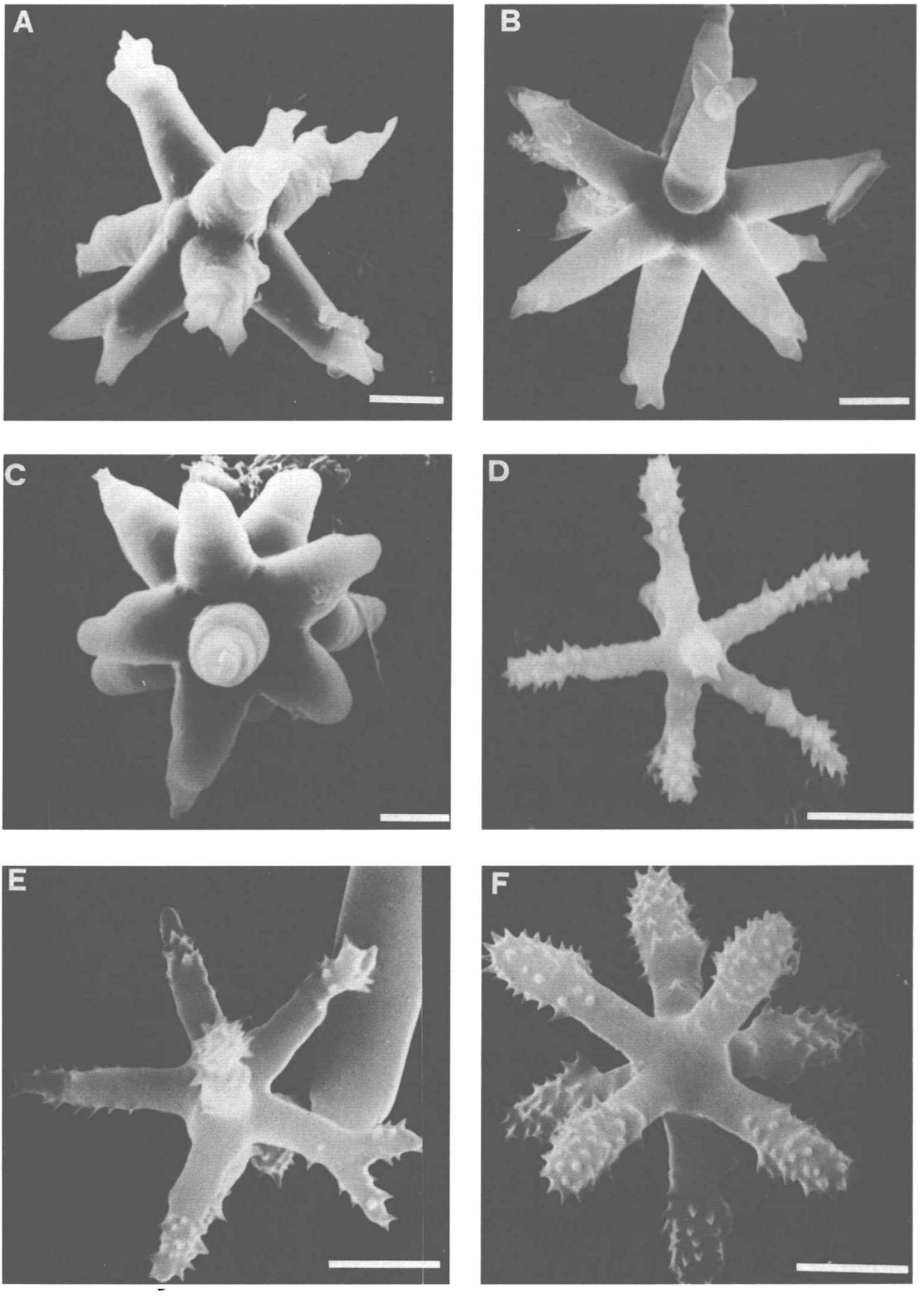

Figure 10. *Tectitethya crypta,* SEM micrographs: A–C, megasters from the holotype; D, micraster from the holotype; E–F micrasters from the specimen BMNH 1928.1.12.167. Bars: A–D, 5 μm; E–F, 3 μm.

