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GUIDE TO WESTERN ATLANTIC SPECIES OF *CINACHYRELLA* (PORIFERA: TETILLIDAE)

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Abstract.—Only a few spicular characters are useful in the determination of *Cinachyrella* (=*Cinachyra* of authors) species once the specimens are preserved. Based on these we recognize four species of this genus in the tropical and subtropical western Atlantic Ocean. *C. alloclada* and *C. kuekenthali* possess two or more size classes of oxeas but only one size class of tetractines, and both lack special accessory spicules. *C. kuekenthali* can be distinguished because the smallest size oxeas are roughened or crenulate. *C. apion* and *C. arenosa* have only one category of oxeote megascleres, but also have rhaphids for microscleres, often organized in trichodragmas; *C. apion* possesses protriaenes in a second, smaller size class, whereas *C. arenosa* adds plagiotriaenes and calthrops to the typical spicule complement. Characteristic specimens, spicules, and special features are illustrated.

The United States continental shelf survey conducted by the Mineral Management Service (Department of Interior) during the early 1980s produced several hundred of the characteristic ball-shaped sponges that are easily classified as belonging to the genus *Cinachyrella* of the family Tetillidae. The necessity of allocating this material to *Cinachyrella* rather than habitually to *Cinachyra* was recently discussed by Rützler (1987) who also reconsidered the status of other genera known in this family. Comparing the newly available large collection with published species descriptions we found that taxonomic revision of the *Cinachyrella* group was needed to provide a practical and reliable manual for non-specialists in need to identify similar material.

Two main difficulties face the identifier of *Cinachyrella,* in fact of most tetillid sponges, particularly preserved ones in small samples: great variation in external characters and spiculation with different habitat conditions and fixation methods; and extreme size range of spicules—from a few micrometers in microscleres to several millimeters in megascleres—which can lead to observation error by loss during standard preparation methods. Also, some spicule types can truly be rare or absent in some specimens and misleading malformations of megascleres occur commonly. Although this paper will not be the cure for all problems associated with identification of these sponges, it can help avoid common mistakes and serve as a practical guide.

Most species of *Cinachyrella* likely to be encountered in the western Atlantic were described by Uliczka (1929), but his paper is confusing because of several inconsistencies between descriptions and illustrations. No one since Uliczka has attempted to reexamine the type material which was thought lost during events of World War II. Luckily, in 1986 most specimens were located in the collection of the Zoological Museum at the Humbold University in Berlin and could be restudied by us. Only one species, *C. kuekenthali,* was not represented, but because it is the most characteristic and best described its validity was never doubted. The following account of recognized *Cinachyrella* species will include reference to the type specimens examined by us.

Material and Methods

Material studied included types borrowed from the Zoological Museum Berlin (ZMB); sponges obtained by the Mineral Management Service (MMS) Continental Shelf Survey off the coasts of South Carolina, Georgia, and southwestern Florida (Gulf of Mexico); and specimens collected by the authors and collaborators in localities ranging from Bermuda throughout the West Indies to Brazil. Observations on live sponges relating to current flow and morphological changes during handling and preservation were made at the National Museum of Natural History's field station on Carrie Bow Cay, Belize.

Ground and polished histological sections were made of formalin-seawater fixed, non-desilicified samples embedded in epoxy resin and spicules were isolated by ashing in boiling nitric acid (for methods refer to Rützler 1978). The great size range of spicules required separate mounts of the very large and the very small ones in order not to miss some types of megascleres and to be able to use high-power objectives to study microscleres. Separation was done in the last alcohol rinse of boiled and washed spicules by gently shaking the test tube and separating its content into a light and a heavy fraction by allowing long (1 h) and short (1 min) sedimentation times. Preparations were made from different regions of a sponge if the resulting spicule complement appeared incomplete.

For spicule dimensions (Table 1), all maximum total lengths were recorded; width measurements were made at the widest point in the case of monaxons (approximately at midlength), and just below the cladomes for tetraxons. Some protriaenes required a second width measurement because they were wider further down the shaft than just below the cladomes. Clad length was measured from the tip to the center point of origin. Only maximum dimension, not thickness, was measured for sigmaspires. Special features and common spicule malformations are shown in previously published photomicrographs (Rützler 1987:figs. 2–5).

Systematic Descriptions

Family Tetillidae Sollas

Tetractinomorph sponges, massive and often globular in shape, with radial skeleton structure, with monaxons, protriaenes, and anatriaenes for principal megascleres, with spinispire-type microscleres, and, in some genera, with unusual accessory spicules.

Genus *Cinachyrella* Wilson, 1925

Globular Tetillidae with porocalices (poriferous pits), without cortex, and without unusual accessory spicules.

Remarks.—*Cinachyra* Sollas was used by previous authors to accommodate the species described below. This genus, however, should remain reserved for species with specialized spicule-reinforced cortex, such as its type, *C. barbata* Sollas (Rützler 1987: 191).

Some accessory spicules, such as plagiotriaenes and calthrops (see the description of *Cinachyrella arenosa* below), are here not considered unusual enough to warrant a different generic placement.

Cinachyrella alloclada (Uliczka, 1929)
Figs. 1–3

Cinachyra alloclada Uliczka, 1929:41, text-figs. 11–15, pl. I, figs. 2, 3; Wiedenmayer, 1977:183, text-fig. 176, pl. 41, figs. 1, 2; van Soest & Sass, 1981:340–341.

Trachygellius cinachyra de Laubenfels, 1936:158, pl. 18, fig. 1.

Cinachyrella alloclada: Rützler, 1987:200, figs. 1d, f; 2a–d; 3a; 5a, b.

Diagnosis.—Orange to yellow reef sponges; globular, up to 100 mm in diameter, with small (3 mm) or large (15 mm) porocalices; with smooth oxeas in two or three size classes, tetractines (pro- and anatriaenes) of only one size, and with sigmaspires of considerable size range (10–23 μm).

