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NEW GENERA AND SPECIES OF CORALLINE SPONGES (PORIFERA) FROM JAMAICA

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ABSTRACT

Three new genera including four new species of coralline sponges from Jamaica are described. The sponges are characterized by a compound skeleton of aragonite, siliceous spicules and organic fibrous elements and are related to *Astrosclera, Merlia* and *Ceratoporella.*

Introduction

The rediscovery of *Ceratoporella nicholsoni* (Hickson, 1911) in Jamaican waters reported by Hartman and Goreau (1966) has been followed by the finding of four additional species of sponges with a compound skeleton of aragonite, siliceous spicules and an organic fibrous material. These coralline sponges occur in the same general habitat of the fore-reef slope environment (Goreau and Hartman, 1963) on the northern coast of Jamaica as does *Ceratoporella*. Together with *Astrosclera* Lister (1900) and *Merlia* Kirkpatrick (1908), the entire complex comprises a group of sponges with certain affinities with the class Demospongiae but with a notable difference in the presence of a basal mass of aragonite intrinsic to the sponges. It is the purpose of this paper to describe these four new species of Jamaican coralline sponges. Their affinities to other sponges are uncertain, and no higher categories are suggested at this time.

Stromatospongia, gen. nov.

TYPE-SPECIES. *Stromatospongia vermicola,* sp. nov.

DIAGNOSIS. Coralline sponges in which an aragonitic basal mass, varying in thickness from 3 mm to 4 cm, is associated with the calcareous tubes of serpulid worms. The surface of the aragonite is ornamented with lamellate or branched processes 0.8 to 2.0 mm high. The siliceous spicules are acanthostyles secreted in the superficial sponge tissue and later entrapped in argonite as the basal calcareous mass grows upward. Often the siliceous spicules protrude from the processes that arise from the surface of the basal calcareous material. This arrangement seems to come about through the fact that the heads of the spicules are joined together by a loose network of fibrous organic material that also serves as a matrix for the calcareous skeleton.

The living tissue of the sponges forms a thin veneer that fills in the irregular spaces between the processes of the calcareous skeleton. Its structural and functional organization is comparable to that of most sponges of the Class Demospongiae. Dermal pores perforate the surface of the tissue and open into vestibular cavities leading into incurrent canals that in turn communicate with excurrent channels by way of choanocyte chambers. The excurrent channels course to the surface and are there visible in living specimens as obvious varicosities along the length of which oscules open. The oscules may be localized at the center of stellate regions of convergence of excurrent channels, and these may leave faint depressions in the surface of the aragonite.

REMARKS. The generic name, feminine in gender, is derived from *stromato*—(Greek), anything spread out + *spongia* (Greek), sponge.

Stromatospongia vermicola, sp. nov.

DIAGNOSIS. An encrusting species that always grows in association with masses of tubes of a serpulid worm. Basal calcareous mass seldom exceeding 3 mm in height above the substrate; the surface of the aragonite is ornamented with multibranched processes. Siliceous acanthostyles present with mean lengths of 165 to 187μ (range of means of three specimens) and mean widths of 6.2 to 8.0μ (range of means of three specimens). The oscules may open anywhere along the length of the superficial excurrent channels. Living sponge tissue apricot to light salmon pink.

DESCRIPTION. *The calcareous skeleton.* As this species spreads over its substrate it lays down a thin layer of aragonite, usually less than 3 mm in height. The sponge occurs inevitably in association with certain serpulid worm tubes, but how this relationship begins in the life of any particular sponge is unclear. Perhaps the young sponges overgrow serpulid tubes initially. Later additional serpulids overgrow the sponge only to be overgrown by the sponge on which more serpulids settle and so on. The calcareous sponge skeleton often extends into the interior of the serpulid tubes. The eventual result of this interaction between the sponge and serpulid tubes is the formation of massive associations of calcareous matter from two sources measuring up to 40 cm in diameter and up to 10 cm in height (Fig. 1).

The surface of the aragonite laid down by the sponge is marked (Figs. 13, 17) by numerous upright, multibranched processes, 1.5

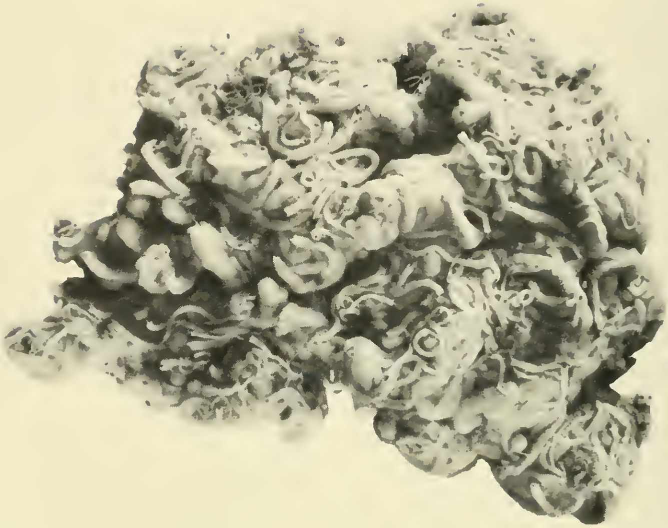

FIG. 1. *Stromatospongia vermicola* sp. nov. Holotype. YPM No. 6376. Runaway Bay, Jamaica; 31-37 m. Entire specimen, ×0.75.

to 2.0 mm high, ornamented with low rounded bosses or spines 25 to 65μ in height. The skeletal surface of *S. vermicola* is, therefore, not provided with regularly arranged pits in which the sponge tissue is organized into units as in *Ceratoporella nicholsoni* (Hartman and Goreau, in press); instead, the living tissue extends down into irregular spaces left between the branching terminal processes of the calcareous skeleton.

The aragonitic skeleton of *S. vermicola* is made up of sclerodermites (Fig. 21). Crystals of aragonite radiate in all directions from centers of calcification that are usually located around spicule heads. Secondary deposits of aragonite filling spaces at the base of some of the surface processes are apparent here and there in ground thin sections. This species spreads out laterally at a quite rapid rate, but the calcareous base grows slowly in thickness. The aragonite of *S. vermicola* has a faint pinkish-brown tint when viewed under the microscope.

Siliceous and organic skeletal elements. The range of means (with standard error) of the length of the siliceous acanthostyles of three specimens (100 measurements per specimen) is 165 (±7.0) to 187 (±7.7)μ and the overall range in length is 75 to

519μ. In width the means (with standard error) of three specimens (100 measurements per specimen) range from 6.2 ($\pm$0.15) to 8.0 ($\pm$0.18)μ, and the overall range in width is 3.3 to 13.0μ. The spicules (Fig. 2) bear several rounded or flattened, sometimes bifurcating, knobs on the head and whorls of spines on the shaft. The whorls of spines tend to be closer together at the head end. Typically the first whorl is recurved toward the pointed end of the spicule; then follow one or two whorls with straight spines. The remaining whorls of spines are recurved toward the head end. The spicules become overgrown by aragonite as the basal calcareous mass is built up, and they often protrude from the calcareous processes at the surface. Many of those embedded in aragonite are partially eroded (Fig. 21). The head of each of the spicules, including those embedded in aragonite, is surrounded by a mass of organic material continuous with sheet-like expansions of the same substance that serves as an organic matrix for the calcareous skeleton.

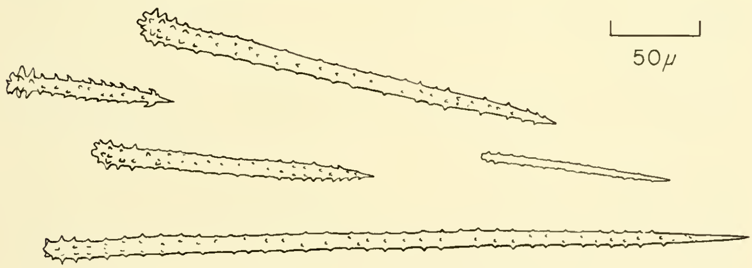

FIG. 2. *Stromatospongia vermicola* sp. nov. Siliceous spicules.

