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PERMIAN SPONGES FROM WESTERN VENEZUELA

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ABSTRACT—An extensive suite of lithistid demosponges and heteractinid and sphinctozoan calcareous sponges has been collected out of the Palmarito Formation in southwestern Venezuela, south of the city of Mérida, in Mérida State. Taxa in the fauna include: *Defordia digitata* n. sp., *Defordia foliata* n. sp., *Defordia verrucula* n. sp., *Jereina robusta* n. sp. and (?) *Collatipora delicata* Finks, 1960, all tetracladine lithistid sponges. Hexactinellid sponges are represented only by root tufts. Calcareous sponges include the first recognized occurrence of the heteractinid *Wewokella solida* Girty, 1911 in South America. Sphinctozoan sponges include *Girtyocoelia dunbari* King 1943, *Vesicocaulis* (?) sp., *Apocoelia sphaera* n. gen., n. sp., *Guadalupia minuta* n. sp., *Cystothalamia nana* n. sp., *Amblysiphonella* (?) sp. and *Colospongia monilis* n. sp. The silicified sponges were collected from gray and dark-brown marine limestones out of the upper limestone member and range from late Leonardian to early Guadalupian age.

INTRODUCTION

PERMIAN Porifera are virtually unknown from Central and South America. Consequently, the rather extensive collections reported by Hoover (1981) from western Venezuela take on unusual significance. Little is known of details of systematic paleontology of many Permian groups between the moderately well-studied Mexican and Guatemalan outcrops of Central America and the Peruvian Permian section in South America (Newell, Chronic and Roberts, 1953). There have been no major systematic studies on Permian Porifera from Central and South America and, as a consequence, many of the sponges collected by Hoover appear to be new taxa. The Venezuelan faunas do show close relationships to those described from western Texas and New Mexico (Girty, 1908a; King, 1943; Finks, 1960).

Initial collections were made by Hoover (1981, p. 7) during June and July of 1971, with access into the primitive area limited principally to areas along the mule trail south of Mucuchachí (Figure 1). He sampled as many fossiliferous localities as were readily available, to determine those that would be most productive and worthy of more intensive sampling at some subsequent time. Of the 41 localities initially sampled, sponges were obtained from four. These localities, and others that were particularly productive for other taxa, were recollected during March and April of 1973, when nine of the 41 original 1971 localities were recollected in bulk. Three localities produced significant sponge faunas.

Hoover (1981, p. 8) concluded that the Palmarito fauna is Tethyan but that much of the apparent temperate-zone character of the fauna was probably related to distribution on a relatively soft substrate, such as characterized nonreef assemblages elsewhere. He concluded that the Venezuelan assemblages are probably a record of a variety of warm-water shelf environments that range from beach or bar to level bottoms below wave base.

Trumpy (1943) described a sequence somewhat similar to the Palmarito Formation from Sierra de Perijá in Colombia, and reported sponges, in addition to foraminifers, crinoids, brachiopods, gastropods and cephalopods. Burgl (1973) reported Permian rocks from other areas in Colombia but did not cite occurrences of sponges. Hoover (1981, p. 9) noted that, to his knowledge, only the foraminifera (Miller and Williams, 1945) and cephalopods (Thompson and Miller, 1949) have been treated in systematic paleontologic literature. Several areas within South America contain faunas or sections of Permian age that all appear to be assignable to the Tethyan realm (Hoover, 1981, p. 8–10) but none have produced extensive sponge faunas. The collection described here, thus, is the most extensive Permian poriferan assemblage known to date from the continent. Hoover (1981, p. 8–13) has summarized regional knowledge of Permian deposits.

The Permian Palmarito Formation is exposed in Mérida State, at approximately 8°

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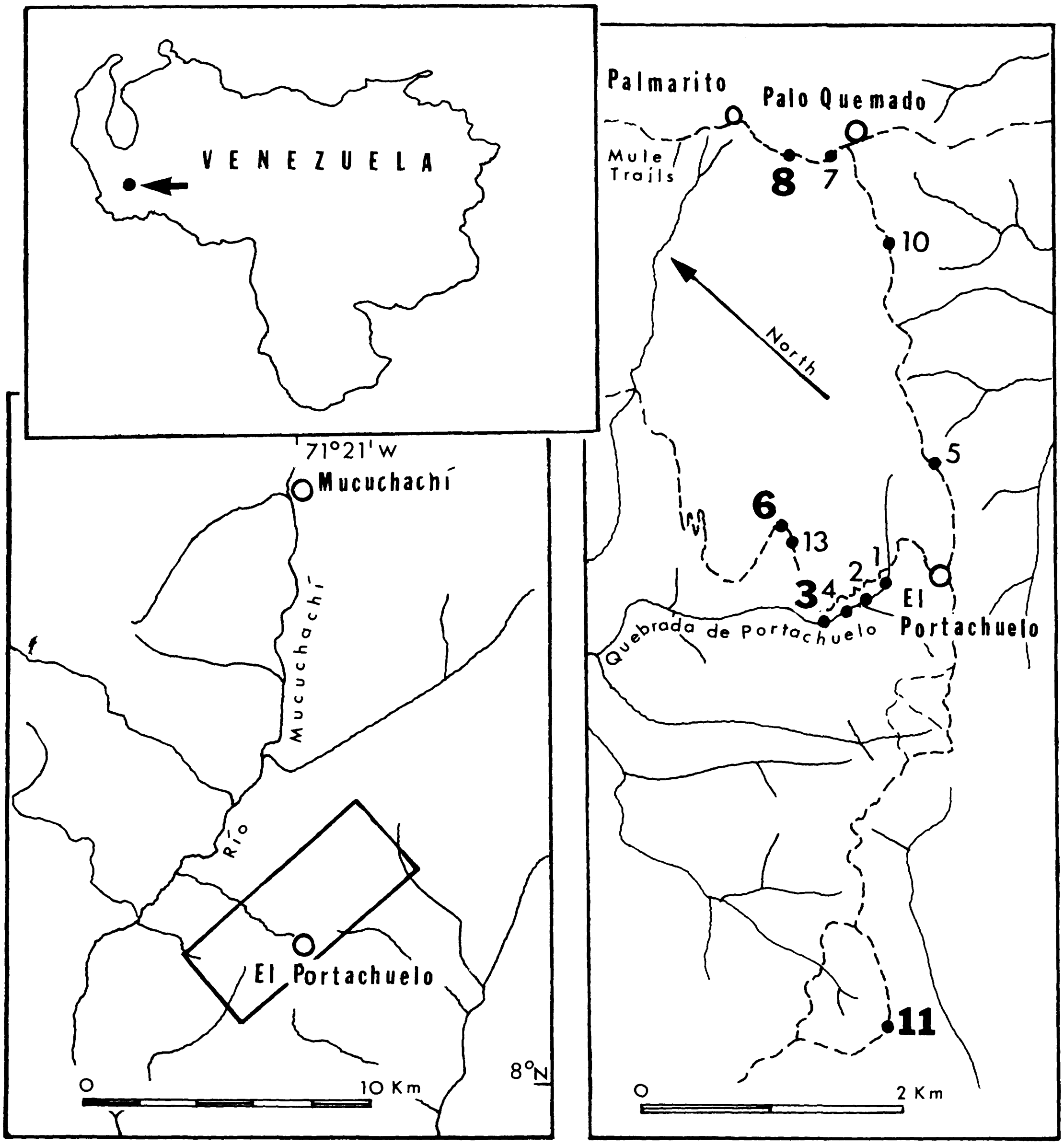

FIGURE *1*—Collecting localities from the Palmarito Formation, Upper Permian, near El Portachuelo in western Venezuela. Localities 3 and 6, west of the community, and Locality 11, south of the community, produced nearly all the sponges described here. The other localities, in addition, are those cited by Hoover (1981), who collected the fossils (Modified from Hoover, 1981, text-fig. 1).