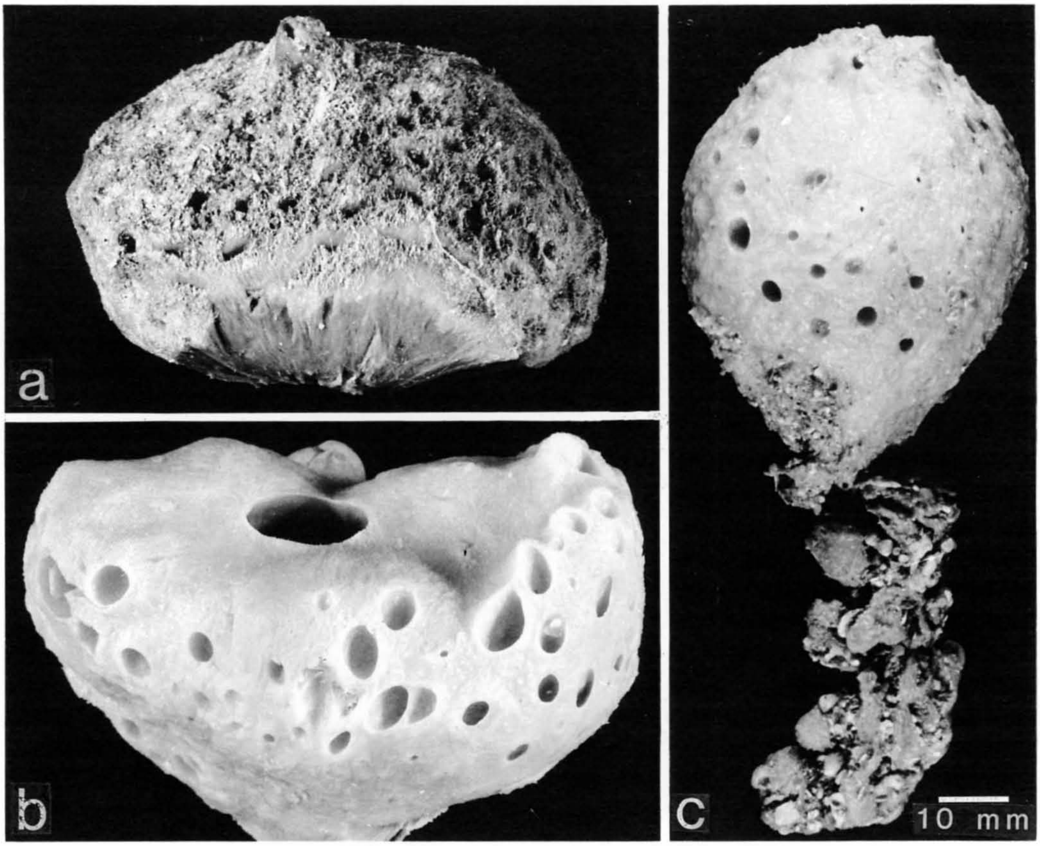

Fig. 1. *Cinachyrella alloclada,* morphology of alcohol preserved specimens: a, High-energy rock pavement, Bimini (Bahamas), 3 m; b, Secondary hard bottom, southwest Florida, 31 m depth; c, Secondary hard bottom, southwest Florida, 56 m. (Scale applies to a–c.)

Color.—Bright orange or yellow in life, except where surface is obscured by sediment; paler colored interior. Preserved specimens turn tan or gray in alcohol.

Shape, size, and consistency (Fig. 1).—Basically globular. Hemispherical specimens occur in high-energy environments, pear-shaped sponges may be the result of calm-water habitats with high sedimentation rate. Large (over 80 mm), old specimens can attain massive cake shape with broad attachment area. Commonly, specimens are 60 mm in diameter and 40 mm in height but some reach 100 × 70 mm. The hispid surface is pitted by numerous porocalices, circular or oval, ranging in some specimens 1–6 mm in diameter and 3–8 mm in depth, in others 5–20 × 3–20 mm. Oscula are few (three to five), ca. 5 mm in diameter and often slightly raised above the sponge surface; they are always contracted in fixed specimens. Consistency of the sponge is very firm.

Spicules (Fig. 2, Table 1).—Smooth oxeas can usually be discerned in three size categories averaging 3500 μm, 1800 μm, and 355 μm in length; one of the smaller classes may be absent in some samples. Many of the large oxeas show malformations, such as a sharp kink near one end, 70–1000 μm (average 260 μm) from the point; other tip modifications result in styloid, substyloid, and anisostrongylote forms. Protriaenes (some modified to prodiaenes) and ana-

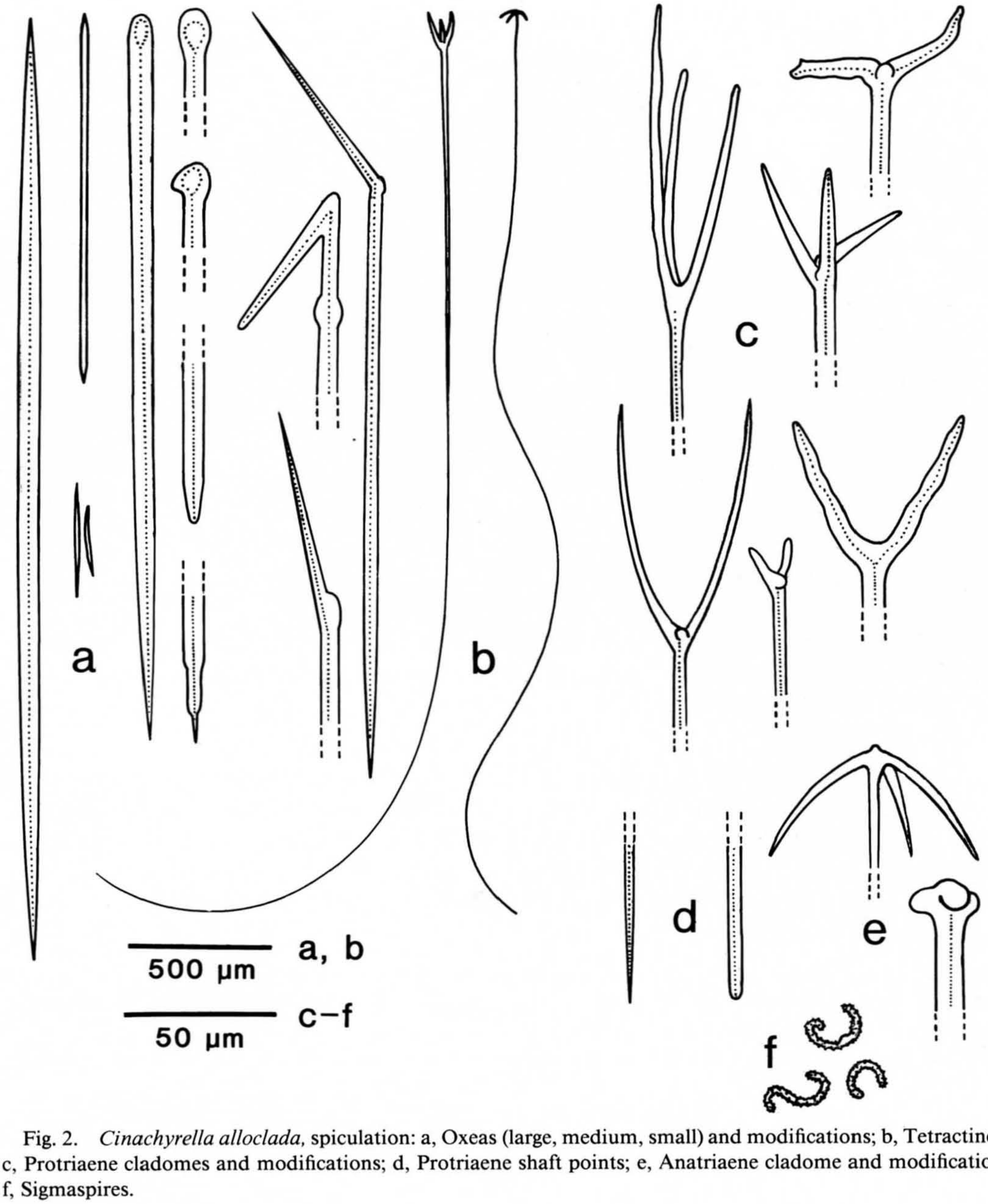

Fig. 2. *Cinachyrella alloclada,* spiculation: a, Oxeas (large, medium, small) and modifications; b, Tetractines; c, Protriaene cladomes and modifications; d, Protriaene shaft points; e, Anatriaene cladome and modification; f, Sigmaspires.

triaenes occur in only one size, similar in length to the largest oxeas but with considerably thinner shafts. Protriaenes are the most common tetractines in most specimens but in a few they are almost entirely replaced by anatriaenes. Variations include prodiaenes (one of the three clads reduced) which can make up almost half the complement of this spicule type, rhabds with rounded points or with thickest diameter at midlength rather than next to the cladome, and clads that are crooked, diverging in an unusually wide angle (as much as 120°), or reduced to knobs. Anatriaenes in some