Living tissues of the sponge. The living tissues, varying from apricot (Maerz and Paul, 1950, Pl. 10, F-7) to light salmon pink (ibid., Pl. 10, A-7), form a thin veneer over the surface of the aragonite and extend downward between the branched processes that ornament the surface of the basal calcareous mass. The epidermis is supported above extensive vestibular cavities by means of vertical tracts of spicules and is perforated by ostia, 50 $\times$ 50 to 75 $\times$ 100μ in major diameters (Fig. 3). Vertical incurrent channels lead from the base of the subdermal cavities into the choanosome where they subdivide and open into spheroidal, eurypylous choanocyte chambers, 16 to 20μ in diameter (Fig. 25).

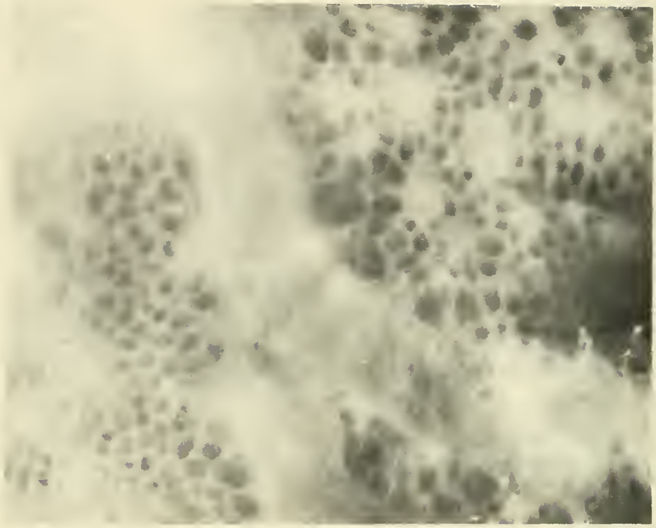

FIG. 3. *Stromatospongia vermicola* sp. nov. Portion of surface of living specimen showing ostia and a branching excurrent channel. Photographed in laboratory. ×40.

The excurrent channels run to the surface where they are apparent in living specimens as dilated tubes (Fig. 29) that may converge upon oscular areas where one to three oscules open to the exterior, or the oscules may open out anywhere along the length of the channels. The oscules are elliptical in outline and vary in diameters from $170 \times 500\mu$ to $500 \times 750\mu$; the dilated exhalant channels on the surface of the sponge vary from 0.9 to 1.2 mm in width.

Egg cells, $40 \times 25\mu$ in major diameters and with nuclei 12μ in diameter and nucleoli 4μ in diameter, are rare in sections. Several ellipsoidal cleaving embryos, probably at the 32-cell stage, and measuring $44 \times 33\mu$ in major axes, are present in sections. Although fully developed larvae have not yet been found, the available evidence suggests that this species incubates its larvae.

SYMBIONTS. The association between *S. vermicola* and the unidentified species of serpulid polychaete appears obligatory with respect to the sponge. Whether or not the serpulid occurs independent of the sponge is unknown.

Branching filamentous organisms are occasionally seen in the organic matrix in decalcified thin sections of *S. vermicola*. The irregular course taken by the filaments and their anastomoses suggest that the organisms are most probably Chlorophyta, but it is possible that they are Cyanophyta.

RANGE AND HABITAT. Known at present only from the northern coast of Jamaica where it occurs from Maria Buena Bay, Trelawny Parish, eastward to Salt Gut, St. Mary Parish. It is especially common in the fore-reef slope environment of Runaway Bay and Discovery Bay at depths of 10 to 95 m. The sponge occurs on rock walls or on the reverse sides of large reef corals, always in deep shade. Its maximum size is reached below 60 to 70 m; above 30 m, individuals are quite small.

HOLOTYPE. Peabody Museum, Yale University (YPM) No. 6376 (Fig. 1). Runaway Bay, Jamaica; 31-37 m. Collected by T.F. Goreau, March 31, 1965.

Repositories of paratypical material: United States National Museum, Smithsonian Institution, Washington, D.C.; British Museum (Natural History), London; Institute of Jamaica, Kingston. About 20 lots of specimens from Runaway Bay and Discovery Bay, Jamaica, were studied.

COMPARISON WITH OTHER SPECIES OF STROMATOSPONGIA. *S. vermicola* may be distinguished from the following species by its habit of growing in association with tangled masses of serpulid tubes on which it deposits a thin layer of aragonite. The upright, branched processes of the calcareous skeleton are higher and less closely spaced than those of the other species of the genus, and the siliceous spicules are somewhat shorter and stouter. Its apricot to light salmon pink color in life is distinctive.

REMARKS. The specific name is derived from *vermis* (Latin), worm + *—colus* (Latin), inhabiting.

Stromatospongia norae, sp. nov.

DIAGNOSIS. A species that takes the form of rounded, mammillate masses extensions of which encrust the tubes of serpulid worms that tend to grow away from the central mass of the sponge.

The basal mass of aragonite may reach a height of 4 cm above the substrate; the surface of the calcareous skeleton is ornamented with upright lamellate processes. Siliceous acanthostyles present with mean lengths of 195 ($\pm$10.6)μ to 215 ($\pm$9.5)μ (range of means of three specimens) and mean widths of 5.5 ($\pm$0.11)μ to 6.1 ($\pm$0.16)μ (range of means of three specimens). The oscules open to the exterior where a group of excurrent channels converge. Faint impressions of the stellate patterns so formed by the excurrent channels may occasionally be seen on the surface of the basal aragonitic mass. The living sponge tissue varies in color from cream to ecru biege.

DESCRIPTION. *The calcareous skeleton.* The aragonitic skeleton of this species has a basic rounded, mammillate form (Fig. 4), but cornuate processes are frequently present representing serpulid worm tubes that become associated with and encrusted by the sponge and grow out away from its central mass (Fig. 5). The largest specimens known at present are 7 cm across in the case of the mammillate form and 20 cm in greatest length for the cornuate form.

Closely set, short, lamellate processes, up to 0.8 mm high, seldom exceeding 1 mm in length, and terminating in low, rounded bosses, arise from the surface of the basal aragonitic mass (Figs. 14, 18). In some areas of the surface several such lamellae run parallel to one another and thus mark off furrows into which the living tissue extends. On other areas the lamellae are shorter and are arranged irregularly, leaving depressions of varying shapes. In fine structure the aragonite resembles that of *S. vermicola* with sclerodermite units (Fig. 22) formed of crystals radiating from centers of calcification which are frequently the organic material that surrounds the heads of entrapped siliceous spicules.

Siliceous and organic skeletal elements. The siliceous acanthostyles (Fig. 6) are similar in form to those of *S. vermicola* but are somewhat longer and thinner. The range of means (with standard error) of the length in three specimens (50 measurements per specimen) is 195 ($\pm$10.6) to 215 ($\pm$9.5)μ and the overall range in length is 75 to 519μ. In width the means (with standard error) of three specimens (50 measurements per specimen) range from 5.5 ($\pm$0.11) to 6.1 ($\pm$0.16)μ and the overall range in width is 2.7 to 9.1μ. The heads of the spicules bear several rounded

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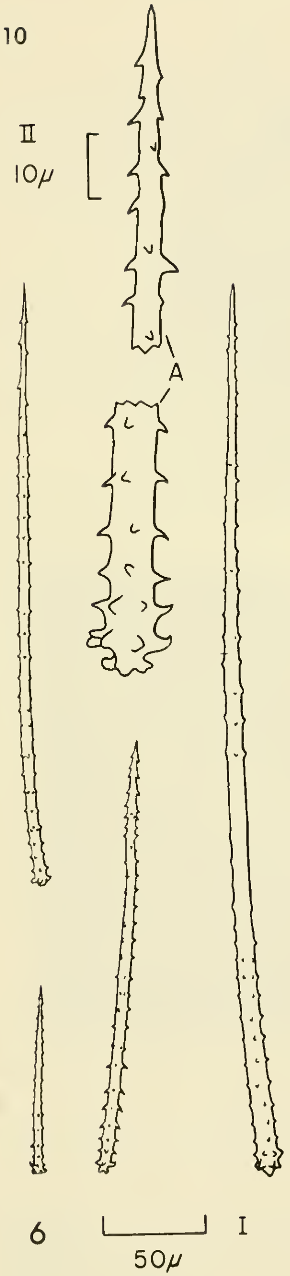
FIG. 4. *Stromatospongia norae* sp. nov. Holotype. YPM No. 7770. Runaway Bay, Jamaica; 26-28 m. Mammillate specimen, × 1.1.