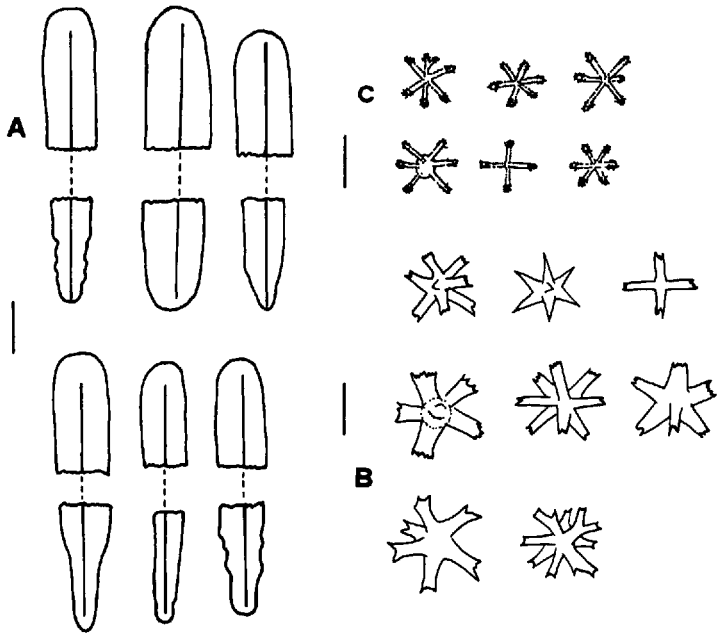

Figure 11. *Tectitethya crypta,* spicules from the specimen BMNH 1928.1.12.167 A, anisostrongyles; B, megasters; C, microasters. Bars: A–B, 20 μm; C, 10 μm.

T. crypta found by Reiswig (1971) at 1–6 m of depth in Discovery Bay (Jamaica) refers to the new species *T. keyensis.*

Tectitethya keyensis new species

Material.—USNM 39330 (holotype); USNM (39332); FK 1–7 (paratypes) Long Key, Florida Keys, Florida Bay, near Florida Key Marine Laboratory, collected by hand on the shore, 1–2 m, February 1994, Bavestrello and Sarà leg.

Shape and Size.—Roughly conical (Fig. 3D), with a width of 5–7 cm and an height of 10–15 cm. Sometimes a smaller conical lobe is fused with the main one.

Color.—(In life). Black brownish, but with a grayish coat due to the sediment on the tubercles and other parts of the surface.

Surface.—Only partially covered by large tubercles (3–5 mm in diameter and 1–2 mm high). They are hispid, of polygonal or irregular shape, widely spaced, contiguous or fused. The surface is covered by seaweeds and sediment.

Consistency.—Firm, fleshy, somewhat compressible.

Aquiferous System.—A large oscule, 1–2 cm in diameter, is visible, also in the preserved material, at the body apex.

Cortex.—Ill defined, macroscopically indistinct. Histologically, the cortical tissue, which penetrates into the medullar one, appears developed in the tubercles and around the distal ends of the megasclere bundles.