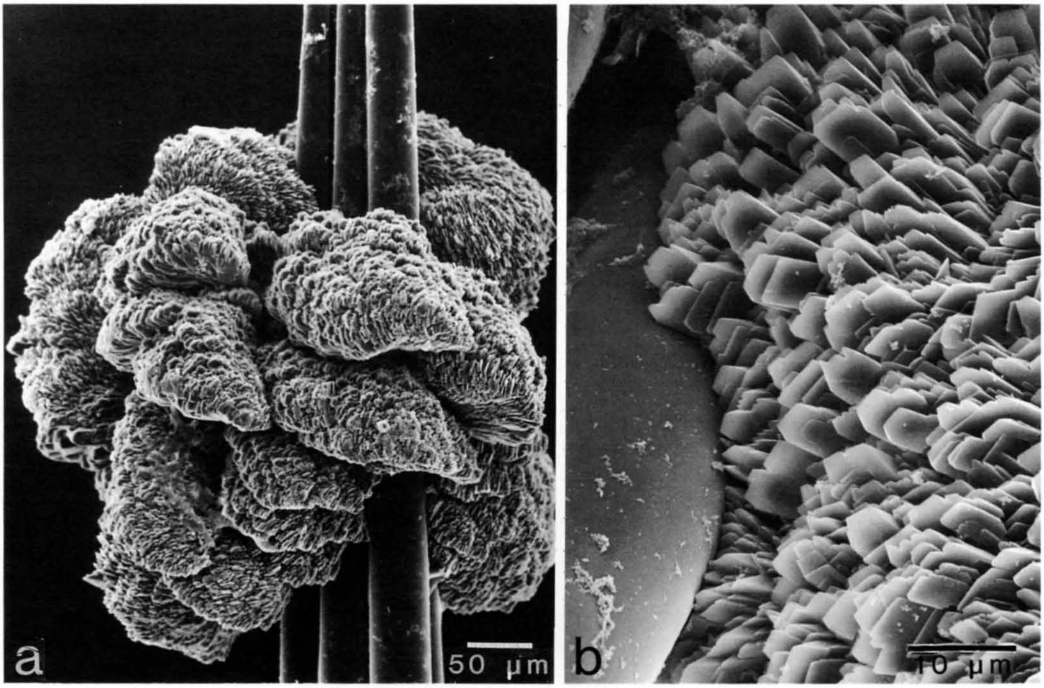

Fig. 3. *Cinachyrella alloclada,* calcareous precipitates: a, Granule enveloping bundle of large oxeas; b, Crystalline granule structure contrasted by smooth siliceous spicule surface.

specimens can be very rare or missing entirely, in others they outnumber the protriaene forms; the clads are usually thin and delicate, but in some material they are stubby, or reduced to mere knobs. Sigmaspires measure 14.3 μm on average and are c- or s-shaped, twisted into third dimension; they are microspined and at times with centrotylote swelling.

Microscopical anatomy.—The basic

Table 1.—Ranges (length, or length × width) and means (*italics*) of spicule dimensions (in μm) of four western Atlantic *Cinachyrella* species. Lengths are overall measurements, widths were measured at the widest part for monaxons, at base of cladomes for tetraxon rhabds. (NP = not present.)

Species	Number of specimens analyzed	Oxeas 1	Oxeas 2	Oxeas 3	Protriaenes, -diaenes 1 Rhabds	Protriaenes, -diaenes 1 Clads	Plagiotriaenes Rhabds
C. alloclada	29	1500–5900 *3500 × 50* 20–65	900–2800 *1800 × 13* 1–20	100–950 *355 × 5.4* 2.5–8.0	2400–6500 *4200 × 10.7* 4–20	14–250 *127*	NP
C. kuekenthali	13	2500–4100 *3200 × 35* 14–40	1300–2700 *2200 × 8* 3–10	70–200 *135 × 2.9* 2–4	400–4600 *3800 × 11.3* 5–18	20–130 *50*	NP
C. apion	16	3500–4600 *4100 × 41* 35–45	NP	NP	1800–8000 *3500 × 8.3* 4–10	25–230 *115*	NP
C. arenosa	19	2900–5500 *3900 × 48* 35–60	NP	NP	1900–4400 *2900 × 10.9* 5–26	40–200 *110*	620–2000 *1650 × 17* 12–20

structure of these sponges is revealed by sections perpendicular to the surface. Oxeas and styloids occur in staggered bundles radiating toward and beyond the ectosome, in places alternating with tetractines, cladomes facing outward; styles seem always positioned with the rounded end directed toward the surface; sigmaspires are scattered throughout the tissue. The ectosome is 0.5–1.0 mm thick and separated from the choanosome by water-carrying spaces. Spherical choanocyte chambers measure 30 μm in diameter. Large (20 μm), microgranular, strongly safranin-O staining cells are common and particularly concentrated in the outer ectosome and in clusters among the choanocyte chambers. There are also conspicuous, rounded, brownish bodies, 150–300 μm in diameter, detectable only in samples not treated by acid. These features were observed by us in a number of specimens but were studied particularly in specimens USNM 30347 from Bimini and USNM 42441 from southwestern Florida. These structures are crystalline, show double refraction in polarized light, dissolve in acid, and are therefore presumed to be of calcareous substance. Embedded spicules indicate that they were formed inside, perhaps even secreted by the sponges (Fig. 3).

Distribution and ecology.—Specimens are found as far north as Cape Hatteras, North Carolina, off South Carolina, in the northern Bahamas, in the Florida Keys including the Dry Tortugas, and off the west coast of southern Florida. These sponges occur in coral habitats and on rock pavements or secondary hard bottoms between 3 m and 80 m.

Redescription of holotype.—ZMB 4921 from the Dry Tortugas, Florida, is semiglobular (apparently torn from hard substrate), 60 mm in length, 50 mm in width, 30 mm in height and of very firm consistency. The surface is bristly. The porocalices are primarily located along sides, 1–2 mm (1.5 mm average) in diameter, mostly in fairly close distance (2–5 mm) from each other. Three oscular mounds (oscula contracted) are on top of the specimen and are 5 mm high. Spicule preparations (from tissue near two existing cuts in the specimen and from the damaged attachment area) revealed paucity of all tetractines, particularly anatriaenes. Description and figures agree well with those of the original author (Uliczka 1929).

Other material studied.—USNM 32664, off North Carolina, 100 m; USNM 30472, off South Carolina, 18 m; USNM 41937, off Southwest Florida, 17 m; USNM 42441, off Southwest Florida, 58.5 m; USNM 22433 (holotype of *Trachygellius cinachyra* de Laubenfels), Dry Tortugas, Florida, 70 m;

Table 1.—Extended.

Plagiotriaenes		Protriaenes, -diaenes 2		Anatriaenes			
Clads	Calthrop rays	Rhabds	Clads	Rhabds	Clads	Raphides	Sigmaspires
NP	NP	NP	NP	2200–4000 *3200 × 8.3* 3–14	13–130 *77*	NP	10–23 *14.3*
NP	NP	NP	NP	1900–6000 *3700 × 6.3* 3–10	20–60 *39*	NP	12–24 *16.3*
NP	NP	400–1800 *1350 × 2.3* 1–4	8–90 *28*	1800–3500 *2900 × 4.6* 3–5	25–60 *40*	200–270 *244 × <1*	12–16 *13.4*
230–550 *265*	160–260 *204 × 23* 18–30	NP	NP	900–5300 *2600 × 8.5* 5–18	10–100 *60*	100–250 *220 × <1*	5–20 *12.8*