FIG. 5. *Stromatospongia norae* sp. nov. Paratype. YPM No. 6463. Runaway Bay, Jamaica; 34 m. Cornuate specimen, × 1.5. Photo by Fritz Goro.

or somewhat flattened, often bifurcating knobs, and the shaft is ornamented with whorls of spines. The first one or two rows of spines at the rounded end of the spicule are recurved toward the pointed end, the next one or two rows are straight and the remaining whorls are made up of spines recurved toward the head



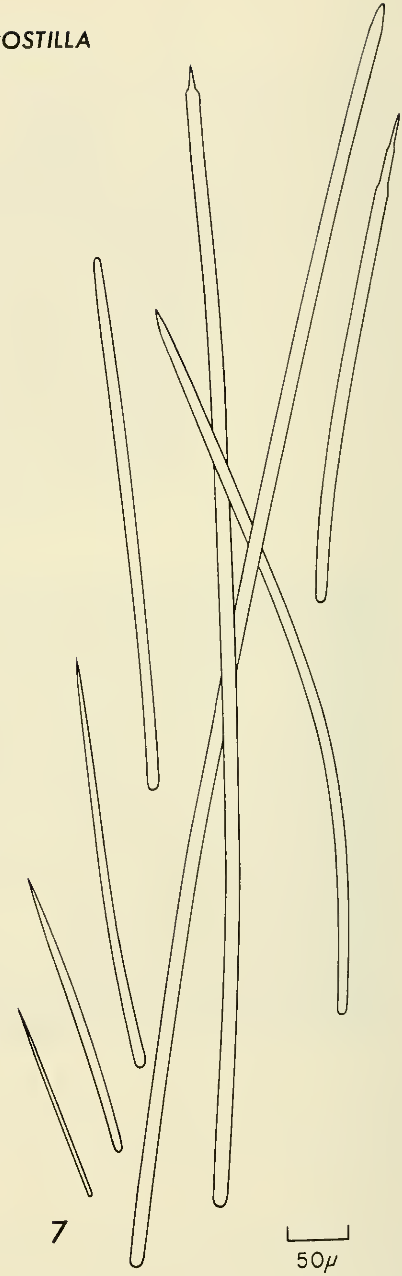


FIG. 6. *Stromatospongia norae* sp. nov. Siliceous spicules. Scale II refers to spicule A.

FIG. 7. *Hispidopetra miniana* sp. nov. Siliceous spicules.

end of the spicule. The spicules are embedded in aragonite as the calcareous skeleton grows upward and some of them become partially eroded. An organic material surrounds the heads of the acanthostyles and a sheetlike matrix may be observed in decalcified thin sections.

Living tissues of the sponge. These vary in color from cream (Maerz and Paul, 1950, Pl. 9, D-2) to ecru biege (ibid., Pl. 11, E-4, "maple"). Ostia, 62 to 186μ in diameter, circular to elliptical in outline and distributed quite evenly over the surface of the epidermis, lead into vestibular cavities from which vertical incurrent canals lead to the tissue masses that fill the spaces between the surface lamellate processes of aragonite. Spheroidal choanocyte chambers (Fig. 26), 15 to 17μ in diameter, join the incurrent and excurrent canals and the latter pass to the surface where they characteristically form radiating patterns (Fig. 30) as they converge upon the elliptical oscules, 350 $\times$ 500μ in major axes. The excurrent channels may leave faint, depressed stellate patterns on the surface of the calcareous skeleton in some specimens.

SYMBIONTS. Every specimen examined during the preparation of this description is associated with at least one serpulid worm tube which it has encrusted, suggesting an obligatory relationship. These worm tubes tend to grow out away from the central mass of the sponge as though attempting to escape complete overgrowth by the sponge. In *S. vermicola,* however, the serpulid tubes attach in entirety to the sponge surface and will eventually be completely covered by an aragonitic deposit secreted by the sponge.

Multibranching cavities, 1μ in width, representing the galleries of a boring organism, are common throughout the calcareous skeleton of *S. norae.* In some instances they are filled with the dried remains of chlorophyll-bearing cells and may have been formed by a species of endolithic Chlorophyta or Cyanophyta.

RANGE AND HABITAT. Known at present only from the North Coast of Jamaica where it ranges from Maria Buena Bay, Trelawny Parish, eastward to Salt Gut, St. Mary Parish. It is moderately common in the fore-reef slope environment of Runaway Bay and Discovery Bay at depths of 8 to 85 m, but chiefly above 35 m. It lives on the sides and ceilings of deep caverns and sub-reef tunnels where little light penetrates.

HOLOTYPE. YPM No. 7770 (Fig. 4). Runaway Bay, Jamaica. 26-28 m. Collected by T. F. Goreau, March 8, 1968.

Repositories of paratypical material: United States National Museum; British Museum (Natural History); Institute of Jamaica. Eight lots of specimens from Runaway Bay and Discovery Bay were studied.

COMPARISON WITH STROMATOSPONGIA VERMICOLA. *S. norae* deposits a thicker basal layer of aragonite than its congener, and the surface processes of the calcareous skeleton are lamellate in form, shorter and more closely spaced. Its siliceous spicules are somewhat longer and thinner. The color of the living tissues of the sponge vary from cream to ecru biege.

REMARKS. The specific name is given in honor of Mrs. Nora I. Goreau who has assisted greatly in studies of the histology of the coralline sponges.

Hispidopetra, gen. nov.

TYPE SPECIES: *Hispidopetra miniana,* sp. nov.

DIAGNOSIS. Coralline sponges varying in form from encrustations to dome-shaped or irregular masses up to 15 cm in diameter and at least 3 cm high. The surface of the aragonitic basal mass is covered with numerous conspicuous processes, variable in shape and up to 7 mm high. The processes are covered with rounded spines, up to 50μ high, from which protrude numerous partially embedded, smooth, stylote, siliceous spicules, slightly curved and varying greatly in length.

The living tissues vary in color from carmine to vermilion and are similar to those of *Stromatospongia* in general organization. Lophocytelike cells frequently occur.

REMARKS. The generic name, feminine in gender, is derived from *hispidus* (Latin), bristly + *petra* (Latin), rock.

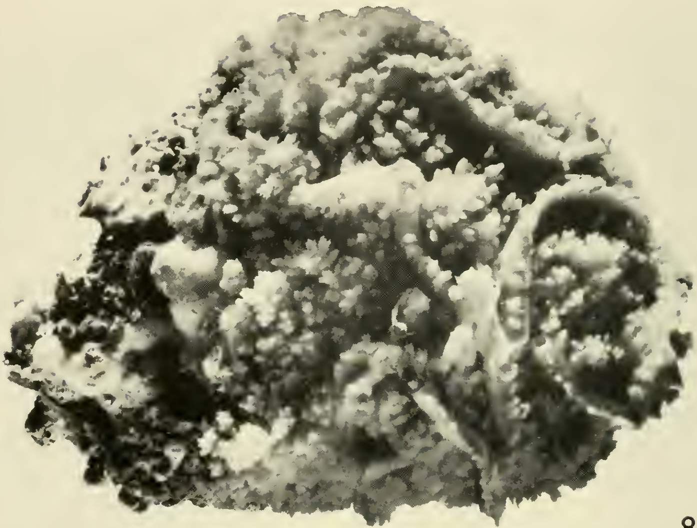
Hispidopetra miniana, sp. nov.

DIAGNOSIS. An encrusting to massive species reaching 15 cm in diameter and 3 cm in height; the surface of the calcareous skeleton is ornamented with processes up to 7 mm in height and of variable shape. Siliceous smooth styles present with mean lengths of 269 ($\pm$6.9) to 301 ($\pm$10.8)μ (range of means of three specimens) and mean widths of 5.4 ($\pm$0.11) to 7.4 ($\pm$0.16)μ (range of means of three specimens). Oscules open anywhere along the length of the superficial excurrent channels. Living sponge tissue varies in color from carmine to vermilion.