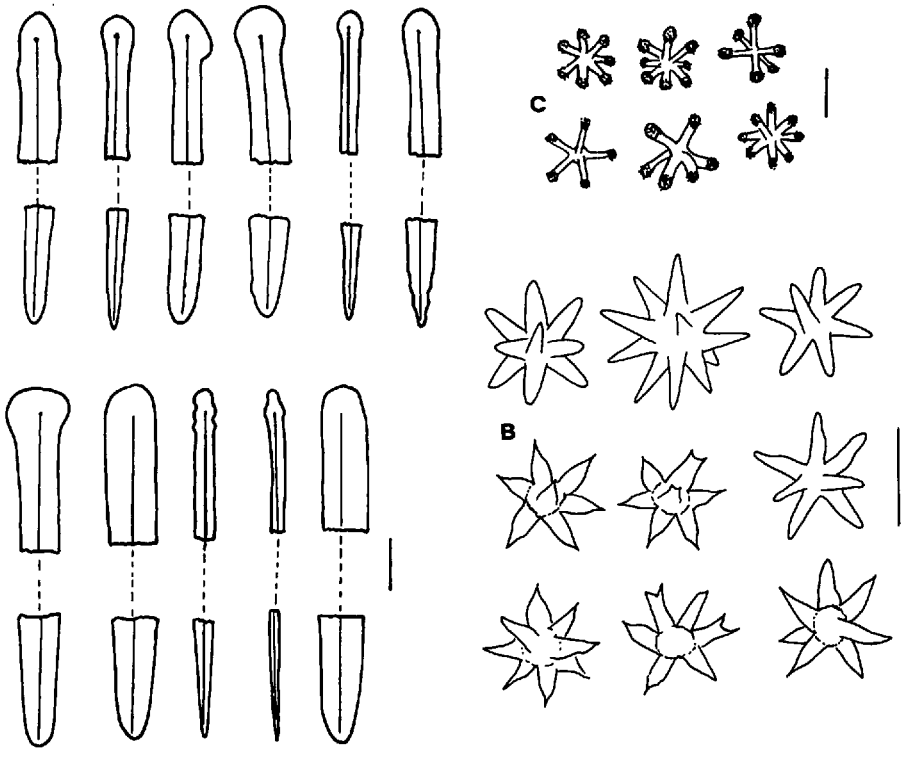

Figure 12. *Tectitethya keyensis:* A, anistrongyles; B, megasters; C, microsters. Bars: A, 30 μm; B, 50 μm; C, 20 μm.

Skeleton.—Megasclere bundles run from the inner body of the sponge to the tubercles, in a parallel and 0.5 cm spaced way. They are frequently branched and the flattened branches can anastomose. Scattered megascleres fill the interstices between the bundles. Sand and foreign bodies are incorporated.

Spicules.—Megascleres (Fig. 12)—Highly variable in size and shape anisostrongyles sometimes with a subtylote head 800–1,500 × 10–30 μm (1106.4 ± 119.4 × 18.5 ± 2.8 in average). Megasters (Fig. 12, 14)—Oxyspherasters, diffuse into the whole sponge, 30–80 μm (44.5 ± 6.8 in average) in diameter. R/C = 1–2 (1.4 ± 0.3 in average). Ray tips frequently rounded and ray base width half its lenght. Microsters (Fig. 12, 14)—Strongylasters to tylasters, D = 10–15 μm (12.3 ± 2.4 in average), with stout rays, thick at the base about half their length.

Etymology.—The name derives from the place of its discovery, Florida Keys.

Remarks.—*T. keyensis* is characterized by a conical erect shape and by the size of its megasters intermediate—as the shape—between those of *T. crypta* and *T. macrostella.* Moreover it is distinguished by *T. macrostella,* the more akin species, by the smaller microster size.

Tectitethya macrostella new species

Material.—USNM 34556 (holotype); USNM 34551, 34552, BA 834, 836 (paratypes); BA829, 833, 838, 841, 842, 1023 (several specimens). Collected by CSA by a triangular dredge from Gulf of Mexico, south western Florida coast. USNM 34550, 34551, 34552, BA 834, 836 Stat. 7–32.5 m, 25°45′53″N and 82°31′37″W, 19.7.81; other specimens: different stations 17–52 m, 1980–83.

Shape and Size.—Irregularly massive and variable. The body may be formed by a single subspherical or cylindro-conical module or by a massive base on which two or more, until ten, subspherical, cylindro-conical or irregular modules (lobes) more or less distinct are developed (Fig. 3E). The holotype is formed by about seven lobes, more or less distinct, with a massive 10 × 8 cm body, 5 cm high. At the top of the single modules or lobes there are oscules, about 3 mm in diameter in the fixed material. The body shape varies also in relation to to its major growth in width or height. Single-module sponges range (width by height) from 4 × 3, 6 × 4.5 or 9 × 6 cm to 6.5 × 6.5 cm to 2.5 × 4, 4.5 × 5.5, 7 × 8 or even 4 × 7, 4 × 9 cm. Plurilobate sponges, more frequently with two or three lobes but also with five, nine or ten lobes, range from 6 × 3.5 (3 lobes), 10 × 7 (2 lobes), 10 × 3 (9 lobes) or 13 × 5 (10 lobes) to 4 × 5 (2 lobes), 6 × 8 (2 lobes), 5 × 9 (2 lobes), 4 × 8 cm (3 lobes).

Color.—(in ethanol). Black or black brownish.

Consistency.—Firm, fleshy, somewhat compressible.

Surface.—Entirely covered by flattened and hispid tubercles, 2–5 mm in diameter, of polygonal or irregular shape, contiguous and delimitating narrow grooves. The surface, in the ethanol preserved specimens, appears clean, without sediment.