North latitude and 72°21′ West longitude, in the Venezuelan Mérida Andes (Figure 1). The rocks range from late Early to early Late Permian (Roadian–Wordian). Hoover (1981) has summarized faunas from extensive collections in the formation, as well as the stratigraphic and regional setting of these significant Permian outcrops. The productive outcrops are approximately 250 km south of the city of Mérida in Venezuela.

The Palmarito Formation consists of a predominantly clastic, terrigenously influenced, lower shaly member and a predominantly marine upper limestone member. The latter

TABLE 1—Distribution of fossil sponges in localities of the Palmarito Formation, Venezuela.

Taxa	Localities 3	6A	6B	6C	11
Demospongea					
Defordia digitata n. sp.	X	–	–	–	–
Defordia foliata n. sp.	–	X	X	–	–
Defordia verrucula n. sp.	X	–	–	–	–
Jereina robusta n. sp.	–	X	X	X	–
(?) *Collatipora delicatula* Finks	–	–	–	X	–
Hexactinellida					
Hexactinellid root tufts	X	–	–	–	X
Calcarea (Heteractinida)					
Wewokella solida King	–	–	–	–	X
Calcarea (Sphinctozoa)					
Girtyocoelia dunbari King	X	–	–	–	–
Vesicocaulis (?) sp.	X	–	–	–	–
Apocoelia sphaera n. gen., n. sp.	X	–	–	–	–
Guadalupia minuta n. sp.	X	X	X	–	–
Cystothalamia nana n. sp.	X	–	–	–	–
Amblysiphonella (?) sp.	X	–	–	–	X
Colospongia monilis n. sp.	X	–	–	X	?

ranges from the late Leonardian to early Guadalupian, according to Hoover (1981, p. 13–17).

Christ (1927, p. 402) described the type section of the formation along the trail between Palmarito and Palo Quemado. Arnold (1966, p. 2373) reported that the rocks there are poorly preserved, however, and are deeply weathered, eroded and faulted. He suggested that one of the more consistently exposed sections along one of the nearby streams should be selected as a reference section. He illustrated a cross section of the formation and underlying beds along Quebrada Portachuelo, cited as Quebrada Quevado in his illustration and discussion (Arnold, 1966, text-fig. 5).

The lower member (Arnold, 1966, p. 2374) is mainly calcareous dark gray to medium gray shale. Resistant bluish gray limestone is a minor constituent and occurs in thin layers or concretionary units. Sandstone is common in the lower 40 m of the lower member and contains plant fragments. Some sandstone units are cross-bedded. Arnold (1966, p. 2374) listed the lower member as 320 m thick.

The upper member, where the sponges described here were collected, consists predominantly of "hard crystalline limestone" that is medium- to thick-bedded, according to Arnold (1966, p. 2375). Layers with chert nodules occur in the lower part of the member and interbedded marly units are abundantly fossiliferous. The upper member is 234 m thick in the Portachuela area (Arnold, 1966, p. 2374).

LOCALITIES

Fossil sponges described here came from three localities. Locality 8 produced only unidentifiable fragments and is not listed in Table 1. These localities are treated extensively in Hoover's (1981) monographic study.

Locality 3.—"Locality 3 lies within the Quebrada de Portachuelo, at the brink of the first high (over 5 m drop) waterfall encountered when proceeding downstream from the head of the stream." Exposures are of the upper Palmarito limestones and are thick to massive beds, separated by partings of medium-gray calcareous siltstone. Fossiliferous limestones are dense, dark gray, silty and petroliferous biomicrite. They contain an apparently transported sponge fauna of dominantly calcareous sphinctozoan and heteractinid sponges in association with a varied gastropod and brachiopod fauna. Hoover (1981, p. 22) noted that the sponges probably initially attached to living or dead brachiopods, but in turn, were subsequently the locus for attachment of other brachiopods in the probably otherwise soft substrate. Dark color of the limestone is interpreted by Hoover (1981, p. 22) to be a result of hydrocarbon infiltration and not an originally euxinic environment.

Locality 6.—"Locality 6 consists of a rolled exotic block located beside the mule trail that connects El Portachuelo and Mucuchachí." Because of the unusual fossil assemblage, discovered there in the 1971 sampling, three levels within the block were later collected (Hoover, 1981, p. 24–25). Block A came from the bottom, block B from the middle, and block C from the top. Hoover (1981, p. 24) reported all three levels in the block appear to be framework-supported, thick-bedded, petroliferous, light gray to tan, silty limestone bearing numerous finely silicified fossils.

Thin sections show the lithology as spicular biomicrite or wackestone and boundstone. The rocks contain a varied assemblage of brachiopods, bryozoans, gastropods and sponges. Again, the sponges functioned as the apparent substrate to many of the brachiopods that lived above the sea floor. Hoover (1981, p. 25) interpreted the basic substrate as apparently the same at all three levels, a soft biomicrite upon which sponges and clams provided a secondarily hard surface. He interpreted the fine calcareous sediment as apparently settling because of effective baffling by fenestellid bryozoans and anastomosing sponges. He interpreted the environment as shallow, warm water with moderate current activity.

Locality 8.—"Locality 8 lies on the side wall of the mule trail connecting Palo Quemado and Mucuchachí, about 200 m towards Mucuchachí from the small chapel locally known as Capilla de la Santa Cruz de Palmarito. This is on the old Santa Barbara de Barinas–Mucuchachí mule trail, within the type section of the Palmarito Formation, as defined by Christ (1927)." Hoover (1981, p. 26) reported that the fossils were recovered from a totally leached section of rock, from which calcareous material has been removed to over 1 m deep and that the fossils were recovered by collecting from the surface.

Locality 11.—"Locality 11 consists of several exotic blocks lying up a steep slope from the disused mule trail that connects the small settlements of El Portachuelo and Santa Rosa (Figure 1). It lies on the west flank of the Quebrada Palmar, near the head of that stream. The rocks are repeated intercalations of thin- to medium-bedded, dense, dark gray, petroliferous fossiliferous silty limestones and thinner fossil-poor calcareous siltstones." The very diverse fauna, dominated by brachiopods, gastropods and sponges, contains bryozoans, cephalopods, corals, and echinoderms, as well, and came from a relatively thin packstone-grainstone layer. These fossils are probably simply localized concentrations derived by winnowing of the thinner bedded, muddier parts of the section. This fauna is one of the most diverse in the Palmarito Formation, but most of the fossils appear to have been derived, that is are allochthonous to their present environment.