DESCRIPTION. *The calcareous skeleton.* This species is encrusting in early life (Fig. 9) and grows into dome-shaped or irregular masses (Fig. 8) up to 15 cm in diameter and 3 cm high. The surface of the aragonitic skeleton bears numerous processes, obvious to the naked eye, arborescent, lamellate or knoblike in form and up to 7 mm high. In some young, encrusting specimens the processes are chiefly arborescent and in others they are knob-like; but in larger specimens the processes are variable in shape. The processes are covered with rounded spines, 25 to 50μ high, and the pointed ends of numerous long stylote siliceous spicules protrude from these (Figs. 15, 19). Serpulid worm tubes, bearing a keel 3 to 4 mm high, invariably overgrow older specimens, and the sponge overgrows them in turn, often giving the keel the aspect of a cockscomb.

The aragonitic skeleton of *Hispidopetra miniana* is similar to that of *Stromatospongia* in fine structure. Sclerodermites (Fig. 23), comprising crystals of aragonite radiating in all directions from centers of calcification, are the basic units of the skeleton. The centers of calcification are frequently located around the heads of siliceous spicules. The aragonite of this species has a pinkish-brown tint in thin sections when viewed under the microscope.

Siliceous and organic skeletal elements. The siliceous spicules (Fig. 7) are smooth, slightly curved styles varying greatly in length. The range of means (with standard error) of the length of the styles of three specimens (100 measurements per specimen) is 269 ($\pm$6.9) to 301 ($\pm$10.8)μ and the overall range in length is 125 to 818μ. In width the means (with standard error) of three specimens (100 measurements per specimen) range from 5.4



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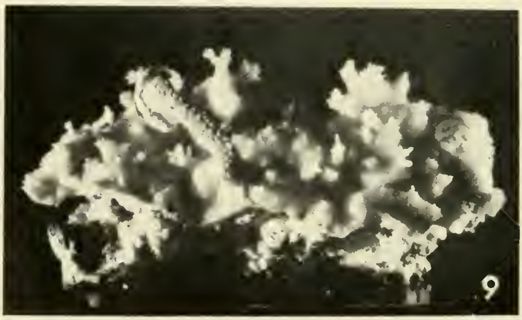

FIG. 8. *Hispidopetra miniana* sp. nov. Holotype. YPM No. 6843. Discovery Bay, Jamaica; 55-57 m. Entire specimen, $\times 1.25$.

FIG. 9. *Hispidopetra miniana* sp. nov. Paratype. YPM No. 6459. Runaway Bay, Jamaica, 25-28 m. $\times 1.95$. Photo by Fritz Goro.

(± 0.11) to 7.4 (± 0.16)μ, and the overall range in width is 1.3 to 10.4μ.

The rounded ends of the spicules are enclosed in an organic material. A fibril-bearing flocculent substance serves as a matrix for the aragonitic basal mass. Both the siliceous spicules and the organic skeletal materials are enclosed within the calcareous skeleton as the sponge increases in size. Some of the siliceous spicules.

but fewer than in *Stromatospongia,* show evidence of erosion after entrapment in the aragonite.

Living tissues of the sponge. In most specimens the living tissue of *Hispidopetra miniana* varies from carmine (Maerz and Paul, 1950, near Pl. 2, L-5) to vermilion (near Pl. 2, L-12). Often the color decreases in intensity toward the base of the sponge. An occasional specimen is light pinkish-orange (near Pl. 2, D-10).

A thin, diaphanous, unpigmented exopinacoderm, often pierced by spicules, stretches between the tips of the vertical calcareous processes of the basal mass and is thus separated from the mesohyl and choanosome by extensive cavities of the incurrent and excurrent water-conducting systems. Ostia, 50 to 100μ in diameter in living specimens, are usually rather sparsely distributed but occur occasionally in groups of 50 or more. The extensive incurrent cavities beneath the exopinacoderm lead into wide incurrent canals that subdivide repeatedly and eventually communicate with eurypylous choanocyte chambers (Fig. 27), 16 to 18μ in diameter. A complicated network of low excurrent canals, 0.5 to 0.6 mm across in expanded sponges in the laboratory, runs above the exopinacoderm (Fig. 31). Oscules, circular to elliptical in outline and ranging up to 1.0×1.5 mm in diameter, open from these canals at any point and not only at sites of anastomoses.

Large ovoid to pear-shaped cells, $10 \times 20\mu$ in major diameters, with nucleolate nuclei, 6μ in diameter, and with processes that may extend over 30μ beyond the cell body, occur clustered at the base of the tissue where it is in contact with the calcareous skeleton. The processes are fibrillar in nature, and the cells may therefore be compared with the lophocytes described from many other sponges. The cell bodies are filled wih large granules and occasionally bear food vacuoles. It is possible, in view of their localization in the sponge, that these cells not only secrete elements of the organic matrix but also may function as calcoblasts.

SYMBIONTS. Serpulid worms grow on the surface of the calcareous skeleton of all older specimens of *Hispidopetra miniana.*

In living specimens the processes of the calcareous skeleton are bright green. The organisms responsible for the color are recognizable in ground thin sections of the skeleton where the tips of the processes are filled with a tangle of filaments of two sizes, 1.0μ and 0.4μ respectively. It is probable that these organisms are boring Chlorophyta, although some of the filaments bear a resemblance to those described by Duncan (1877, pl. 7, fig. 39-44) as boring fungi.

RANGE AND HABITAT. Known from the northern coast of Jamaica where it ranges from Maria Buena Bay, Trelawny Parish, eastward to Salt Gut. St. Mary Parish. It is common locally in the fore-reef slope environment of Runaway Bay and Discovery Bay at depths of 10 to 95 m and is restricted in these areas almost entirely to overhanging surfaces in caves, crevices and under ledges. The species increases in abundance and size of individuals with depth.

This species is also known from the southern coast of Jamaica where two specimens were dredged in 40 m south of Great Pedro Bay by R/V *Gosnold.*

HOLOTYPE. YPM No. 6853 (Fig. 8). Discovery Bay, Jamaica; 55-57 m. Collected by Roma Chapman, July 20, 1966.

Repositories of paratypical material: United States National Museum; British Museum (Natural History); Institute of Jamaica. Ten lots of specimens from Runaway Bay and Discovery Bay, Jamaica, were studied.

COMPARISON WITH OTHER CORALLINE SPONGES. *Hispidopetra miniana* is readily distinguished from other Jamaican coralline sponges by its carmine to vermilion color in life and its long, smooth stylote siliceous spicules. The surface processes of the aragonitic basal skeleton are more prominent (up to 7 mm in height) than in any other known species and are often marked by protruding siliceous spicules.

REMARKS. The specific name is the Latin word for vermilion.

Goreauiella, gen. nov.

TYPE SPECIES. *Goreauiella auriculata,* sp. nov.

DIAGNOSIS. Coralline sponges with an auriculate or saucer-like form, living attached to the substrate by a broad peduncle. Individuals vary up to 16 cm in diameter and 3 mm in thickness. The surface of the aragonite is covered with delicate arborescent processes, up to 1 mm or more in height, and is marked by raised, branching patterns that run to the edge of the skeleton. Siliceous spicules in the form of short acanthostrongyles or truncate acanthostyles are present and become embedded secondarily in the aragonitic basal mass.

The living tissue forms a thin veneer that fills in the intricate spaces between the surface processes of the aragonitic skeleton. The organization of the tissue is similar to that described for *Stromatospongia* except that in this form all the oscules open at the edge of the sponge and the excurrent canals at the surface run toward the peripheral oscules.

REMARKS. The genus, feminine in gender, is named in honor of Dr. Thomas F. Goreau, who discovered the remarkable fauna of coralline sponges on the Jamaican reefs.

Goreauiella auriculata, sp. nov.

DIAGNOSIS. With the skeletal characters of the genus. Living tissue, various shades of light yellow, with a pattern of organization as described above.