Aquiferous System.—Single oscules, visible in the preserved material, are placed at the top the body or, if the body is plurilobate, at the top of each lobe. Ostia are placed into the grooves building cribles which communicate with a system of small lacunes. The whole sponge is pierced by channels and lacunes of small size. Foreign bodies, likely organic detritus 20–50 μm in diameter, are incorporated by giant amoebocytes which are scattered into the whole sponge but more densely around the channels, the lacunes, the sponge surface and the megasclere bundles. In addition to the giant amoebocytes, 20–60 μm in diameter, another characteristic cell type is represented by very numerous small pigmented granulocytes.

Cortex.—Ill defined, macroscopically indistinct. Histologically, the cortical tissue appears developed in the tubercles and, penetrating into the choanosome, around the megasclere bundles. On the other hand the choanosome reaches the sponge surface at the level of the grooves.

Skeleton.—Formed by ascending megasclere bundles which run from the sponge base to the tubercles parallely, about 0.5 cm spaced, with a somewhat flexuous course. These main fibers irregularly ramify in partially flattened branches which anastomose with those of the other fibers, building on the whole a dendritic-reticulated skeleton. In the interstices of this network there is a confuse pattern of scattered megascleres. The megasters and microasters are abundant in the whole sponge, the microasters preferentially placed on the sponge surface and around the lacunes and the channels.

Spicules.—Megascleres (Fig. 13)—Mainly anisostrongyles sometymes with a subtylote head, often with anomalies. Variable in size: 500–1,900 × 5–50 μm (1223 ± 117.5 × 38.4 ± 2.1 in average). Megasters (Fig. 13, 14)—Oxyspherasters of regular shape with small centrum, 20–100 μm (65.3 ± 5.8 in average) in diameter; R/C = 2–3 (2.6 ± 0.5 in average). The rays are sometimes forked or a little bent: lenght, thickness and number of the rays are variable. The ray base thickness is about one fourth of the ray length. Microasters (Fig. 13, 14)—Strongylasters, tylote strongylasters or tylasters with stout rays. D = 10–16 μm (15.1 ± 3.4 in average). The ray number is variable, sometimes reduced to 4 (cruciform). The ray base thickness is about one third of the ray lenght.

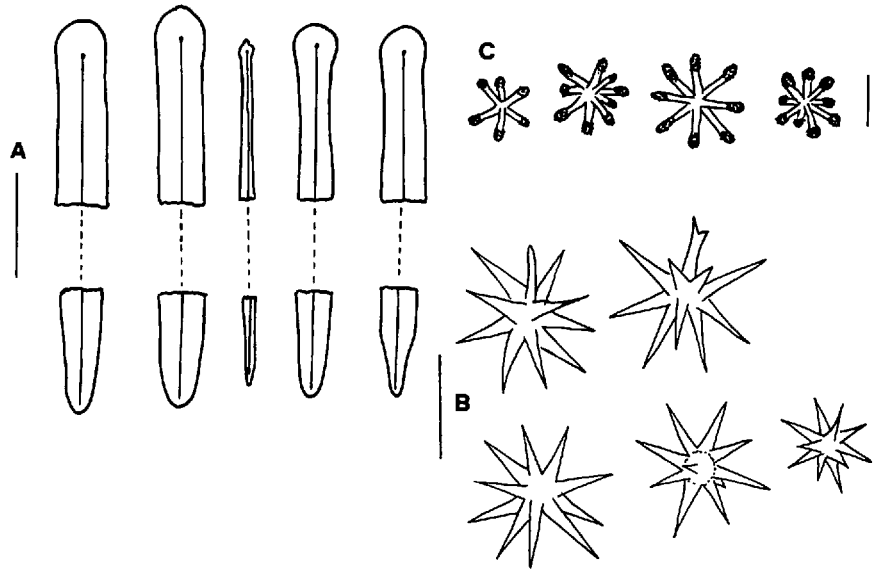

Figure 13. *Tectitethya macrostella:* A, anisostrongyles; B, megasters; C, microasters. Bars: A, 50 μm; B, 50 μm; C, 10 μm.

Etymology.—For the size of its megasters, considerably larger than in the other *Tectitethya.*

Remarks.—*T. macrostella* is characterized by an irregularly massive, lobate shape, the larger size slender shape of its megasters. In addition to these traits it is distinguished by the akin *T. macrostella* for the larger microasters size.