Localities 3, 6, and 11 produced virtually all of the identifiable sponges in the collection. Hoover (1981, p. 31) concluded that almost all of these assemblages are characteristic of soft, muddy substrates. However, rocks at Localities 3 and 6, which produced important sponge associations, show evidence of elevated energy levels, with some hard-bottom assemblages that particularly colonized the sponge substrate. Hoover (1981, p. 31) interpreted hypersaline conditions to have existed during deposition of rocks at Locality 3 and to have limited optimal development of the full faunal diversity provided by the hard substrate. This contrasts to Locality 6 where more normal open-marine conditions were present and where greater diversity could have developed. Hoover (1981, p. 13–16, 31–37) has extensively treated similarities of these faunas to those from other areas of Central and North America, as well as elsewhere in the general Tethyan Belt.

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SYSTEMATIC PALEONTOLOGY

Class DEMOSPONGEA Sollas, 1875
Suborder TETRACLADINA Zittel, 1878
Family CHIASTOCLONELLIDAE Rauff, 1895

Finks summarized the chiastoclonellids as massive sponges with variously developed radial architecture and with a skeleton composed mainly of chiastoclones. Dendroclones and tetraclones may also be present and the skeleton is not strongly organized in linear series, as it is for example in the Anthaspidellidae (Ulrich, 1890, p. 221). Finks (1960, p. 63, 64) discussed the family and included *Chiastoclonella* Rauff, 1895 from the Silurian, *Insulipora* Finks, 1960, *Defordia* King, 1943, and *Actinocoelia* Finks, 1960 within it. The latter three genera are from the Permian of North America.

Insulipora (Finks, 1960, p. 64) is a massive sponge with a surface marked by circular oscular depressions and isolated, circular, ostia with meandering and anastomosing surface grooves that generally avoid the large openings. *Defordia* is commonly a massive sponge, although some species are lobate or subdigitate, as well, but with an upper surface bearing oscules that are more or less uniformly distributed, with large ostia, and shallow to deep grooves that connect each of the large pores and converge towards the oscula. Interior canals are generally radial and concentric. *Actinocoelia* is also a massive sponge but with a skeleton and canal system so oriented that continuous radiating trabeculae are produced. These tend to give the sponge a more organized skeleton than in other genera in the family.

The Jereidae (De Laubenfels, 1955, p. E57) have skeletons composed of tetraclones and chiastoclones in irregular orientation, according to the diagnosis presented by Finks (1960, p. 74). These sponges have an axial region occupied by large parallel excurrent canals that open chiefly on the summit.

Genus DEFORDIA King, 1943
DEFORDIA DIGITATA n. sp.
Figures 2E, 4A

Diagnosis.—Markedly digitate to subdigitate sponges with a flattened or lobate base; surfaces generally smooth except at oscula, which are irregularly developed along the branches and particularly well developed at the ends of the branches, as shallow depressions into or from which a series of circular canals radiates or converges. Principal canals upward converging, radially arranged and connecting with a subdermal vertical series that is parallel to the length of the branches. Otherwise interior dense, lacking major central canals. Skeleton principally of chiastoclones with minor small tetraclones and possible dendroclones, not strongly organized into radiating or linear series.

Description.—Numerous fragments and many nearly complete sponges are in the collection. They range from relatively massive bases, 50–70 mm across, to delicate branches only 7–8 mm in diameter. In general, the growth form of the sponge is like a hand with upcurved fingers, although with some irregularity. The holotype is characteristic of the digitate part of the sponge. Above the somewhat massive, irregular lobate base it has a branched growth form with digitations up to 10 cm long, with two minor branches 3–4 cm long. Broken bases of other short smaller digitations occur along the major branches. Individual digitations are irregular but range from 8 mm to a maximum diameter of 14 mm. Each of the branches shows irregular expansion and contraction along its course, not regular annulations, but undulating irregularities in the growth of the sponge.

Tips of branches are capped by oscula. The major branch terminates in a shallow depression, into which excurrent canals empty from the interior of the branch. The branch also has several low, conical, oscula that are irregularly spaced 5–8 mm apart. These are on low cones, up to 2 mm above the general branch, and have small openings 1 mm deep and up to 2.5–3.0 mm wide at their crest. They appear somewhat like small volcanic craters. Oscula at the tips of the branches, however, are considerably larger and deeper. For example, one at the tip of the main branch is 6 mm in diameter and approximately 3 mm deep. Others are less pronounced.

The sponge surface generally is smooth, except for the small conical oscula, but is pitted with small openings of incurrent canals that penetrate through the relatively thick dermal layer and interconnect to larger canals in the interior of the sponge. In general, these small openings are only moderately well-defined and are widely spaced. They are 0.08–0.16 mm across and are circular to irregularly elliptical. However, most interconnecting openings through the dense dermal layer are small skeletal pores between the spicules. A well-defined series of canals through the outer dermal layer is only locally well-developed.

Principal canals are well preserved in the interior of the sponge. Most evident in transverse section are the ascending to radial canals that are 0.4–0.5 mm in diameter. These canals are irregularly spaced. In some areas they occur 7 or 8 per 5 mm, as measured parallel to the circumference of the sponge branches, but in other areas, only 1 or 2 canals occur in that same distance. The radiating canals rise upward and inward, converging toward the axis of the sponge, apparently subparallel to rounded tips of earlier stages of growth.

A vertical series of the same general size, to slightly smaller, cross-connects with the radial series immediately beneath the dermal layer. These vertical canals are 0.3–0.6 mm across, although most are 0.5–0.6 mm in diameter. These openings are concentrated within 0.5–1.0 mm of the exterior, beneath the dermal layer that is 0.3–0.6 mm thick. The canals are circular to slightly elliptical. Elliptical ones have their long axes parallel to the radial canals and, in reality, the radial canals may have their origin in the vertical series.

A less well-defined concentric canal series cross-connects with others at irregular intervals. The concentric series is particularly well-defined in the outer third of the branch. Concentric canals are 0.2–0.4 mm in diameter and are irregular in terms of their traceable length. They cross-connect only two or three vertical or radiating canals. Where most prominently developed, they are separated by approximately the same width of skeletal material as their diameter.

In general, courses of all the canals are somewhat irregular. None are distinctly straight or very long. The dominant canals are the inward ascending radial series. They are evident in every section through the sponge, whereas the other canal series are less prominently developed.

Large canals, 0.7–1.3 mm across, locally occur in the middle third of the branches. These are very discontinuous, nearly vertical parallel to the long axis of the digitation, and are most pronounced in the immediate vicinity of oscula, but certainly do not form a major excurrent series in the center of the sponge.

Filled oscula are evident in some cross sections where individual gastral layers, 0.10–0.15 mm of dense thickened spicules, define former excurrent openings. In one example on the holotype, still open radiating canals terminate against the dermal layer or in the spicular filling of an osculum. Spicules that fill the early oscula are of essentially the same character as endosomal spicules elsewhere in the sponge.