DESCRIPTION. *The calcareous skeleton.* The aragonitic basal mass has an auriculate or shallow dishlike shape (Fig. 10), with the edges upturned or curled downward, and is attached to the substrate by a broad peduncle. Individual sponges range up to 16 cm in longer diameter, but the calcareous skeleton is very thin, seldom exceeding 3 mm. Numerous, closely set, delicate, arborescent calcareous processes (Figs. 16, 20), from 0.5 to 1.1 mm in height, arise from the surface of the calcareous skeleton; the processes are covered with rounded spines, 12 to 40μ high. When viewed with the unaided eye the surface of the calcareous skeleton of most specimens reveals raised multibranching patterns resembling the delta systems of rivers (Fig. 10) and draining to the very edge of the skeleton. Under a dissecting microscope it is apparent that these raised areas result from an increased height of the arborescent processes that cover the surface.

As in the other coralline sponges described, the basic units of

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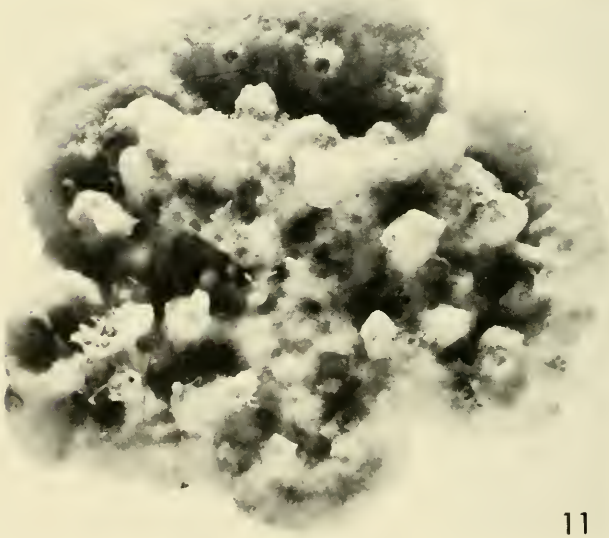

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FIG. 10. *Goreauiella auriculata* sp. nov. Holotype. YPM No. 6858. Runaway Bay, Jamaica, 25 m. Entire specimen. ×1.4.

FIG. 11. *Goreauiella auriculata* sp. nov. Paratype. YPM No. 7773. Runaway Bay, Jamaica, 26-28 m. Entire specimen with upright processes induced by presence of commensal zoanthideans. ×1.3.

the calcareous skeleton are sclerodermites (Fig. 24) made up of crystals of aragonite radiating out from centers of calcification. The aragonite is colorless in this species when ground thin sections are examined microscopically.

Siliceous and organic skeletal elements. The siliceous spicules (Fig. 12) are relatively short rods of equal diameter throughout, straight, slightly curved or with a pronounced curve; each is ornamented with whorls of spines that vary greatly in size and orientation. Typically one end of the spicule is provided with rounded knobs or a whorl of spines recurved toward the opposite end; there follow one to three whorls of spines recurved in the same direction. Then one or two whorls of straight spines occur followed by many whorls of spines recurved toward the end with blunt knobs. The tip of the spicule is provided with a whorl of straight or recurved spines. The orientation of the spines is thus reminiscent of that in *Stromatospongia vermicola* and *norae,* although the spicules of these species are stylote and lack the terminal whorl of spines. In *Goreauiella auriculata* the spines vary in length from less than 1μ to 5μ. The spicules become embedded in aragonite as the calcareous base builds up, and some of them show evidence of erosion as in the other coralline sponges described above. Mean values for length and width measurements

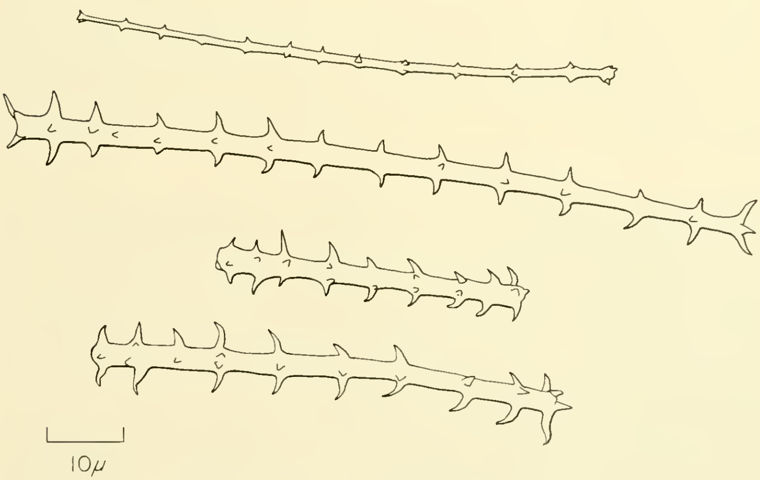

FIG. 12. *Goreauiella auriculata* sp. nov. Siliceous spicules.

(with standard errors) of spicules of three specimens (50 spicules measured per specimen) are 60 ($\pm$1.5) to 68 ($\pm$2.3)μ by 2.3 ($\pm$0.06) to 2.7 ($\pm$0.08)μ. Overall ranges in length are 35 to 124μ, and in width, 1.3 to 3.9μ.

That end of each spicule that bears blunt knobs is always enclosed in an organic material, suggesting that the end in question corresponds to the rounded end of the styles in *Stromatospongia* and *Hispidopetra*. A fibril-bearing flocculent material remains as a matrix after decalcification.

Living tissues of the sponge. The color of the living tissue of *Goreauiella auriculata* varies from straw yellow (Maerz and Paul, 1950, Pl. 10, F-2) to chrome lemon (Pl. 9, K-2) or yellowish-gray. Ostia, 50 to 150μ in diameter in the living sponge, are evenly distributed over the exopinacoderm between the branching excurrent canals. The ostia lead into vestibular cavities lying beneath the exopinacoderm and these in turn lead into wide incurrent canals which, after branching, open into eurypylous choanocyte chambers (Fig. 28), 14 $\times$ 15 to 18 $\times$ 26μ in major diameters. The oscules, with diameters of approximately 300μ, open out along the edge of the sponge where their positions are marked by indentations in the periphery of the calcareous skeleton. The excurrent canals (Fig. 32) are transparent, dotted with fine white spots and receive short side branches from the adjacent tissues as they run along the surface of the sponge. The systems of branching excurrent canals lie directly above the raised branching patterns of the calcareous skeleton described above, suggesting that the flow of water in the former influences the deposition of aragonite beneath each canal.

SYMBIONTS. Orange-tan zoanthideans occasionally grow with *Goreauiella auriculata.* The polyps often induce the formation of processes of the calcareous skeleton (Fig. 11) reaching heights of one cm and widths up to 6 mm. The zoanthideans, distributed over the surface of the sponge at intervals of 6 to 8 mm, sit in depressions in the calcareous skeleton. Whether or not the polyps are interconnected by stolons is unknown.

Boring algae, probably Chlorophyta but possibly Cyanophyta, with filaments 1.2μ in width, are commonly present in the calcareous processes of the skeleton.

RANGE AND HABITAT. Found on the northern coast of Jamaica from Maria Buena Bay, Trelawny Parish eastward to Salt Gut, St. Mary Parish. It is common in the fore-reef slope environment of Runaway Bay and Discovery Bay at depths of 8 to more than 70 meters. It is most abundant in narrow passages in the reef framework and occurs also in larger caves; in both habitats the sponges are found attached to the ceiling of the cavities and are suspended with the tissue side down.

HOLOTYPE. YPM No. 6858 (Fig. 10). Runaway Bay, Jamaica; 25 m. Collected by T. F. Goreau, March 8, 1968.

Repositories of paratypical material: United States National Museum; British Museum (Natural History); Institute of Jamaica. Eighteen specimens from Runaway Bay and Discovery Bay, Jamaica, were studied.

COMPARISON WITH OTHER CORALLINE SPONGES. *Goreauiella auriculata* is distinguished by its auriculate external form and yellowish color in life. The siliceous spicules are short, truncate acanthostyles with a terminal whorl of spines. The delicate arborescent processes of the aragonitic basal skeleton and the raised, branching patterns running to the edge of the skeleton are additional distinctive features of this species.

REMARKS. The specific name is derived from *auricula* (Latin), diminutive of *auris,* ear.