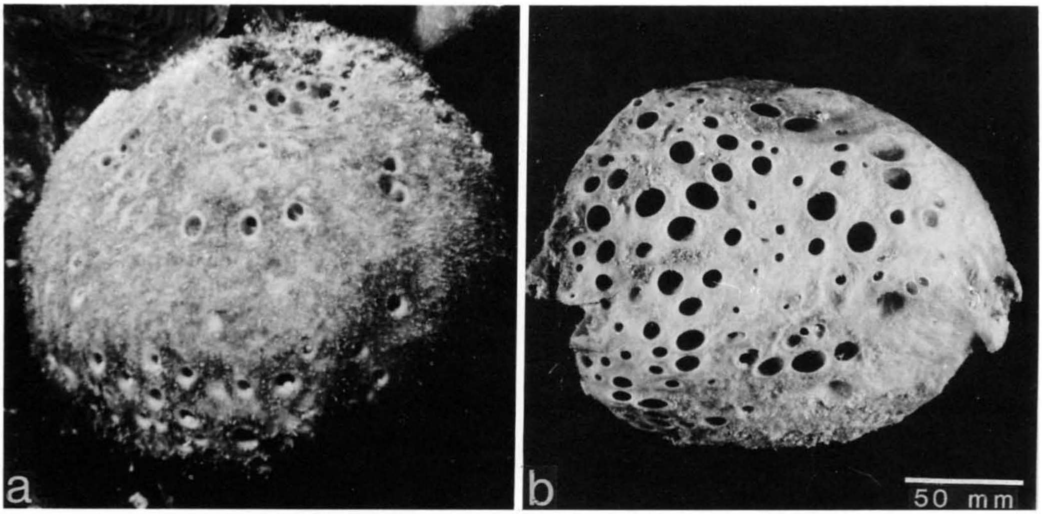

Fig. 4. *Cinachyrella kuekenthali*, morphology: a, Live in situ, patch reef near Carrie Bow Cay, Belize, 4 m; b, Alcohol preserved after initial freezing, off Pará River, Brazil, 68 m. (Scale applies to a, b.)

USNM 30347, Bimini, Bahamas, 7.5–9 m; and 23 uncataloged specimens from the MMS Continental Shelf Survey.

Remarks.—*Trachygellius cinachyra* de Laubenfels (1936:158) is a member of this species; the diagnosis by the original author was flawed by poor preparation technique. On the other hand, *C. alloclada* described from Bermuda (Rützler 1986:126; also, *C. cavernosa* sensu de Laubenfels 1950) must be reexamined; all specimens available to us from that location belong to *C. apion*.

Cinachyrella kuekenthali (Uliczka, 1929)
Figs. 4, 5

Cinachyra kuekenthali Uliczka, 1929:43, text-figs. 16–21, pl. I, fig. 4; Wiedenmayer, 1977:185, text-fig. 177, pl. 41, figs. 3, 4; van Soest & Sass, 1981:340–341; van Soest & Stentoft, 1988:42, fig. 19.

Cinachyra schistospiculosa Uliczka, 1929: 45, text-figs. 27–30, pl. I, fig. 6.

Cinachyrella kuekenthali: Rützler, 1987: 200, figs. 2f, 5c.

Diagnosis.—Orange to brownish orange reef sponges; subspherical, reaching 200 mm in diameter, with small (5 mm) porocalices; with three size classes of oxeas, the smallest one crenulate; with one size class of tetractines (pro- and anatriaenes); and with large sigmaspires (16.3 μm average).

Color.—The surface color of the live sponge is orange or yellow orange, the interior is rich yellow. Brown-appearing specimens are coated by a film of filamentous algae or cyanobacteria, such as *Schizotrix mexicana*. Specimens preserved in alcohol appear gray or light tan.

Shape, size, and consistency (Fig. 4).—Subspherical, globular, or erect egg-shaped. Specimens of 150–200 mm diameter are common, placing this among the largest species of the genus. Characteristically, these sponges have a more or less pronounced depression on top in which porocalices are high in density. The surface is moderately hispid. Porocalices are numerous, 1–5 mm in diameter, 5 mm deep; only in some deep-water forms (below 30 m) they were noted as big as 10 mm across. Oscula are comparatively few and clearly separate from porocalices, 1–5 mm in diameter in life, always contracted in preserved material forming wart-like structures. The consistency of these sponges is elastic but firm.

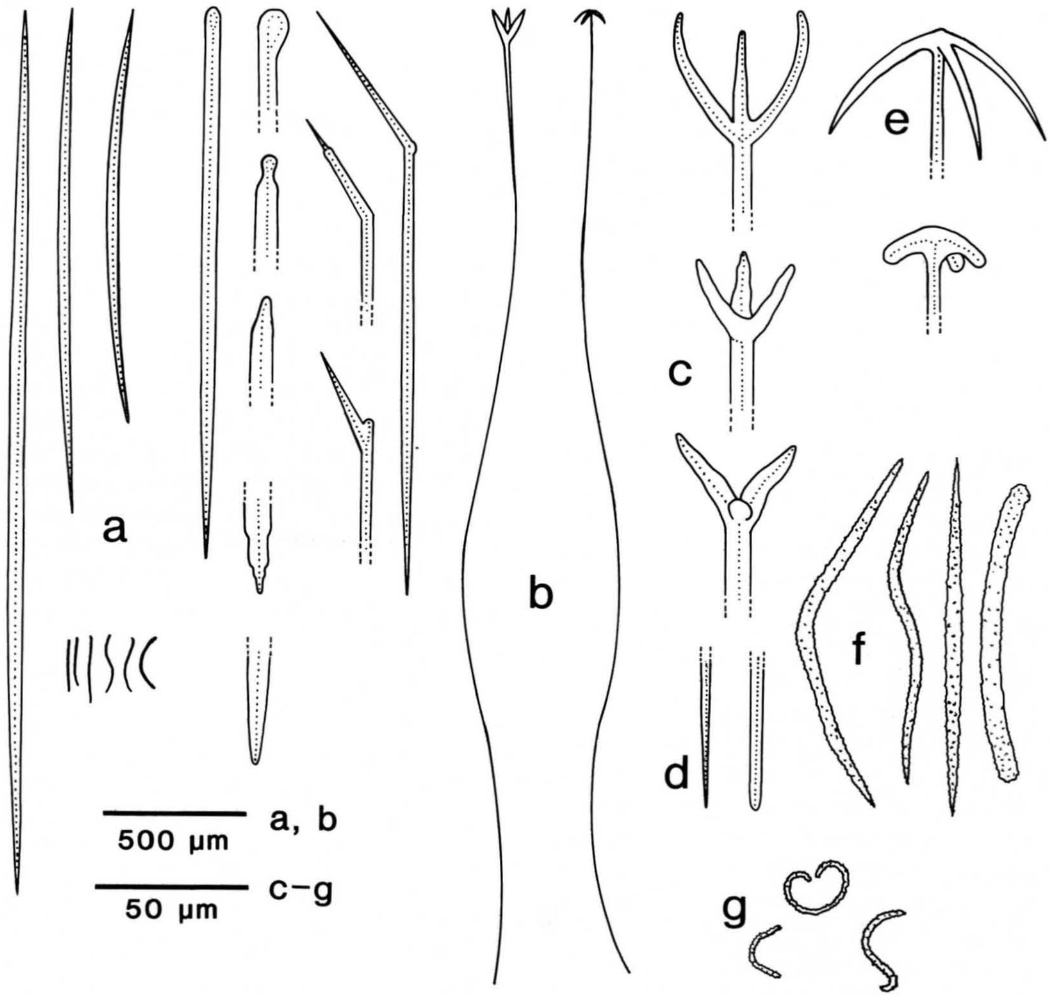

Fig. 5. *Cinachyrella kuekenthali,* spiculation: a, Oxeas (large, medium, small) and modifications; b, Tetractines; c, Protriaene cladomes and modifications; d, Protriaene shaft points; e, Anatriaene cladome and modification; f, Smallest (crenulate) category oxea enlarged; g, Sigmaspires.