Irregular thickened layers that may mark former dermal layers also occur as well. They are generally 0.1 mm thick and show in transverse sections as somewhat irregular concentric lines in the moderately dense, uniform, fine endosomal net.

Canals in the irregularly subdigitate or lobate bases are even more irregular than in the finger-like parts of the sponges. These canals are 0.5 mm in diameter, are smaller, and are the dominant openings in the skeleton. They are irregularly spaced and certainly not organized into a distinct geometric pattern.

Water, thus, appears to have flowed in through the relatively minor incurrent canals and skeletal pores, into the large concentric or ascending radial canal series and through these, up and out the oscula. The dense dermal layer in older parts of the sponge suggests that these parts may have been sealed from the exterior and that active circulation was most vigorous in the finger-like distal parts of the sponge.

Fabric of the skeleton, when exposed in broken sections consists of an outer dense dermal net, an open porous zone of radial, concentric and vertical canals in the 1–2 mm inside the dermal layer, and the principal, much more dense interior of the digitation, where canals are less common. Such skeletal zonation shows in virtually all specimens in the collection, but, because of somewhat irregular or crude silicification, details are commonly lost.

Spacing, pore size, and gross shape of the spicules are clearly evident in all of the specimens but in only a few specimens are details moderately well-preserved. The fused chiastoclones, dendroclones and tetraclones produce a compact uniform skeleton. Interspicular spaces are rounded and are 0.03–0.08 mm in diameter, with most openings approximately 0.05 mm across. These skeletal pores are complexly interconnected and produce a uniformly open, porous, fused skeleton. The small skeletal pores are usually bounded on at least half their circumference by rays of single spicules.

Tetraclone and chiastoclone rays are 0.015–0.020 mm in diameter and 0.05–0.06 mm long, to where the arborescent ray tips of spicules are firmly fused to one another. These fused tips are the most consistently preserved part of the skeleton and are 0.03–0.05 mm in diameter. These give a "dotted" appearance to the net in areas where silicification is less than ideal. Individual X-, H-, or occasional Y-shaped chiastoclones are regularly oriented and have total spicule lengths of approximately 0.1–0.14 mm, from ray tip to ray tip.

The rhabdome and cladome are not clearly differentiated in the almost Y-shaped dendroclones because of the moderately coarse silicification. Chiastoclones have smooth rays 0.06–0.10 mm long. Details of ray tips are obscured in all but exceedingly rare, delicately silicified spicules.

Isolated bits of the skeleton show limited linear arrangement, particularly along canals or in areas where the smallest incurrent openings are evident. Trab-like structures are only local and the massive, uniformly dense, nonradiating character of the net is evident in virtually every cut or broken section through the sponge. Trabs, like those in the Anthaspidellidae, are certainly not developed, nor are there other than rare oxeas or similar spicules.

Discussion.—Finks (1960, p. 65) noted that species of *Defordia* are differentiated chiefly on the basis of shape of the sponge, and by number, size and distribution of pores and canals. We have applied those criteria to differentiate the Venezuelan species from ones described by Finks and others. In general, most species previously included within *Defordia* are massive bun-shaped or slightly lobate, but none are distinctly digitate, as is *Defordia digitata.*

Most species of the genus have distinct surface grooves or marked surface sculpture. For example, *Defordia defuncta* King (1943, p. 17) is a massive spheroidal to bun-shaped species with surfaces covered by small, flat-topped, projections outlined by deep grooves and with nodes capped by open oscula. *Defordia lobata* Finks (1960, p. 69) is a similar massive spheroidal species in which the interior of the sponge is dense, but that has distinct lobes in which the oscules are found. Finks noted that depressed sulci between digitations are commonly lined with an imperforate dermal layer. *D. digitata* has a similar dense dermal layer but it extends over much of the finger-like digitations. Ostia and pore sizes are generally similar to those in *D. lobata* or other species of *Defordia.*

Individual spicules in the Venezuelan material are difficult to identify because of their irregular and often coarse silicification. Many of the spicules are obvious tetraclones and have four rays of nearly equal length, producing an X- or H-shaped smooth-rayed spicule. Chiastoclones, in which the smooth shaft has three arborescent clads at each end, are also evident but the spicules are small and usually obscure.

The Venezuelan species lacks, for example, the prominent radial architecture of *Actinocoelia* Finks (1960, p. 70), the prominent axial canals of *Jereina* Finks (1960, p. 74–76) or the moderately well-organized architecture of the anthracosycons (Finks, 1960, p. 76–86).