Acknowledgments

I am deeply grateful to Thomas F. Goreau, University of the West Indies, Kingston, Jamaica, and the State University of New York at Stony Brook, who entrusted the description of these remarkable sponges to me. He and his diving associates, Eileen A. Graham, Roma Chapman, Paul Chapman, Judith Lang and the late R. S. Jackson collected the specimens upon which this study is based. Nora I. Goreau and Aimorn Stewart assisted in the histological work. T. F. Goreau and Fritz Goro kindly made available to me the photographs accredited to them. I am also indebted to A. H. Coleman and Diane M. Barker who assisted in the photography and to my wife, Shirley G. Hartman, who prepared the drawings.

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FIG. 13. *Stromatospongia vermicola* sp. nov. Enlarged view of processes on surface of aragonitic basal skeleton, living tissues removed. YPM No. 6379. Discovery Bay, Jamaica; 71 m. × 10.

FIG. 14. *Stromatospongia norae* sp. nov. Enlarged view of processes on surface of aragonitic basal skeleton, living tissues removed. YPM No. 6463. Runaway Bay, Jamaica; 34 m. × 10.

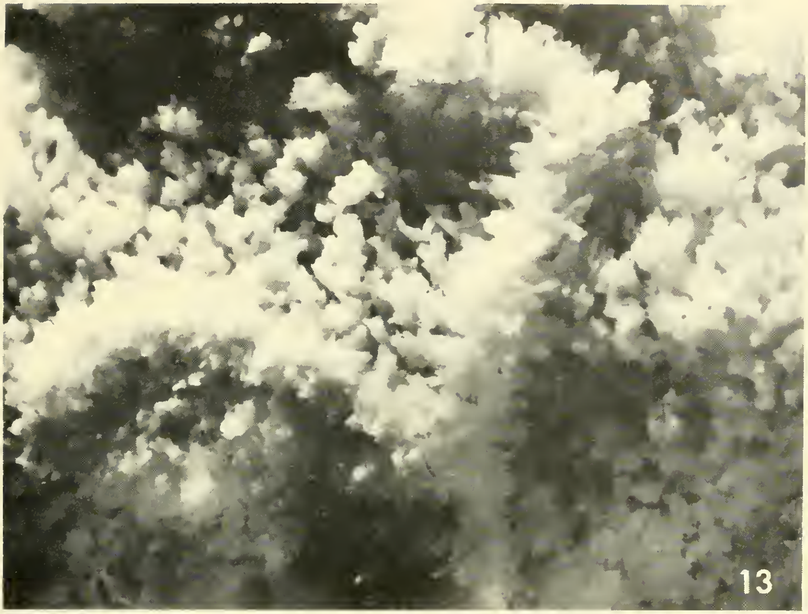
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FIG. 15. *Hispidopetra miniana* sp. nov. Enlarged view of processes on surface of aragonitic basal skeleton, living tissues removed. Numerous siliceous spicules hispidate the processes. YPM No. 6460. Runaway Bay, Jamaica; 38 m. × 10.

FIG. 16. *Goreauiella auriculata* sp. nov. Enlarged view of processes on surface of aragonitic basal skeleton, living tissues removed. Lighter bands represent lines of somewhat higher processes that are formed beneath excurrent channels on surface. YPM No. 6465. Runaway Bay, Jamaica; 28 m. × 10.


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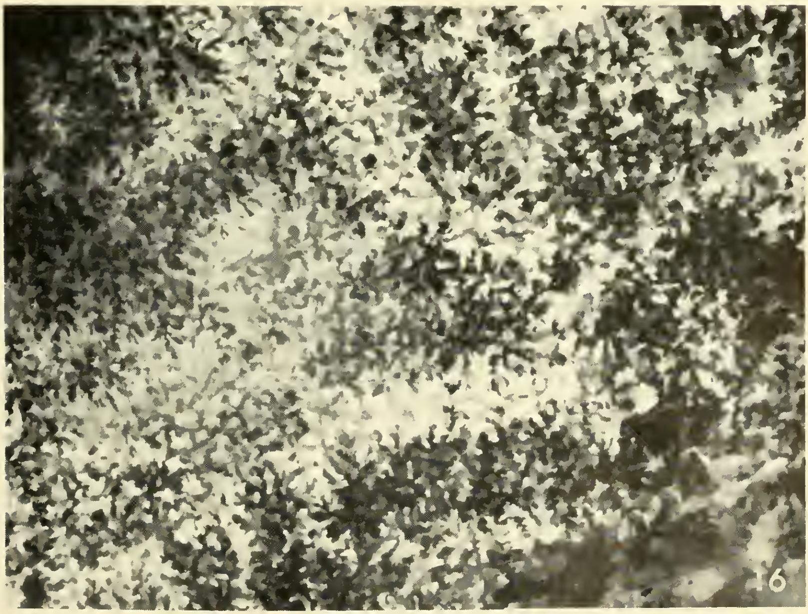
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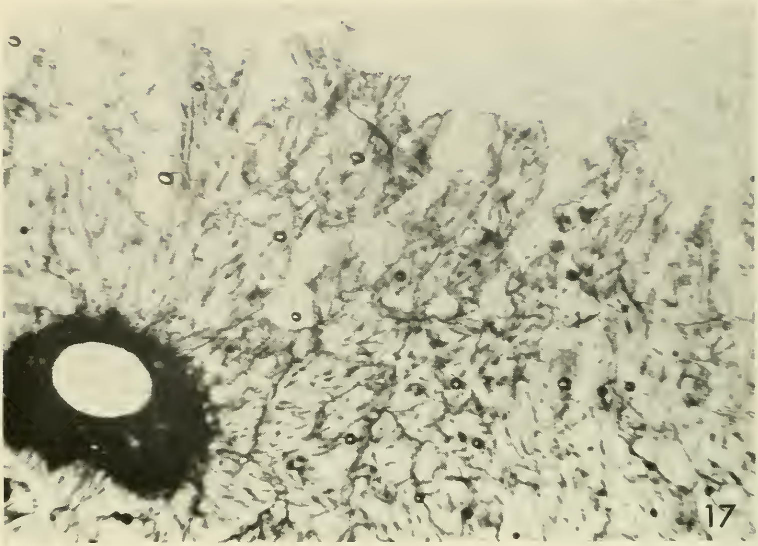

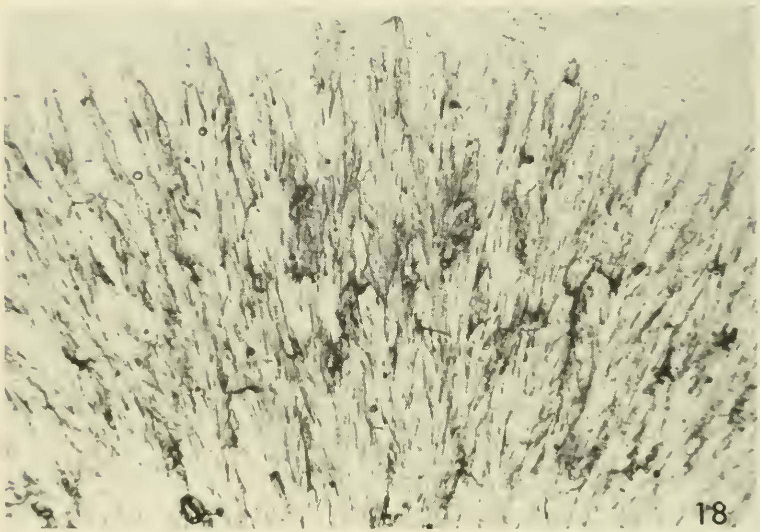

FIG. 17. *Stromatospongia vermicola* sp. nov. Ground thin section of calcareous skeleton perpendicular to surface showing surface processes, siliceous spicules embedded in aragonite and section of serpulid tube. ×25.

FIG. 18. *Stromatospongia norae* sp. nov. Ground thin section of calcareous skeleton perpendicular to surface showing surface processes and siliceous spicules embedded in aragonite. ×25.