Tectitethya raphyroides new species

Material.—BMNH 1939.2.14.37 (holotype), collected by the Oxford University Expedition at South Sound, sand shoal off Red Bay, Cayman Islands (south of Cuba), 17-6-38 at a depth of 1–2 m.

Description.—This specimen has been described as *Tethya raphyroides* by Burton in an unpublished manuscript with the following diagnosis: "sponge irregularly massive, surface papillose, papillae hispid, 2–5 mm in diameter; ectosome smooth between papillae; oscules not apparent; texture firm, fleshy; colour in spirit blackish brown. Skeleton of irregularly arranged styles, becoming arranged in radial bundles in subcortical region and ending in penicillate brushes in surface papillae. Both choanosome and cortex abundantly filled with large pigment cells and medium sized foreign bodies. Megascleres strongyloxeas 1.0 to 1.6 by 0.02 to 0.024 mm, often malformed and distorted. Microscleres: spherasters with rounded rays, sparsely scattered in cortex and choanosome 0.02 mm in diameter and strongylasters with 6 to 10 rays usually roughened, often tylote 0.07 to 0.12 mm in diameter."

We can add some other observations: the specimen is big, roughly pyramidal, 14 cm long by 8 cm wide and 9 cm high. The flattened tubercles reach 5 mm in diameter and 1 mm in height. The upper surface is lobate. The cortex is thin and irregularly developed: following the megasclere bundles it penetrates into the choanosome. The megascleres (500–1,300 × 5–25 μm; 865.4 ± 77.6 × 12.8 ± 2.4 in average) (Fig. 15) are frequently anisostrongyles often with anomalies as distal rings. The megasters (Figs. 15, 16) measure only 10–30 μm (14.7 ± 4.2 in average) in diameter, and are characterized by a large shape variability. Generally