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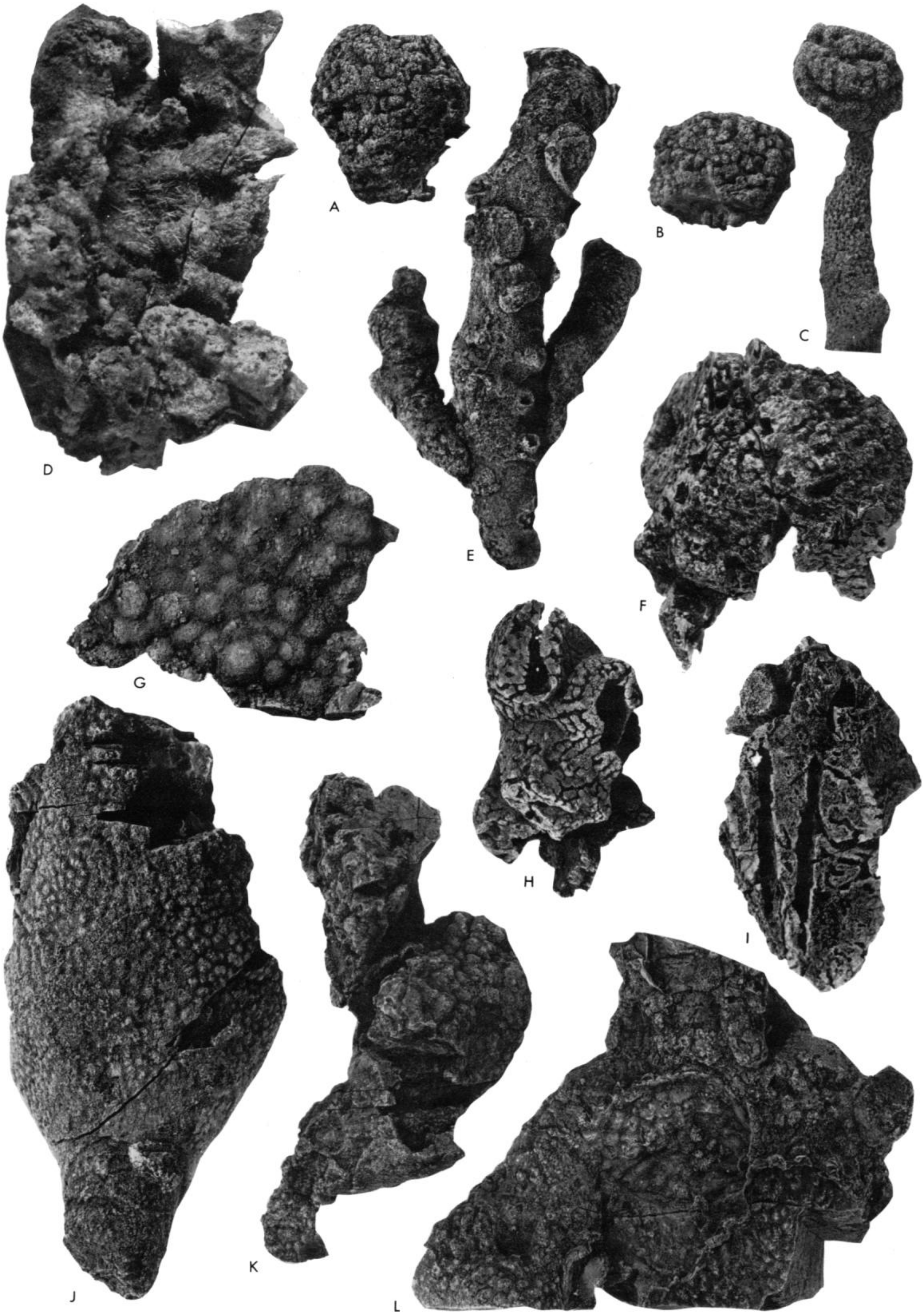
FIGURE 2—The lithistid sponge genera *Defordia, Collatipora,* and *Jereina* and hexactinellid root tufts from the upper Palmarito Formation. *A, B,* (?) *Collatipora delicata* Finks, Locality 6C, USNM 340076. *A,* side view showing general form, surface-canal development, ×2. *B,* view from above showing ostia field near the center and knobby sculpture of the species, ×2. *C, H, Defordia foliata* n. sp. *C,* juvenile specimen attached to trepostome bryozoan. Canal dimensions and pattern relate even small sponges of the species. Locality 3, USNM 340064, ×2. *H,* holotype from above showing irregular wavy growth form and canal pattern typical of the species. Locality 6A, USNM 340065, ×1. *D,* hexactinellid root tuft showing packed monaxial spicules in the center of the silicified limestone. Locality 3, USNM 340078, ×2. *E, Defordia digitata* n. sp., holotype, digitate form and conical ostial openings of densely-spiculed skeleton are characteristic. Locality 3, USNM 340060, ×1. *F, I, Jereina robusta* n. sp. *F,* holotype from above showing distribution of major excurrent canals (arrows) and sculpture produced by tangential surficial canals. Locality 6C, USNM 340073, ×1. *I,* paratype, side view through the interior showing distinctive large vertical excurrent canals and relationships to radial subhorizontal series of canals. Locality 6C, USNM 340074, ×1. *G, J–L, Defordia verrucula* n. sp. *G,* rounded characteristic nodes of the exterior of a fragment. Locality 3, USNM 340069, ×2. *J,* large conical paratype with distinctive rounded nodes from the side. Upper end fragmented. Locality 3, USNM 340070, ×1. *K,* knobby paratype from the side, showing canal pattern and dense skeleton in upper fractured surface. Locality 3, USNM 340071, ×1. *L,* massive holotype showing knobby surface and irregular growth form. Base fractured. Locality 3, USNM 340068, ×1.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B
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Dactylites (Finks, 1960, p. 84) is a digitate sponge with a rather smooth surface. Finks included *Dactylites* in the Anthracosyconidae, a family in which the skeleton is organized in horizontal and concentric layers. He noted that *Dactylites* (1960, p. 84) has spicule layers concentrically arranged, parallel to the surface. In this important respect, *Dactylites* differs from the present species. They are similar, however, in their digitate form, relatively smooth surface and moderately uniformly distributed ostia and fused surface canals. Differences in orientation of the skeletal net in the interior, however, are significant and certainly separate the genera and species.

Etymology.—Digitata, Latin fem., having fingers.

Type specimens and available material.— Holotype USNM 340060 and paratypes USNM 340061–340063, from Locality 3.

DEFORDIA FOLIATA n. sp.
Figures 2C, H, 4D

Diagnosis.—Irregularly thin, foliate, wrinkled or anastomosing sponges marked on their exterior by irregular grooves that produce a knobby surface and that generally converge to widely spaced oscula. Oscula formed by junction of excurrent canals. Skeleton of tetraclones, with combined dendroclones or chiastoclones, irregular and non-aligned; radial orientation generally lacking. Principal canals feed directly through the thin walls.

Description.—Numerous fragments and several nearly complete sponges, up to 5 cm long or in diameter occur in the collection. They sometimes form irregular anastomosing tube-like masses. The holotype is one of the largest fragments and shows the general form of the species. This sponge is approximately 5 cm long and 3 cm across and is anastomosing. Characteristically, individual layers or walls of the sponge are 3–6 mm thick, with thinnest areas generally at the rounded convoluted edges of undulating, sometimes merging, lower or inner surfaces.

Dermal surfaces are relatively dense, pitted with small incurrent openings 0.13–0.20 mm in diameter. The latter are closely spaced, where the dermal layer is preserved. However, where the dermal layer is poorly defined, a more open texture is developed. Individual incurrent canals and ostia there are 0.45–0.90 mm in diameter, with most approximately 0.6 mm across. These canals may pierce directly through the wall or may branch into the interior. In some areas these incurrent ostia are arranged in linear series but generally they are irregularly spaced. In linear series, they are 0.45–0.90 mm apart and occur 4 or 5 per cm. The small canals, so well defined in the dermal layer, also may occur in skeletal sections between the larger openings. The small canals occur two per node in the skeleton between ostia of the main incurrent canals. The radial incurrent canals expand slightly into the middle part of the wall, where they may cross-connect with canals that are subparallel to the direction of growth. This produces an irregular meshwork of canals in the middle part of the sponge that is the most open porous part of the wall.

Canals that are subparallel to the surface are generally subcircular and are 0.8–1.0 mm in diameter. Some may be slightly elliptical in cross-section, with the long axis at right angles to the dermal or gastral layer. These connect to the exterior through excurrent canals that are mainly 0.5–0.8 mm in diameter. The linear, subparallel dermal canals are often only partially bridged with lobate skeletal tracts. These canals and ones developed right at the surface produce the strongly marked, highly open texture of the exterior. These canals converge to the occasional well-defined osculum on the surface. Canals near the exterior characteristically are not bridged across totally. Canals may be up to 1.0 mm across, 0.8 mm below the exterior, but then narrow unevenly to meandering, irregularly oriented grooves only 0.3–0.6 mm across. The canals in the middle and inner part of the sponge are the coarsest ones and produce the grooved surface so characteristic of even fragments of the form.

In some fragments, the canal system produces long, almost slit-like, openings in the middle part of the wall where the two major canal series merge. The slits are oriented approximately at right angles to the gastral-dermal margin and may be twice as high as wide. Slits up to 2 mm high result from canals that are approximately 1 mm or slightly less wide. This does produce a somewhat elongate fabric to the sponge skeleton.

Skeletal tracts are 0.5–1.0 mm across in the interior and those between canals are characteristically 0.8–1.0 mm in diameter and expand in outer parts. In the zone of maximum internal canal development, these tracts are only 0.1–0.5 mm across. This produces a distinctly open wall in the interior, in contrast to the dense dermal and gastral layers.