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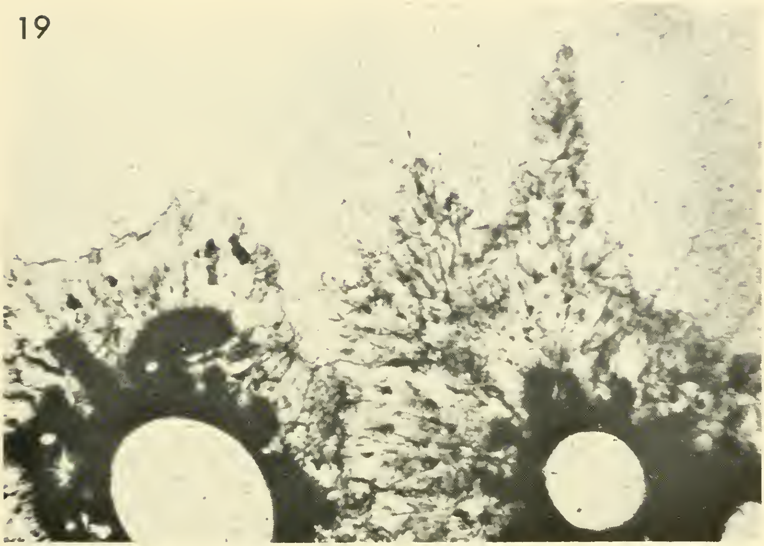

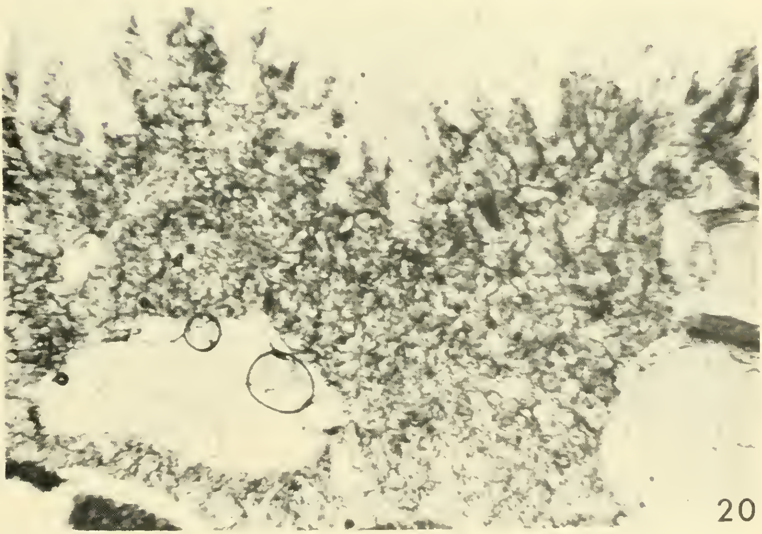

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FIG. 19. *Hispidopetra miniana* sp. nov. Ground thin section of calcareous skeleton perpendicular to surface showing surface processes from which siliceous spicules protrude and sections of serpulid tubes. ×25.

FIG. 20. *Goreauiella auriculata* sp. nov. Ground thin section of calcareous skeleton perpendicular to surface showing outlines of surface processes. Cavities represent clionid galleries. ×25.

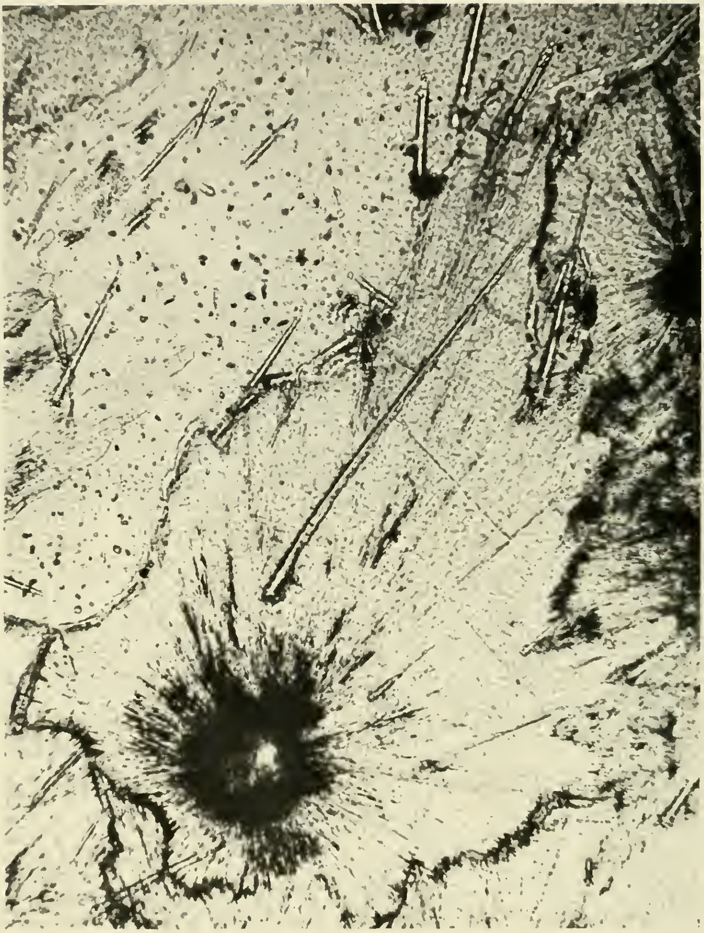


FIG. 21. *Stromatospongia vermicola* sp. nov. Ground thin section of calcareous skeleton showing sclerodermite surrounding serpulid tube. Note partially eroded siliceous spicule. YPM No. 6377. Discovery Bay, Jamaica: 71 m. × 132.

FIG. 22. *Stromatospongia norae* sp. nov. Ground thin section of calcareous skeleton showing sclerodermite and siliceous spicules embedded in aragonite. YPM No. 7770. Runaway Bay, Jamaica; 26-28 m. ×132.

FIG. 23. *Hispidopetra miniana* sp. nov. Ground thin section of calcareous skeleton showing sclerodermite. YPM No. 6460. Runaway Bay, Jamaica; 38 m. $\times$132.

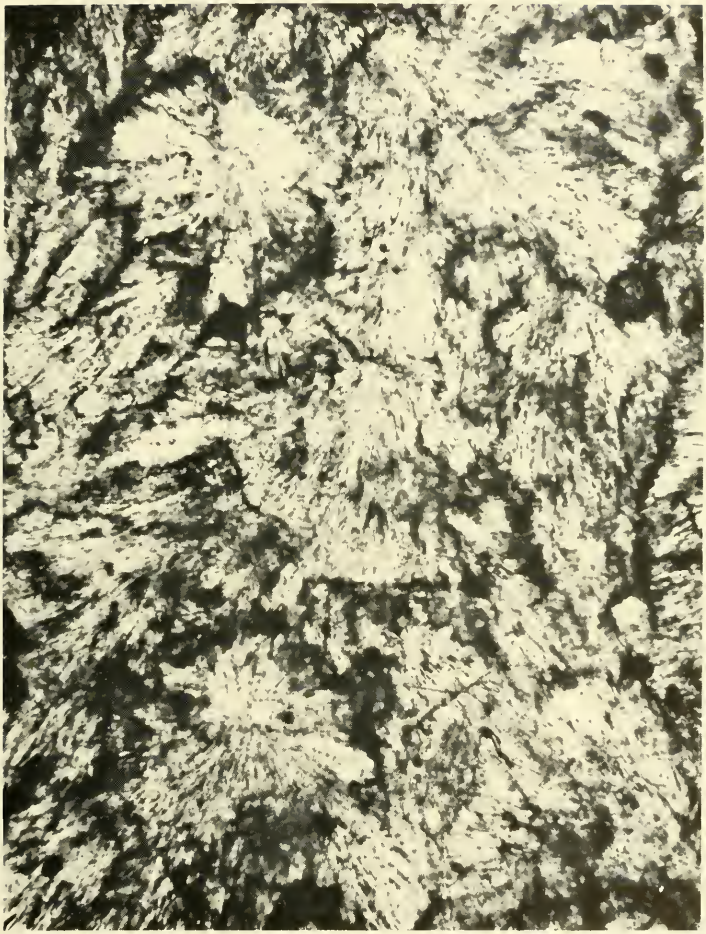
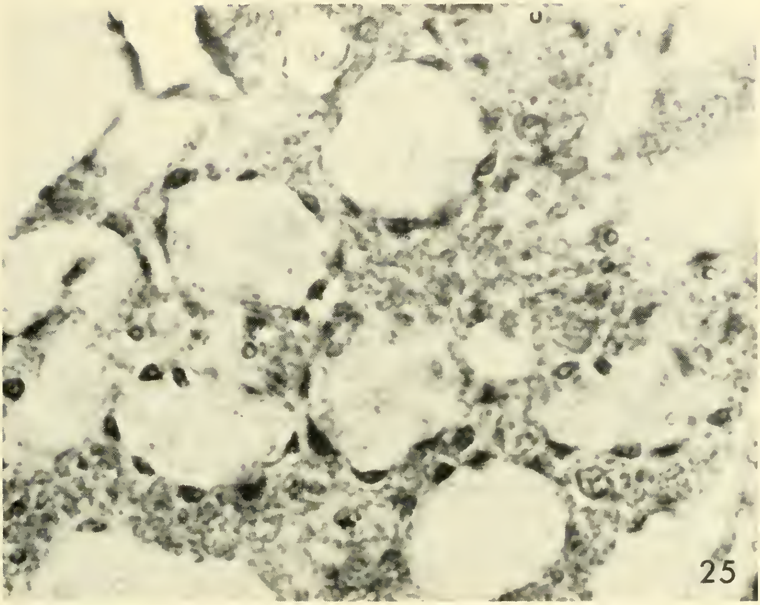