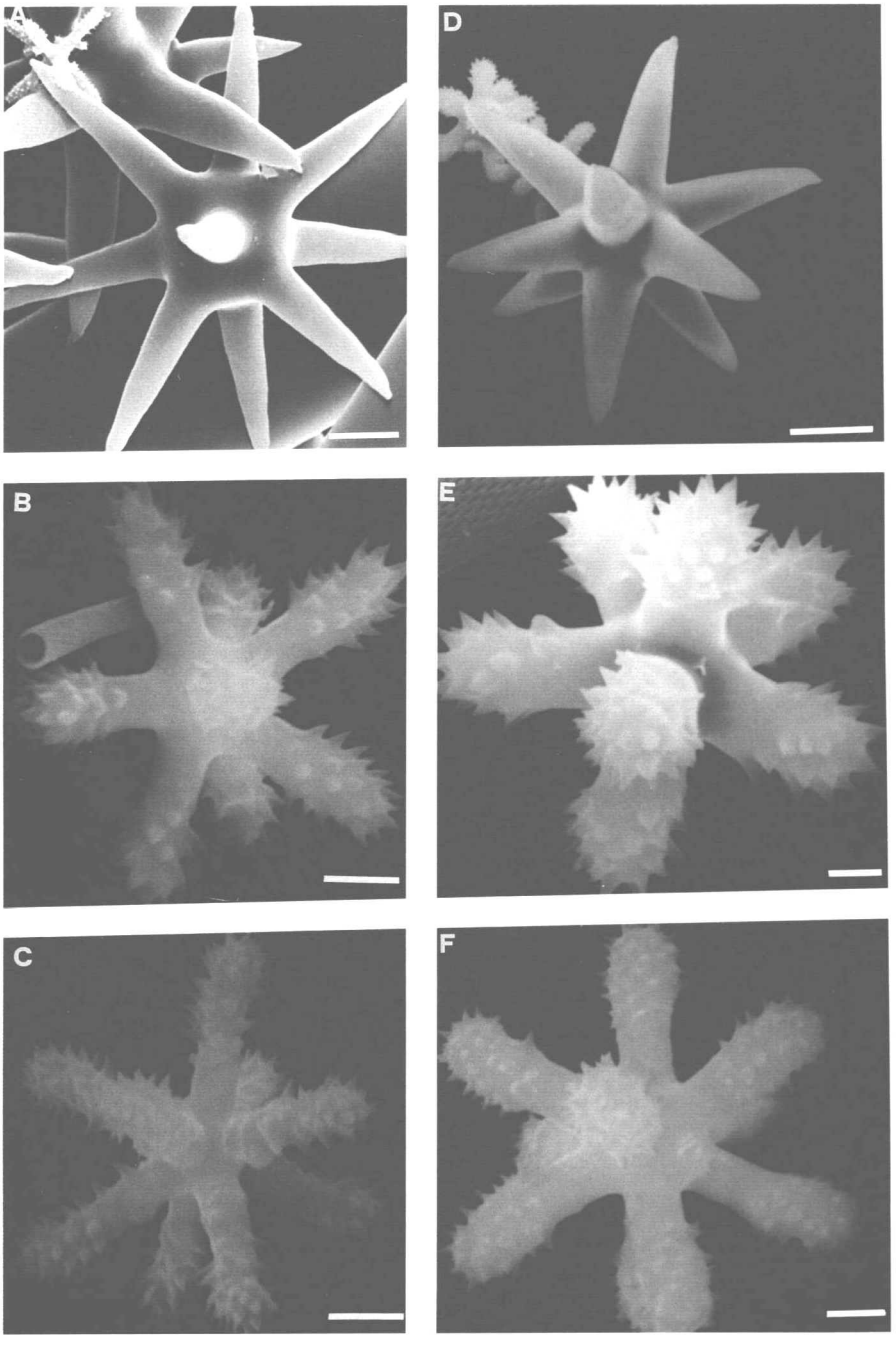

Figure 14. SEM micrographs: *Tectitethya macrostella* A, megasters; B–C, micrasters; *T. keyensis* D, megasters; E–F, micrasters Bars: A, D, 10 μm; B, C, E, F, 2 μm.

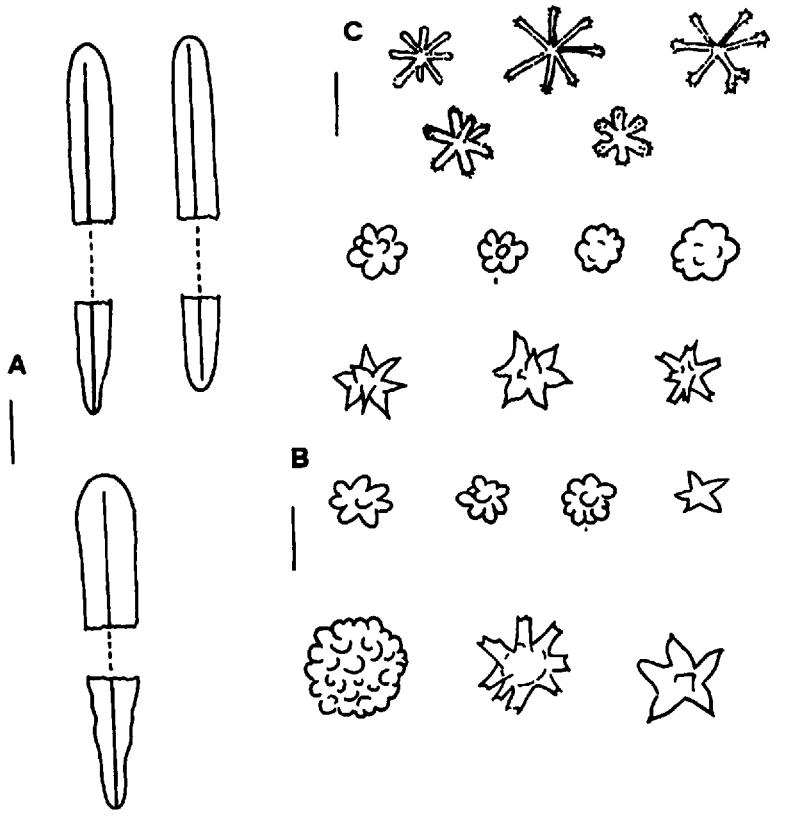

Figure 15. *Tectitethya raphyroides:* A, anisostrongyles; B, megasters; C, micrasters. Bars: A, 20 μm; B, 20 μm; C, 10 μm.

they have rounded rays, sometimes globular: the megaster may be transformed into a sphere covered by rounded and low outgrowths. However it is possible to find some normal spherasters or also forked spherasters similar to those of *T. crypta.* The micrasters (Figs. 15, 16) are strongylasters with blunt spined tips and slender rays, without centrum. They measure 8–16 μm (10.5 ± 2.7 in average). In this specimen as in the other *Tectitethya* foreign bodies are englobed in giant amoebocytes and a special category of small pigmented granulocytes also occurs.