Details of the skeleton were not preserved on most specimens and the skeletal tracts are preserved as dense, vitreous, coarsely crystalline chalcedony. On a few specimens, however, silicification has not been so intense and the general fabric of the skeleton is better preserved. Spicules were characteristically thickened during silicification even here, however. Pores between spicule rays are 0.03–0.06 mm across. They are circular and have irregular courses because of uneven radial or linear orientation of individual spicules. The entire skeleton tends to be massive and dense. Spicule ghosts are outlined by irregular grains in the chalcedony. In some of these, X-shaped tetraclones show well, with short, smooth central shafts, 0.02 mm long and 0.01 mm in diameter, that expand into the four principal rays. Each ray is 0.04 mm long and terminates in an arborescent, hand-like structure. Additional details are lost because of the preservation. Such spicules are rare, however, and most of the net has been merely replaced by massive chalcedony. Trabs, or other prominent structures that show lineations, are wanting.

A few minor oxeas also occur in sections and in some of the broken fragments. These appear to be foreign rather than an integral part of the skeleton.

Discussion.—The principal diagnostic feature of the sponge is the irregular crinkled, anastomosing form of the species. The distinctive, partially bridged, canal system that forms surficial and intermediate open porous spaces is also characteristic so that even fragments can be recognized.

Etymology.—*Foliata,* Latin fem., leafy.

Type specimens and available material.—Holotype, USNM 340065, and paratypes USNM 340064 and 340066 from Locality 6A, and another paratype, USNM 340067, from Locality 6B. In addition dozens of fragments occur in collections from the same localities.

Defordia verrucula n. sp.
Figures 2G, J–L, 4B, F

Diagnosis.—Massive incrusting to hemispherical lobate sponge in which the outer surface is nodose or with rounded mounds, with radiating canal systems, lacking major surface canals or oscula through the moderately dense, thin dermal layer. Skeletal net dense, perforated only by small radiating descending canals, most evident around the periphery. Net of equidimensional tetraclones and perhaps including chiastoclones and dendroclones as well, with crude radiating fabric.

Description.—Several large fragments and many minor fragments are in the collection. They range from nearly complete bun-shaped sponges, 3 or 4 cm in diameter, up to more irregularly lobate, massive and subdigitate forms, 8 or 9 cm across. The rounded bun-shaped or lobate forms are most typical, and are distinctly marked by the low rounded nodules over the entire surface. Most of these arise as subhemispherical mounds approximately 2 mm across and as much as 1 mm high. Bases of the almost circular nodes touch so that locally they appear almost subprismatic. On some specimens, the nodes are obscure, but on others they rise as almost conical knobs up to 1.5 mm high. The relatively uniform, yet not geometrically linear, packing is characteristic of the exterior.

The dermal layer over the mounds is dense, with most ostia opening in the intermound low spots. The dense dermal net is perforated by skeletal pores over the mounds. There are no major oscula nor are there major surface canals or broad wrinkles on the sponge exterior. The only sculpture is the low subhemispherical mounds characteristic on all fragments.

Ostia on the exterior are generally 0.2–0.3 mm across and occur subprismatically, though not uniformly, around bases of the more densely spiculed round nodes. In those few sponges where ostia are obviously prismatically arranged around the nodes, large interior canals occur near the side with the most obvious ostia and with the most pronounced low nodes. The opposite side is relatively smooth and may have functioned as a partially buried or attached base.

Cross sections through the sponge show

dominantly radial canals, each approximately 0.5–0.7 mm across. These are generally linear and lead out from the central part of the sponge, but are so spaced that the sponge does not have a major open porous section. These radial canals interconnect horizontal ones oriented subparallel and concentric to the dermal surface. The two series are principally at right angles. The latter subdermal ones are 0.5–0.8 mm across, but with some variation. These horizontal canals are most apparent immediately beneath the dermal layer, which is approximately 0.5 mm thick, but they are scattered moderately uniformly throughout the entire net. Canals of the radiating series are spaced approximately 1 mm apart, as are those of the concentric series, throughout the entire skeleton.

Rare canals, approximately 1 mm in diameter, occur in several specimens, but the significance of these large canals is not understood. They tend to be concentrated on one side of the bun-shaped forms; whether this is the upper or lower side is difficult to tell because of the predominantly radial character of the canal system. In some, the radial canals are stacked so that they occur approximately 1 mm apart, where three or four can be measured in a rectangular direction. Canals, 0.3–0.5 mm across, occur no farther apart than 1.5 mm throughout the interior of the sponge.

The nature of the dense dermal net is obscured by coarse silicification on all specimens. Individual skeletal elements appear to be markedly thickened. Some of this may be due to secondary coarse replacement by silica, but the dense layer is so omnipresent on all fragments that it must be related to initial differences in the skeleton of the outer 0.5 mm from endosomal parts.

Smallest openings in the sponge are skeletal pores that are 0.02–0.04 mm across. These are circular openings bounded by fused rays of the tetraclone-based skeletal net.

The general fabric of the sponge skeleton parallels the pronounced radial canals. This may induce a superficially radiating structure, in the otherwise only irregularly spaced, laterally fused, tetraclones.

Details of spicules are generally only poorly preserved. Most spicule centers are 0.05–0.08 mm apart in a non-linear arrangement, although locally short sections of trab-like rods appear in the silicified structure. These are discontinuous and rarely traceable for more than 0.2–0.3 mm in the net. Centers of the spicules are commonly short shafts, 0.03 mm or less long and 0.01–0.015 mm across. The tetraclones have four equal rays that are of essentially the same proportions, although up to 0.05 mm long in some large spicules near canals, where the skeletal net is occasionally best preserved. Details of the fused articulation of the spicules, however, are lost in the very coarse, sometimes crystalline or irregular ragged rhizoid silicification. Silicification of the net in most fragments has produced subspherical masses of silica spaced approximately 0.08–0.10 mm apart, three-dimensionally, though not geometrically predictably, throughout the sponge.

Discussion.—This species is associated with *Defordia digitata* n. sp. and was grouped with that sponge in initial classification. Almost all of these massive hemispherical sponges, however, are nodose and none of the digitate sponges have even suggestions of nodes. This dermal sculpture, plus growth form, separates these two sponges in the Venezuelan material. In canal dimensions and spicule characteristics, however, the forms are strikingly similar. *D. digitata* does have oscula and some weak surface canal development, whereas the massive forms do not.

Other associated massive lithistid sponges have large open canals and ornamentation marked by subparallel near-surface canals that immediately differentiate even fragments. Dimensions of the skeletal net, however, appear similar in all of the lithistids, perhaps because of the irregular silicification, but more probably because of the original similarity in size and orientation of individual spicules.