Spicules (Fig. 5, Table 1).—Oxeas in three size categories, two smooth (3200 μm and 2200 μm in average length), the third and smallest one (135 μm long) microspined or crenulate (use high-resolution microscopy, possibly phase contrast, to ascertain this structure). Variations of the larger oxeas include kinked, styloid, and asymmetrically strongylote forms; the microxeas, commonly straight and fusiform, can display strongly center-bent, s-shaped, even strongylote forms. Protriaenes are very common and of one size class. They have short, stout clads, one of which may be reduced to a knob, or missing (prodiaene, numbering about half the population of protriaenes). Their rhabds may have rounded points or increase at midlength to greater diameter (15 μm) than at the cladome base (6.3 μm average). Anatriaenes are less common but not rare; they have very slender clads except for a few reduced, crippled forms. Sigmaspires are thin and large compared to the other species (over 16 μm), c- and s-shaped, and microspined.

Microscopical anatomy.—The histological structure is identical to that of the previous species except that the ectosomal region in these large sponges is about 2.5 mm thick and reinforced by conspicuous surface sediments and commonly covered by a layer of intertwined filamentous oscillatorians. No special calcareous grains were found in the choanosome.

Distribution and ecology.—Locations of material examined by us range from off North Carolina (34° northern latitude) throughout the West Indies to northeastern Brazil (1° northern latitude), including the Bahamas, southwestern Florida, Puerto Rico, Jamaica, Belize, and Colombia. These sponges are characteristic of medium-energy coral reef environments in 4–20 m depth but are also common on hard bottoms down to 100 m.

Holotype.—Uliczka's specimen from St. Thomas (Virgin Islands) was unavailable for examination and is presumed lost. We are therefore establishing specimen USNM 31491 as neotype. The alcohol-preserved sample constitutes about 20% of a 7 cm diameter subspherical sponge which was brilliant red orange in life. It shows numerous 1–2 mm porocalices as well as a few oscular openings. The characteristic small, crenulate oxeas measure 70–139 × 2–3 μm. It was collected by one of us (KR) on 29 March 1967 near the original type locality off St. John, Virgin Islands, in 16 m depth.

Other material studied.—USNM 33559, off North Carolina, 100 m; USNM 42521, off southwest Florida, 31.5 m; USNM 30348, Bimini, Bahamas, 20 m; USNM 30138, Puerto Higuera, Puerto Rico, 6–8 m; USNM 42431, Discovery Bay, Jamaica, 6–10 m; USNM 32323, Lighthouse Reef, Belize, 6–10 m; USNM 42433, Carrie Bow Cay, Belize, 4 m; USNM 31983, Colombia, 22 m; USNM 42427, off Amazon River, Brazil, 63 m; and 3 uncataloged specimens from the MMS Continental Shelf Survey.

Remarks.—Uliczka's (1929) description and figures leave no doubt about the validity of this species although he overlooked the microspination on the small size class of oxeas, a feature first pointed out by Wiedenmayer (1977). The latter author, in turn, did not find anatriaenes which are fairly common in our material. We examined the type specimen of *Cinachyra schistospiculosa* Uliczka (ZMB 4906) and found the characteristic microspined microxea, confirming our earlier suspicion that it is conspecific with *Cinachyrella kuekenthali* (van Soest & Sass 1981, Rützler 1987). The "split" oxeas reported by Uliczka (1929) are an artifact commonly observed in spicule mounts of these sponges, that is, two or three very thin hair-like spicules (raphids, broken rhabs of tetractines, etc.) of equal length are bundled together in the center, appearing like a homogenous monactin, but are slightly separated toward the ends.

Cinachyrella apion (Uliczka, 1929)
Figs. 6, 7

Cinachyra apion Uliczka, 1929:43, text-figs. 16–21, pl. I, fig. 4; van Soest & Sass, 1981: 340–341.

Cinachyra rhizophyta Uliczka, 1929:38, text-figs. 1–10, pl. I, fig. 1.

Cinachyra cavernosa (Lamarck) sensu de Laubenfels, 1950:128, text-fig. 56, pl. II, fig. 7.

Cinachyra subterranea van Soest & Sass, 1981:337–341, text-fig. 4, pl. II, fig. 2.

Cinachyrella apion: Rützler, 1987:200, figs. 2g; 3b–g; 4a, c; 5d, e.

Diagnosis.—Yellow or light gray calm-water lagoon sponges; globular, up to 100 mm in diameter, with small (3 mm) porocalices, often with surface buds; with one size class of oxeas and anatriaenes, two size classes of protriaenes, and with raphids and small (13 μm) sigmaspires.

Color.—Clear yellow or light gray in life, tan or gray in alcohol.

Shape, size, and consistency (Fig. 6).—Small (10–40 mm) specimens are spherical, larger ones (50–100 mm) are oval or lumpy

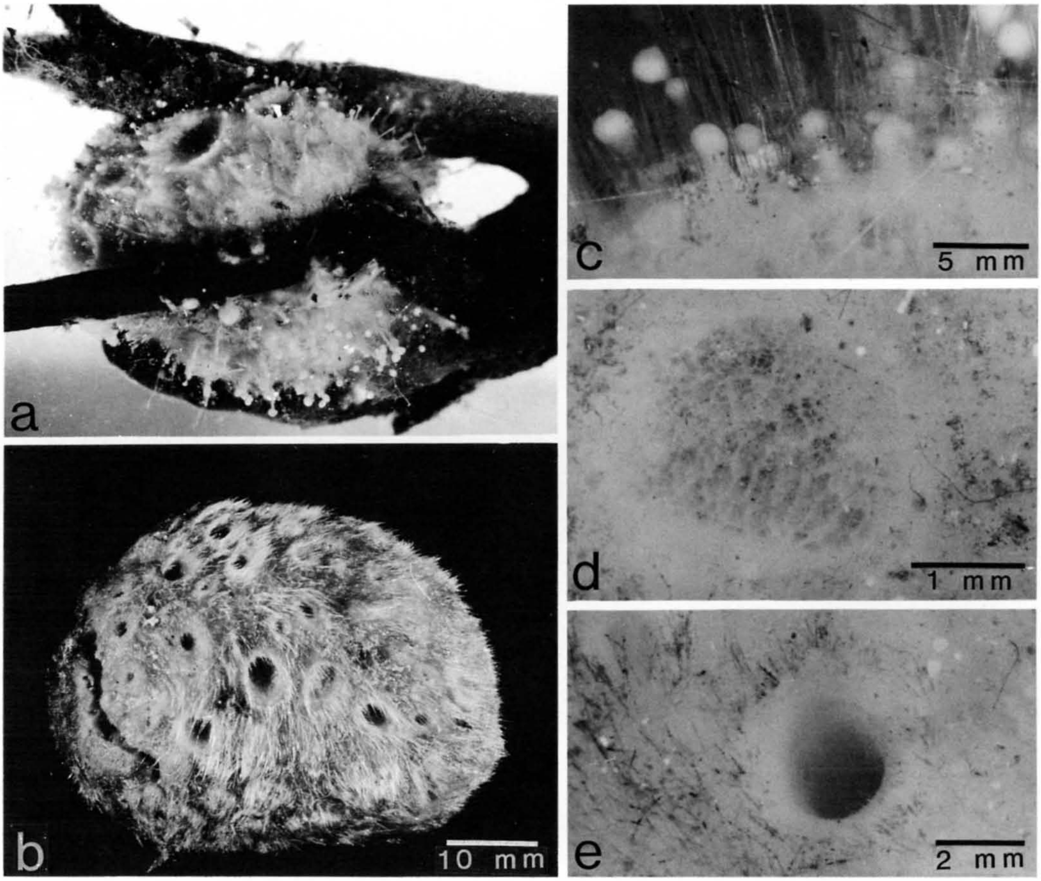

Fig. 6. *Cinachyrella apion,* morphology: a, Live specimen attached to alga *Avrainvillea,* Twin Cays mangrove pond, Belize, 0.3 m; b, Alcohol-preserved specimen, same location as a; c, Buds, close-up of specimen similar to a; d, Porocalyx, close-up of specimen similar to a; e, Osculum, close-up of specimen similar to a. (Scale in b also applies to a.)

massive; the latter may have derived from fusion of two or more adjacent specimens, possibly originating from liberated buds. The surface is strongly hispid, even furry from protruding hair-like spicules, and studded with 0.5–2 mm buds. Procalices are abundant but small, rarely exceeding 3 mm in diameter; they can be shallow (0.5 mm) or more than 3 mm deep. Oscula are rare, 2–3 mm in diameter, and flush with the sponge surface. The consistency of the sponges is soft and compressible.