Etymology.—The name derives from Burton's unpublished description.

Remarks.—T. raphyroides is distinguished by the reduced size and anomalous shape of its megasters. From *T. crypta,* the more akin species, it differs also for the larger size of its tubercles.

Discussion

A recent rearrangement of the Tethyidae (Sarà, 1994) has led to a cladistic analysis of the phylogenesis of this family (Sarà and Burlando, 1994). According to this analysis a clade formed by the West-Indies genera *Columnitis* and *Tectitethya* has been singled out. This is confirmed by the study of the new material and description of the new species. *Columnitis* and *Tectitethya* share the massive irregular shape and large size, the frequent transformation of the strongyloxeas in anisostrongyles or

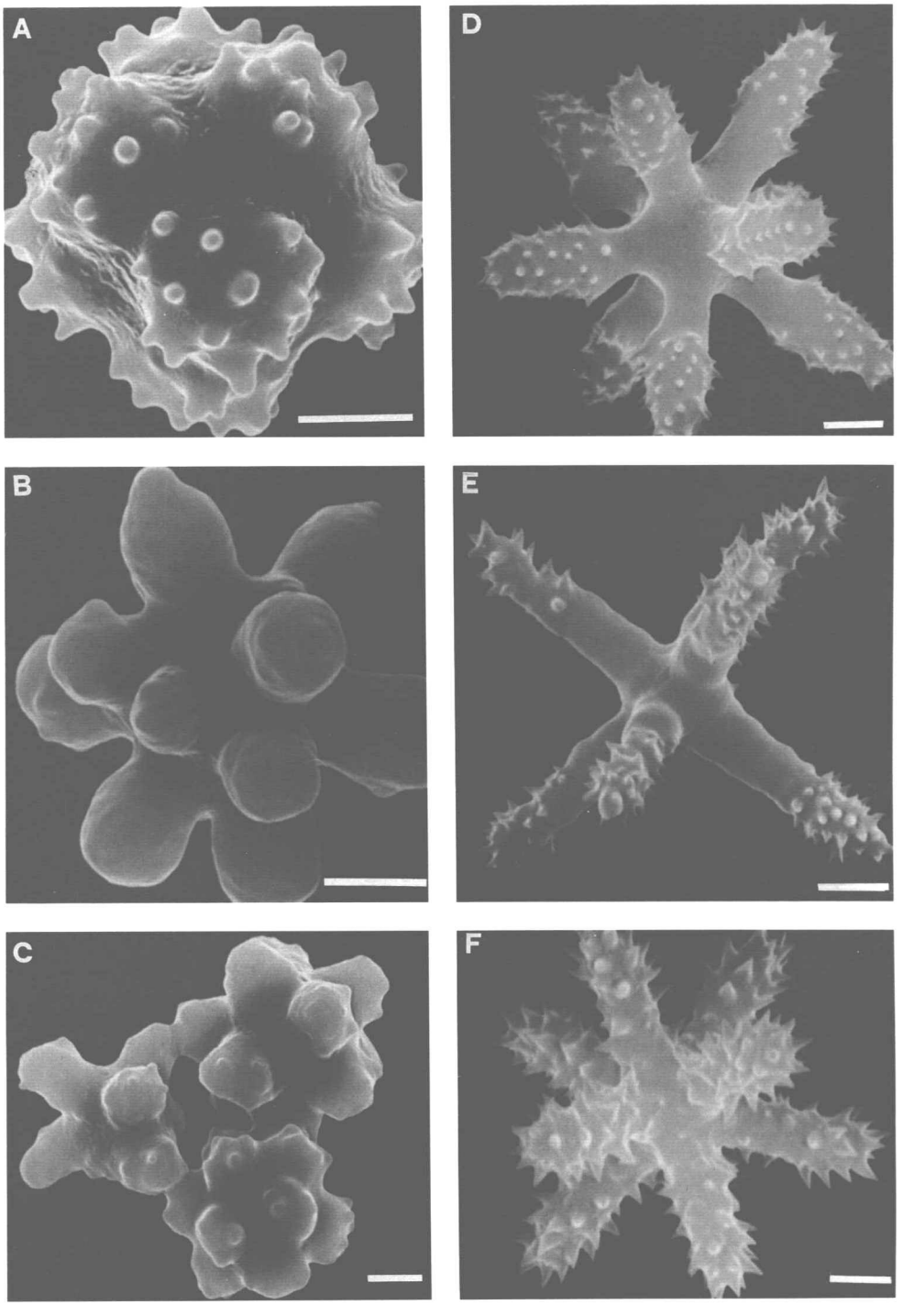

Figure 16. *Tectitethya raphyroides,* SEM micrographs A–C, megasters; D–F, micrasters. Bars: A–C, 5 μm; C–F, 2 μm.

subtylostyles, the oxyspheraster shape of its megasters, the lack of a defined cortex and the incorporation of sand. However, the new data single out the differences between *Columnitis* and *Tectitethya* in body structure and skeletal architecture and show the existence in *Columnitis* of two distinct categories of microasters.

The new genus *Nucleotethya* seems close to the group *Columnites-Tectitethya,* as indicated by its irregular shape, even if more similar to that of *Tethya,* its indistinct cortex, the skeleton structure in which, as in *Columnitis,* basal rows of thinner megascleres cross transversally the main vertical bundles and the incorporation of sand. However, important distinctive traits separate *Nucleotethya* from the two other genera: the remarkable existence of a large nucleus with a peculiar skeletal structure, the subtylostyle type of the megascleres, the giant size and spheraster shape of the megasters. The indopacific genera *Xenospongia* and *Stellitethya* can be added to the same clade. It is one among the three main clades in which the family Tethyidae can be split (Sarà and Burlando, 1994) and includes massive or incrusting species adapted to tropical shallow waters and generally incorporating sand. It is represented by different genera in the West-Indies and Indopacific areas. The other two clades are the *Tethya* clade, represented only by this specious rich cosmopolitan and eurytopic genus and the deep water stalked Tethyidae, with *Halicometes, Tethycordyla* and *Tethycometes.*