Defordia verrucula appears similar to *Defordia densa* Finks (1960, Pl. 14, fig. 10) in terms of general canal size and dimensions, although there is crude clustering of canals around the somewhat larger apochetes in the West Texas Permian forms (Finks, 1960, Pl. 13, fig. 8). Such canal arrangements are not seen in any of the Venezuelan sponges. In addition, the consistently pustulose surface characterizes all of the Venezuelan material but is not developed in West Texas representatives of *Defordia.* That sculpture is somewhat similar to the bumpy surface of (?) *Actinocoelia verrucosa* Finks. In that species, however, the nodules are considerably more conical, irregular and distinctly larger.

Etymology.—Verrucula, Latin fem., diminutive, wart, referring to the nodose surface of the sponge.

Type specimens.—Holotype USNM 340068 and paratypes USNM 340069–340072, all collected from the upper Palmarito Formation at Locality 3.

Family JEREIDAE DeLaubenfels, 1955
Genus JEREINA Finks, 1960
JEREINA ROBUSTA n. sp.
Figures 2F, I, 4C, E

Diagnosis.—Massive to sublobate, hemispherical to subspherical sponges, with the interior pierced by prominent, parallel to slightly diverging, large excurrent apochetes that terminate at the crest of the sponge in moderately widely spaced oscula. Prosochetes principally radial and connected to large apochetes in the interior. Surface marked by deep, meandriform, sometimes anastomosing grooves that subdivide the surface into irregular projections. Skeletal net dense, composed principally of small, uniformly spaced, tetraclones with possible chiastoclones and dendroclones, as well.

Description.—Two nearly complete, massive sponges of the species are in the collection, along with numerous extensively fractured fragments. The holotype is a nearly complete subhemispherical to massive sponge, approximately 6 cm tall and 5–6 cm in diameter, but with parts of the side and the base broken. This specimen shows the characteristic canal system and ornamentation of the species. Major excurrent canals produce broad round oscula at the summit, but without pronounced mounds or spongocoel depressions.

The exterior of the sponge is moderately rough, with projections outlined by the closely spaced radial canal series and the meandering to anastomosing series of paratangential surface canals. This produces a knobby, or almost warty-appearing sponge. Irregular protuberances on the surface are 2–4 mm apart. Some tend to be slightly linear, particularly along the flanks of the sponge. Those near the crest are stubby, stalk-like, or rounded finger-like features only 1–2 mm high.

The interior of the sponge is massive and perforated by relatively straight, tubular, excurrent canals that empty at round oscula on the summit or steep upper flanks. These large excurrent canals begin near the base of the sponge, although the exact bases on the specimens available have been fractured, where the canals are somewhat elliptical and approximately 2 mm in diameter. They expand upward to as much as 3.5 mm across, although most are approximately 2.0–2.5 mm across, even at the summit. In one of the paratypes, the near-basal origins of some large excurrent canals are moderately well shown. Here, canals 1.5 mm across, are traceable upward but bifurcate, and in so doing only one branch remains almost vertical for a short distance. The other bends sharply, becomes somewhat meandriform, and then sweeps laterally to join another large canal. Another associated large canal makes almost a right angle bend near its base but then trends vertically through the interior of the complex sponge net.

The large excurrent canals range from only 1.5–2.0 mm apart up to 6–10 mm apart. Each major excurrent canal is lined by a thin, dense skeletal layer, 0.5 mm thick, which is perforated here and there by large radial canals, approximately 1.2–1.5 mm across and 1.0–1.5 mm apart where they empty into the excurrent system. These large radial canals are slightly elliptical, and sweep up to form acute angles where they join the excurrent system, locally at 30°. Others, however, come in at almost right angles. The ones that meet more acutely form slits, whereas, those that join more or less at right angles form circular openings into the large vertical canals. The radiating canals are spaced 3–4 mm apart, generally, although in some areas three canals were seen to join one side of the canal in a distance of 4 mm, as measured vertically. In another excurrent canal, major radial canals enter about 5 mm apart.

In addition to the radial series, a crudely concentric, horizontal canal series parallels the dermal layer. These canals are approximately the same diameter as the radiating series, that is, 1.0–1.5 mm across. These are bridged in the interior, but only partially bridged on the exterior of the sponge. This produces some of the distinct dermal fabric characteristic of the species. When seen in eroded sections of lower parts of the sponge, these canals tend to be vertically elongate and merge in slit-like junctions with the radial series. Where these dermal canals are not developed, small circular ostia perforate the surface.

Finer intermediate canals, 0.15–0.2 mm in diameter, are commonly vertically arranged and interconnect the strong radiating series. Others of the same size are somewhat anastomosing and interconnect both the radial series and other intermediate canals that are more or less vertically oriented.

Smaller circular openings, 0.1–0.15 mm across, also occur in some areas where the skeletal net is well preserved. These small canals are spaced approximately 0.5–1.0 mm apart, although locally only 0.1–0.2 mm apart, such that 4 or 5 occur per millimeter, for a concentration of 20–25 per square millimeter. Elsewhere, however, the skeleton is less well-preserved, and the small canals are largely lost. These small canals pierce the rather wide skeletal tracts between the vertical excurrent canals and radiating intermediate-size canals.

The canal system of the sponge consists of: 1) dominantly vertically oriented, radiating canals that produce the characteristic texture of the sponge and lineated lumpy exterior as well; 2) lined, straight excurrent tubes, sometimes with curved bases; 3) concentric, horizontal canals of intermediate size; and 4) smaller canals that may be vertical or irregularly anastomosing through the skeleton.

Smallest openings are skeletal pores between or enclosed by spicule rays. These are generally 0.04–0.05 mm across and are outlined by individual arched rays. These pores are moderately uniformly spaced throughout the skeleton and would have allowed communication throughout the entire porous net.

In general, the skeletal net is not well-preserved because of coarse and sometimes massive vitreous chalcedonic replacement or silicification. In a few places the silicification was sufficiently fine textured that uniformly spaced individual spicules are preserved. Tetraclones or dicranoclones and some dendroclones are identifiable. Rays are approximately 0.05 mm long and clads are 0.015–0.020 mm long. Rays are 0.015–0.020 mm in diameter where best preserved, and expand slightly at the common ray junction. Clads are rarely preserved, but are 0.015 mm across where they first branch. Shafts in some are 0.04 mm long and 0.02–0.03 mm across. Shafts bifurcate to form the uniformly smooth rays. Preservation of clad tips is poor and details are largely wanting.

In some areas, the tetraclones are stacked in a radial pattern that is traceable a millimeter or so, but the skeleton, in general, is not strongly linear nor radial, but it does have fairly uniform spacing. Spicule centers are approximately 0.1 mm apart and show remarkable uniformity throughout the skeleton, except in the immediate vicinity of the canal walls where some openings are enlarged or in the dense lining of the canals where some of the skeletal pores are filled by swollen rays.

Discussion.—General growth form and the large straight excurrent canals differentiate the massive *Jereina* from the more leaflike *Defordia foliata* and associated species. Finks proposed *Jereina cylindrica* and *Jereina ramosa* (1960, p. 74–76) for cylindrical, commonly unbranched or ramose, slender, cylindrical sponges. This is a growth form quite different from the massive species described here. The canal pattern of the Venezuelan species is strongly reminiscent of that in the Permian species from West Texas, however. *Jereina cylindrica* Finks (1960, Pl. 19, figs. 1, 2) in particular, shows thickened walls on the large excurrent canals and the bordering radiating series. These canals and linings are of the same general proportions to slightly coarser than in the Venezuelan sponges. Illustrated exteriors of *Jereina ramosa* Finks (1960, Pl. 19, figs. 4–6) are also similar to sculpture on the Venezuelan species. Growth form and size of the canals, however, do differentiate the species from those described from West Texas.