Spicules (Fig. 7, Table 1).—Large oxeas occur in one size class and include common styles and few subtylostyles and strongyles. Protriaenes are of two size classes, the larger one almost as long as the oxeas, the smaller one less than half as long and less than one-third as thick. Large protriaenes can have strongly crippled clads and rhabds that are thickest at midlength (14–20 μm) rather than at the clad base and often end in rounded points; prodiaene forms make up almost half the number. Small protriaenes and prodiaenes occur in equal proportion. Anatriaenes have slender, curved rays, some end in rounded shaft tips. They are common in most specimens. Microscleres include raphids, some arranged in bundles (trichodragmata), and small (13.4 μm), thin sig-

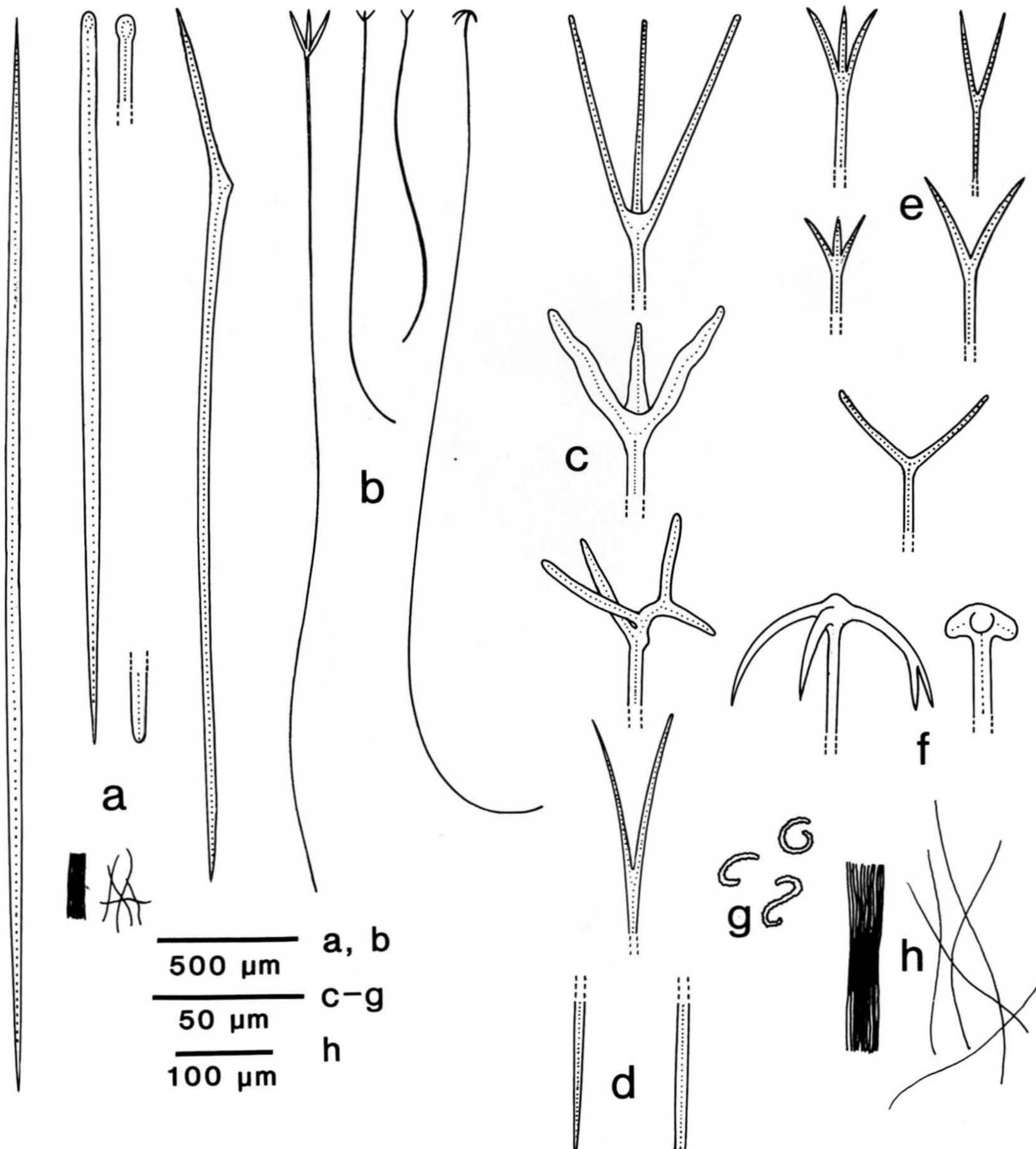

Fig. 7. *Cinachyrella apion,* spiculation: a, Oxeas and modifications, raphids; b, Tetractines in two size classes; c, Protriaene 1 cladomes and modifications; d, Protriaene 1 shaft points; e, Protriaene 2 cladomes and modifications; f, Anatriaene cladome and modification; g, Sigmaspires; h, Raphids enlarged, some bundled into a trichodragma.

maspires that vary considerably in shape, forming s-, c-, and o-figures.

Microscopical anatomy.—Ground epoxy sections show clearly that the second, smaller category of protriaenes occurs primarily in and around the porocalices. Choanocyte chambers measure about 25 μm in diameter, rarely as much as 30 μm. Histological variety, even in well fixed material, is generally poor. Brownish, double refracting spherical inclusions of the kind described for *Cinachyrella alloclada* are common in some specimens; they occur in the 20 μm as well as 150–300 μm size class. There are also grayish spherical inclusions, not double refracting and of unknown origin, seen in material from Belize mangroves; they measure 20 μm.

Distribution and ecology.—This species is common in shallow calm-water and inshore environments but it has generally been overlooked by previous authors because of its small size and cryptic occurrence. Our material indicates a distribution from offshore North and South Carolina, to Bermuda, southwestern Florida, Bahamas, Virgin Islands, and Belize. The recorded depth range is from 0.3 m to almost 60 m. In Bermuda we collected it in the intertidal from overturned rocks and from mangrove roots and inside shallow caves in inshore saltwater ponds and lakes. In Belize we found it most common in mangrove creeks and ponds, attached to red mangrove stilt roots, peat banks, and *Avrainvillea* algae stipes. One record from Grand Bahama is from 20 m depth, 100 m into a large limestone cave.

Redescription of holotype.—ZMB 4911 from St. Thomas, Virgin Islands, has the shape of an erect pear, 55 mm tall, 35 × 40 mm in diameter. It is firm, elastic, with bristly surface. No oscula are clearly discernible except for two apical openings, 2 mm and 4 mm in diameter and flush with the surface, which are in connection with large canals; other holes may be punctures. Porocalices are mostly collapsed but still recognizable from the dense lining of small protriaenes. No buds are visible on the surface but these could have been removed by handling and wrapping in cotton. Generally, the description of spicules by the original author (Uliczka 1929) is accurate but he neglected to figure the smaller category of protriaenes and he overlooked the raphids altogether.