FIG. 24. *Goreauiella auriculata* sp. nov. Ground thin section of calcareous skeleton showing sclerodermites. YPM No. 6464. Runaway Bay, Jamaica: 25 m. ×132.

FIG. 25. *Stromatospongia vermicola* sp. nov. Decalcified thin section showing choanocyte chambers. Hematoxylin and eosin; 7μ section. $\times$ 1538.

FIG. 26. *Stromatospongia norae* sp. nov. Decalcified thin section showing choanocyte chambers. Mallory's phosphotungstic acid hematoxylin; 7μ section. $\times$ 1538.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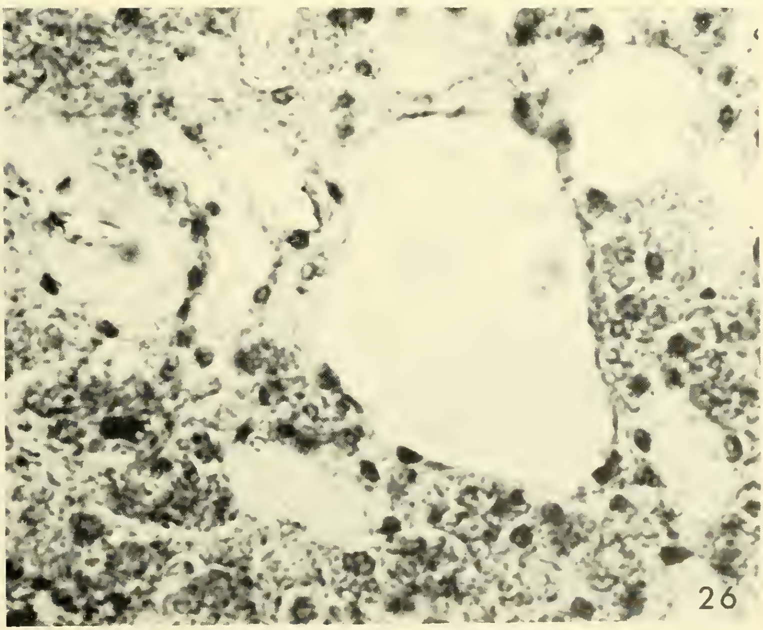
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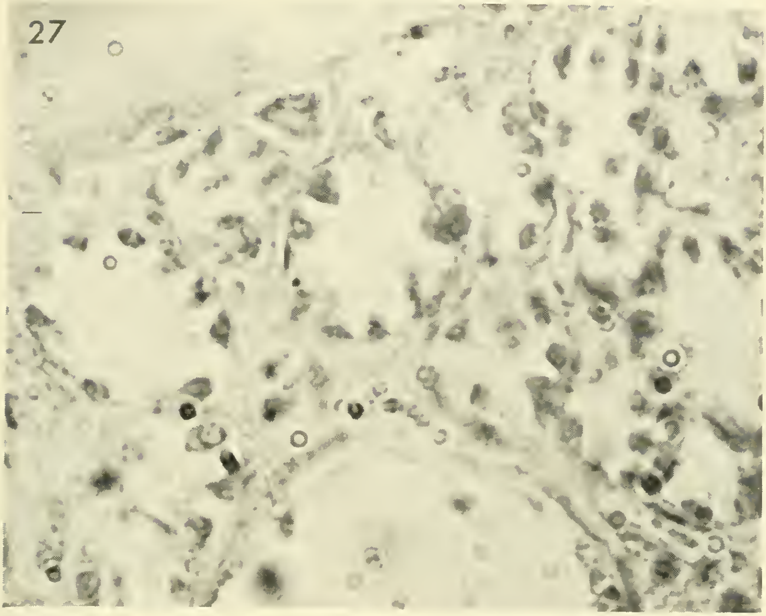
FIG. 27. *Hispidopetra miniana* sp. nov. Decalcified thin section showing choanocyte chambers. Hematoxylin and modified Mallory trichrome; 7μ section. × 1538.

FIG. 28. *Goreauiella auriculata* sp. nov. Decalcified thin section showing choanocyte chambers. Hematoxylin and modified Mallory trichrome; 8μ section. × 1538.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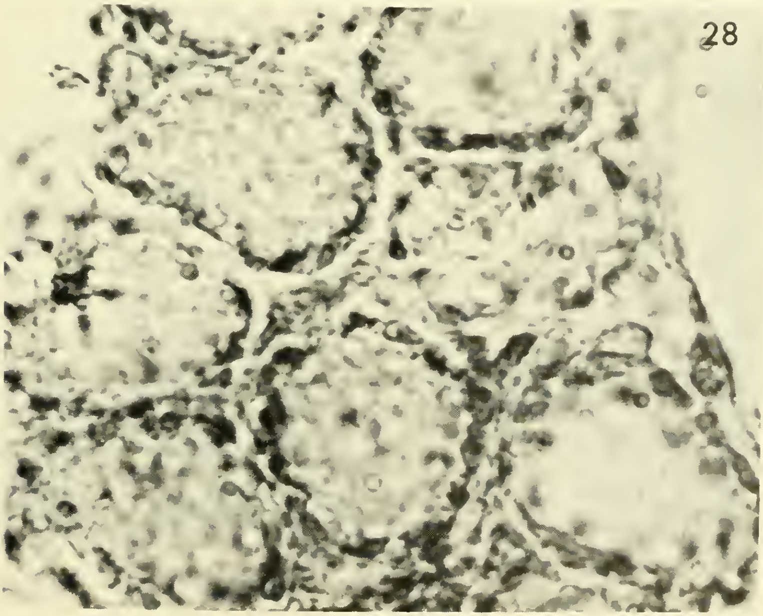
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FIG. 29. *Stromatospongia vermicola* sp. nov. Surface view of living specimen *in situ* showing expanded excurrent channels. Oscule opens out at center of stellate pattern of channels at right top. Small dark dots represent incurrent openings from the vestibular cavity into the choanosome of the sponge. Runaway Bay, Jamaica, 40 m. ×7. Photo by T. F. Goreau.

FIG. 30. *Stromatospongia norae* sp. nov. Surface view of living specimen *in situ* showing stellate patterns of excurrent channels converging upon oscules. Dark spots represent incurrent openings from the vestibular cavity into the choanosome of the sponge. Runaway Bay, Jamaica; 25 m. ×7. Photo by T. F. Goreau.

FIG. 31. *Hispidopetra miniana* sp. nov. Surface view of living specimen *in situ* showing excurrent channels. Small dark spots represent incurrent openings from vestibular cavity into the choanosome of the sponge. Runaway Bay, Jamaica; 34 m. ×7. Photo by T. F. Goreau.

FIG. 32. *Goreauiella auriculata* sp. nov. Surface view of living specimen in *situ* showing dilated excurrent channels. Small dark spots represent incurrent openings from vestibular cavity into the choanosome of the sponge. Runaway Bay, Jamaica; 25 m. ×7. Photo by T. F. Goreau.

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