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LITERATURE CITED

Bergquist, P. R. and M. Kelly-Borges. 1991. An evaluation of the genus *Tethya* (Porifera: Demospongiae: Hadromerida) with description of new species from the Southwest Pacific. Beagle 8: 37–72.

Dendy, A. 1905. Report on the sponges collected by Professor Herdman in Ceylon in 1902. Rep. Pearl Oyster Fisheries Roy. Soc. London III: 57–246.

de Laubenfels, M. W. 1949. Sponges of the western Bahamas. Amer. Mus. Nov. 1431: 1–25.

Reiswig, H. M. 1971. In situ pumping activities of tropical Demospongiae. Mar. Biol. 9: 38–50.

Sarà, M. 1987. A study of the genus *Tethya* (Porifera, Demospongiae) and new perspectives in sponge systematics. Page 205–226 *in* Vacelet, J. and N. Boury-Esnault, eds. Taxonomy of Porifera: Springer-Verlag, Berlin, Heidelberg.

———. 1994. A rearrangement of the family Tethyidae (Porifera Hadromerida) with establishment of new genera and description of two new species. Zool. J. Linn. Soc. 110: 355–371.

——— and B. Burlando. 1994. Phylogenetic reconstruction and evolutionary hypotheses in the family Tethyidae (Demospongiae). Page 111–116 *in* van Soest, R. W. M., Th. M. G. van Kempen and J. C. Braekman, eds. Sponge in time and space Balkema, Rotterdam. 515 p.

Schmidt, O. 1870. Grundzuge einer Spongen-Fauna des Atlantischen Gebietes. Engelmann, Leipzig.

Storr, J. F. 1964. Ecology of the Gulf of Mexico commercial sponges and its relations with the fishery. U.S. Fish Wildl. Serv., Spec. Sci. Rept. Fish. 466: 1–73.

Tabb, D. and R. B. Manning. 1961. A checklist of the flora and fauna of the Northern Florida Bay and adjacent brackish waters of the Florida mainland collected during the period July 1957 through September 1960. Bull. Mari. Sci. Gulf. Caribb. 11: 552–649.

Wiedenmayer, F. 1977. Shallow-water sponges of the western Bahamas. Experientia Suppl. 28: 1–287. Birkhauser Verlag, Basel Stuttgart.

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