Other material studied.—USNM 32652, off North Carolina, 34 m; USNM 33109, off South Carolina, 33 m; USNM 33249, off South Carolina, 17 m; USNM 42413, Hungry Bay, Bermuda, 1 m; USNM 42416, Walsingham Pond, Bermuda, 4 m; USNM 42417, Ferry Reach, Bermuda, 1 m; USNM 42422, Sarasota Bay, Florida, 9–11 m; USNM 33698, Grand Bahama, Bahamas, 20 m; USNM 42428 & 42429, Twin Cays, Belize, 1 m; and 6 uncataloged specimens from the MMS Continental Shelf Survey.

Remarks.—Examination of the holotype of *Cinachyra rhizophyta* Uliczka (1929; ZMB 4910) confirmed earlier suspicions (van Soest & Sass 1981, Rützler 1987) that this is a synonym of *Cinachyrella apion.* This specimen is not well preserved, it is badly contracted and torn, but a number of buds are still preserved in one area of the surface and the spiculation shows all characteristic features. Restudying preparations made from the type of *Cinachyra subterranea* van Soest & Sass (1981) we found a few small prodiaenes and raphids indicating that this sponge belongs to *Cinachyrella apion* rather than *C. alloclada* as previously assumed (Rützler 1987); this view is also consistent with records of distributional ecology for *C. apion.*

Cinachyrella arenosa
(van Soest & Stentoft, 1988)
Figs. 8, 9

Cinachyra arenosa van Soest & Stentoft, 1988:45, text-fig. 20, pl. VI, fig. 4.

Diagnosis.—Whitish to orange(?) deep-reef sponges; globular to ovoid, not more than 45 mm in diameter, with relatively large (5–10 mm) porocalices; with large oxeas, protriaenes and -diaenes (all of one size class), with robust accessory plagiotriaenes and calthrops, and with raphids and small (13 μm) sigmaspires.

Color.—We observed no live material. Based on alcohol-preserved specimens which range from gray (dominated by protruding spicules) to tan and reddish brown, we assume that small live sponges are gray,

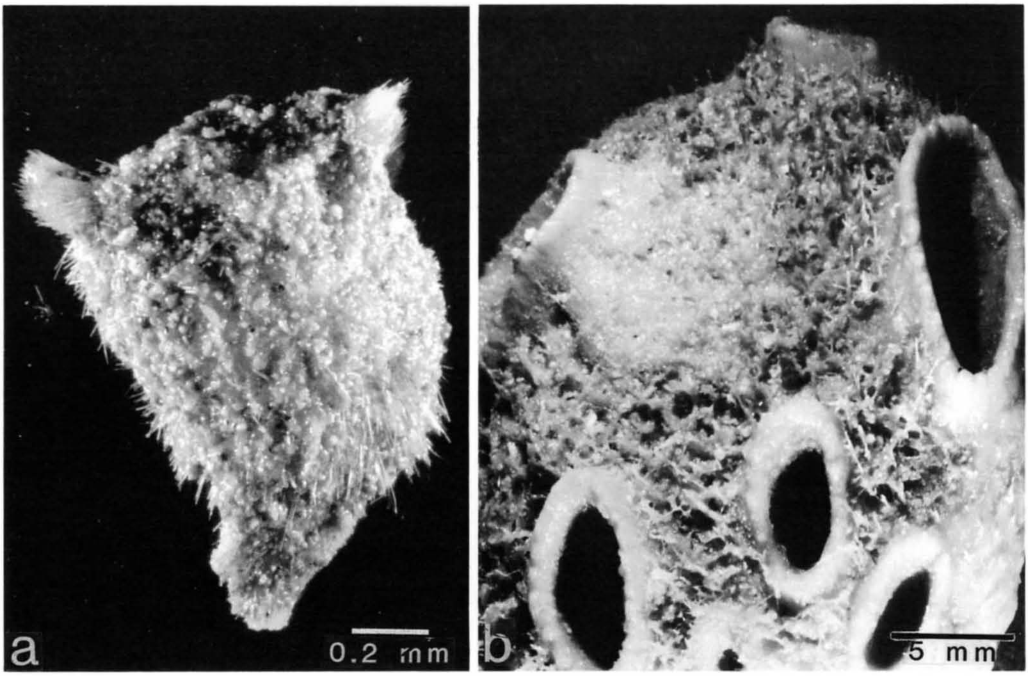

Fig. 8. *Cinachyrella arenosa,* morphology: a, Holotype, dry ZMA 5266, Barbados, 153 m (photo courtesy of R. W. M. van Soest); b, Alcohol-preserved specimen from southwest Florida, 44 m.

larger ones vary from yellow to orange. The color may often be obscured by sediments trapped between exposed spicules.

Shape, size, and consistency (Fig. 8).—Small specimens (5–15 mm tall) are ovoid erect, some are stalked; larger sponges are globular or subglobular and reach 45 mm in maximum dimension. The surface is usually hispid from protruding spicules which may trap large amounts of sand and other sediments. Porocalices are few (2–6) and mostly large (5–10 mm) compared to body size; they are elevated and many are surrounded by a fleshy rim or a collar of spicules. All observed oscula were contracted, located on top of cone-shaped protuberances. Consistency (alcohol material) is soft (small specimens) to moderately firm.

Spicules (Fig. 9, Table 1).—All spicules occur in one size class, with a few exceptions noted below. Oxeas are large and smooth; only a few are misformed to styles or with a kink near one tip. Protriaenes and prodiaenes (which occur in about equal proportions) display a considerable variety in shapes. They can have unusually short and stout rays, rays that open outward in a wide angle (45° from the rhabd axis), rhabds that are thickest at midlength rather than next to the cladome, and those that end rounded rather than pointed. Two (of 19) specimens studied had porocalices adorned by a number of very small protriaenes or -diaenes (900 × 3 μm overall, 40–60 μm clads); these were too rare and untypical to be included in Table 1. Plagiotriaenes are common and conspicuous. Despite their variation in shape and cladome angles they are always distinct from protriaenes (even crippled ones) by having much shorter (half the length) rhabds and much longer (three times the length) clads. In regular cladomes, the clad angle is about 45° to the rhabd axis, directed straight forward, but many are angulate, crooked, distally recurved, or otherwise deviating from the typical symmetry. Regularly co-occuring with plagiotriaenes is a related spicule type, the calthrop, which

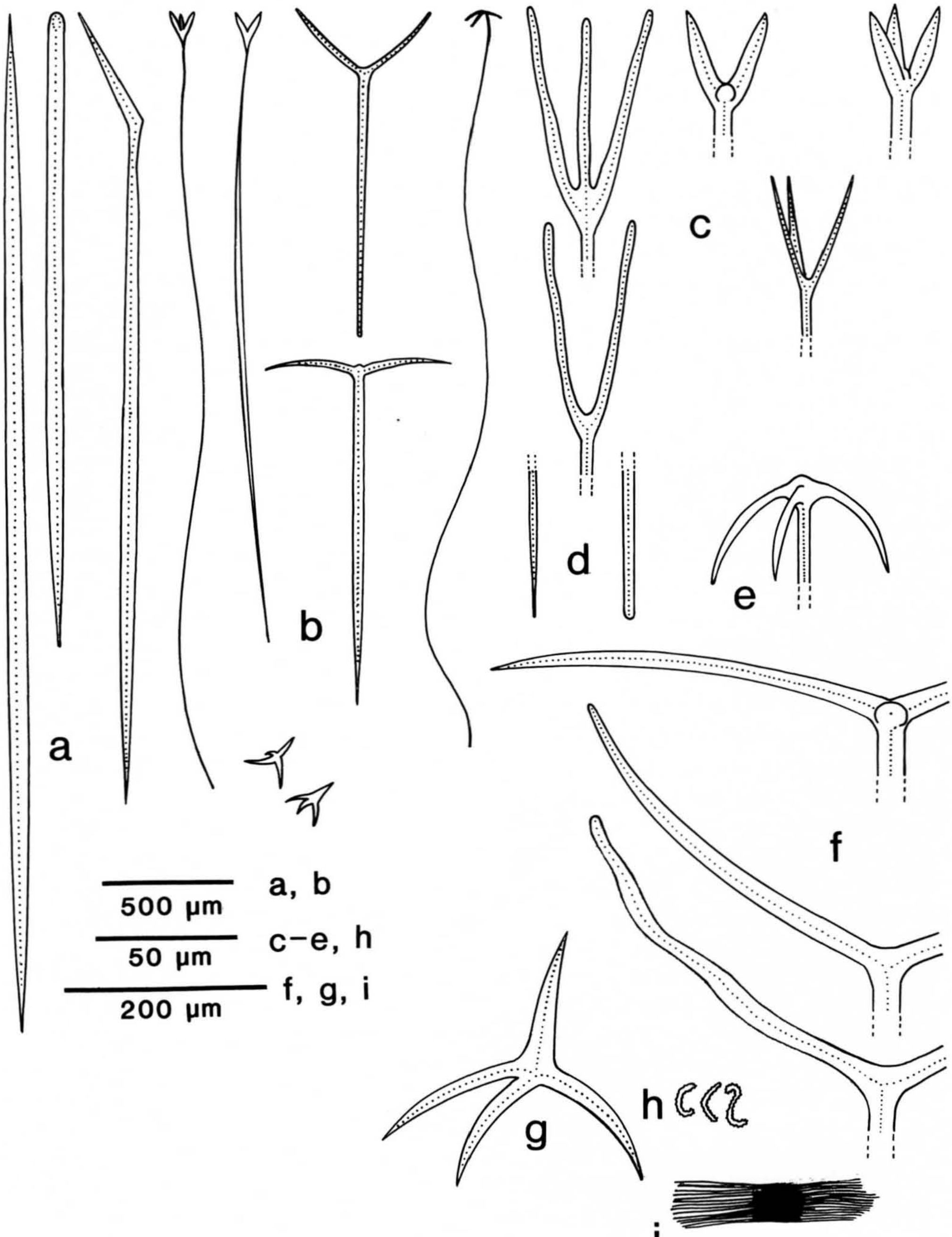

Fig. 9. *Cinachyrella arenosa,* spiculation: a, Oxea and modifications; b, Tetractines; c, Protriaene cladomes and modifications; d, Protriaene shaft points; e, Anatriaene cladome; f, Plagiotriaene cladomes; g, Calthrops; h, Sigmaspires; i, Raphids bundled in trichodragma.

is characterized by four equal rays that radiate from a common center. The fifth type of megasclere are anatriaenes with slender, regularly curved clads. They show little variation in shape. In some sponges they occur in numbers equal to protriaenes, but in many they are dominating the latter ten to one or more. Microscleres include raphids, often forming trichodragmata, and small (12.8 μm), regular (mostly c-shaped) sigmaspires.

Microscopical anatomy.—None of the available specimens were fixed for histological examination. Choanocyte chambers could be measured as 25 μm in diameter and it is apparent that histological diversity in this material is low. A ground, polished section revealed that the small category of protriaenes detected in abundance in one specimen (see comment above) was indeed implanted around porocalices in natural position and can be assumed to be a feature genuine to this particular sponge. Other sections show that strands of ana- or plagiotriaenes (in places reinforced by calthrops) may occur in dense staggered fashion (cladomes facing outward), radiating out in large portions of certain specimens. Crystalline, calcareous spherical bodies of the kind described above, 50–100 μm, are often present in the tissue.

Distribution and ecology.—Material on hand originated from offshore Georgia and South Carolina, 18 to 34 m, and from nearshore to offshore southwest Florida, including Dry Tortugas, 17 to 50 m. Based on dredge hauls, habitats are noted as secondary hard bottoms ("live bottoms"). The type material for this species came from Barbados, off Paynes Bay, 153 m (van Soest & Stentoft 1988). No observations on living sponges are available.

Reexamination of types.—One paratype (ZMA POR. 5267) was reexamined and was found to contain, along with the spicule complement originally described (van Soest & Stentoft 1988:45), a fair number of plagiotriaenes and calthrops. Upon our request, R. W. M. van Soest (Amsterdam) restudied the holotype preparation (ZMA POR. 5266) and confirmed presence of the unusual accessory spicules.

Other material studied.—USNM 33104, off South Carolina, 18 m; USNM 42467, off South Carolina, 34 m; USNM 42468, off Georgia, 28 m; USNM 33217, off southwest Florida, 20 m; USNM 42465 & 42466, off southwest Florida, 17 m; USNM 22442, Dry Tortugas, Florida, 70 m; and 12 uncataloged specimens from the MMS Continental Shelf Survey.

Remarks.—One other recently described species of *Cinachyrella, C. tarentina* (Pulitzer-Finali 1983), shares plagiotriaenes with short rhabds with *C. arenosa.* We studied one specimen of *C. tarentina* obtained from the type locality (courtesy M. Pansini, Genova) but found neither calthrops nor raphids. The habitat of this Mediterranean species is sandy or detrital rock bottom in very shallow (0.5–1 m) water. This distribution, geographical distance, and spicule characteristics prompt us to include our material with *C. arenosa.*

The presence of calthrops in this species would be grounds to place it in *Paratetilla* Dendy, but our analyses of genera and species (Rützler 1987) speak against such classification.

The significance of a second, smaller category of protriaenes and prodiaenes in two of our specimens cannot yet be evaluated. This feature could be a response to unusual or seasonal environmental conditions or a genetic aberration. Only in *C. apion* is it a reliable characteristic although even in this species there are mechanically damaged specimens in which these delicate structures are hardly detectable.

Conclusions

Cinachyrella is a characteristic and easily recognized genus of sponges yet its species are still poorly understood. Our study of large specimen series helped to clarify the taxonomic significance of morphologic characters—spicules in particular—and to define four species that can be recognized in the western Atlantic Ocean. At the same time it was frustrating to find that museum material is of very limited use, despite the fact that it is indispensable as documentation of our findings. The variability of preservable features is enormous and what appears as a clear-cut taxon upon examination of one or a few specimens may, after study of dozens, turn out to be nothing but a section from a spectrum of variants.

It was highly beneficial to our analysis that we were well acquainted with live populations of two of the described species, *Cinachyrella kuekenthali* and *C. apion*. This allowed us to better understand morphological adaptations to changing environmental conditions and effects of different methods of preservation. Reproductive specialization, such as the formation of buds, has significance for the genetic make-up of a population. In our material, this feature was only found in *C. apion* and is still under study, but it has also been reported from at least one Indopacific species, *C. australiensis* (Carter) (Yung-hui Chen, Kaohsiung, Taiwan, pers. comm.). More work on reproduction, ecology, histology, and possibly molecular biology will have to be used to improve the objectivity of taxonomic conclusions.

A particularly curious feature discovered during our study is the apparent formation of presumed calcitic granules inside the tissue of many of these sponges, even enveloping siliceous spicules. The only comparable previous report is by Vacelet et al. (1987) who found similar calcium carbonate spherules in *Hemimycale columella*, representative of a different order (Poecilosclerida) of demosponges. The mechanism and significance of calcium carbonate secretion inside a sponge that also precipitates (simultaneously ?) opaline silica has yet to be determined.

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