It is relatively easy to recognize species in the Venezuelan fauna based on canal patterns, even in some juveniles. In *Jereina,* the straight excurrent canals developed early in ontogeny of individual sponges. In these juveniles, only 1–2 cm or so across or high, the central canal is evident as a major opening in the otherwise typically canaled skeletal net. These canals tend to be large central openings, 2 mm or more in diameter, and are commonly situated on the upper surface of the sponge or as a terminal osculum on somewhat digitate lobes.

Etymology.—*Robusta,* Latin fem., hard and strong.

Type specimens.—Holotype USNM 340073, and paratypes USNM 340074, 340075, along with numerous fragments, all from Locality 6C. The species also occurs at Localities 6A and 6B.

Family ANTHRACOSYCONIDAE Finks, 1960
Genus COLLATIPORA Finks, 1960
(?) COLLATIPORA DELICATA Finks, 1960
Figure 2A, B

Collatipora delicata FINKS, 1960, p. 82–85, Pl. 22, figs. 6–12.

Diagnosis.—"Encrusting hemispherical; one ostial field and one or a few oscules; ostia small for genus; spicules not grouped in bundles" (Finks, 1960).

Description.—A single specimen which has been tentatively identified as *Collatipora delicata* Finks occurs in the Venezuelan collection. The single top-shaped sponge is approximately 14 mm high, and 11–12 mm wide. It is elliptical in cross section but shows the characteristic sculpture and ostial field development of the species, although the ostial field is somewhat smaller than on the type specimens. Ostia are concentrated on the upper end in an area approximately 3 mm across. They are circular openings 0.3–0.4 mm across and are spaced similarly or up to 0.6 mm apart. Ostia of similar size also occur elsewhere and are not concentrated in fields.

In addition to those in the ostial field, two additional oscular openings occur on the middle flank of the sponge. They are 0.8–1.2 mm across. Excurrent canals that lead to them penetrate into the sponge, are apparently vertically oriented, although arching out slightly somewhat parallel to the general subradiate character of the principal canals in the skeleton.

The sponge lacks a broad spongocoel, but the surface is marked by indented grooves or canals that are tangential or subparallel to the surface. They leave lobate areas of skeletal mesh rising above the general cone. In general, the canals are less deeply entrenched and more closely spaced in the lower stalk-like part than in the upper, more open-textured part of the skeleton.

Upper canals are sometimes slit-like, 0.2–0.3 mm wide, and may be as much as 0.5 mm deep at the surface. The surface canals are variously separated and produce irregular polygonal to rounded semilobate tracts of spicules approximately 0.5–1.5 mm across. Meshwork between canals on the upper part of the sponge may be two or three times as coarse as the canals in the lower parts.

A series of radial canals, 0.4–0.5 mm across, is oriented roughly normal to the exterior of the sponge in the upper top-like part. These produce a distinct upward and outward radial arrangement to the overall skeletal pattern.

In general, the skeleton appears dense and irregular, but when viewed from the base, the concentric parallel arrangement of the spicules is apparent, particularly in the outer part of some of the knobs between the most deeply incised grooves, at about the maximum diameter. Spicules are spaced so that five or six layers occur per 0.5 mm where the structure is most evident. From other directions the spicules appear to be moderately uniformly, though not geometrically, placed with spicules centers 0.10 mm apart. Individual centers are swollen, as are ray junctions of the apparently tetraclone-based spicules. These are 0.04–0.06 mm across. They are separated by coarsely silicified rays 0.02–0.03 mm across and 0.04–0.05 mm long. Identification of clads versus rays is questionable because of their coarse silicification, but in general, the skeleton appears like that in associated tetraclone-based lithistid species.

Discussion.—The single specimen in the collection is similar in growth form, as well as in sculpture and in canal dimensions, to the small incrusted hemispherical sponge described and illustrated by Finks (1960, p. 82–83; Pl. 22, figs. 6–12). Details of the skeleton, however, are obscure in the Venezuelan material so that positive identification is impossible, but the overall characteristics relate the form.

At first, the small specimens were thought to be juveniles of the associated larger species of *Defordia* and *Jereina,* but the canal diameters and clustering of ostia into fields separate these from the associated taxa. *Collatipora* is much finer textured than either of the other associated forms. Differences are marked when specimens of similar size are compared and the large size of the canals becomes readily apparent.

Figured specimen.—USNM 340076, from

the Permian upper (?) Palmarito Formation at Locality 6C.

Class HEXACTINELLIDA Sollas, 1887
Order, Family, Genus Uncertain
Figure 2D

Several fragments of root tufts and miscellaneous aligned spicules occur in the collection. These fragments are commonly composed of large monaxial spicules, dominantly oxeas, that are 0.1–0.15 mm in maximum diameter and at least 3 or 4 mm long, judging from fragments in the most closely packed parts of the net. Spicules are stacked like cordwood, typical of root tufts seen in hexactinellid sponges elsewhere, although there are no organized hexactinellid sponges included in the collection. There seems little question, however, that these forms represent occurrences of the class in rocks there. These spicules are so generalized, and root tufts are so widely developed in the Hexactinellida that little can be done beyond noting the occurrence of the class. Oxeas are also common in the Demospongia, but rarely do they occur in tuft-like concentration as seen here.

Figured specimen.—USNM 340078, limestone of upper Palmarito Formation from Locality 3.

Class CALCAREA Bowerbank, 1865
Order HETERACTINIDA Hinde, 1888
Family WEWOKELLIDAE King, 1943
Genus WEWOKELLA Girty, 1911
WEWOKELLA SOLIDA Girty, 1911
Figure 3H

Wewokella solida GIRTY, 1911; GIRTY, 1915 p. 17, 18, Pl. 1, figs. 12–13b; RIGBY, 1978, p. 712–715, Pl. 1, figs. 3, 5, 8, Text-fig. 3.

Description.—One small silicified fragment of *Wewokella* occurs in the collection. It is a club-shaped piece approximately 15 mm high and up to 6 mm in diameter. An open-textured area, approximately 1 mm across in the upper part of the sponge, may correspond to the spongocoel in larger forms. The sponge has been somewhat flattened, but the fused generalized character of the skeletal net is typical of the genus. Individual skeletal elements have been grossly enlarged from the initial triradiate spicules. Many of the junctions show 120° angles, like those characteristic of the basic triactines of the genus. Individual segments are 0.1–0.6 mm across, and are distinctly vertically elongate, as defined by the dominant vertical rays of the basic triactine.

Even though spicules have been enlarged

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FIGURE 3—Calcareous sponges from the Palmarito Formation of Venezuela. *A, B, D, Colospongia monilis* n. sp. *A,* side view of branching paratype showing spherical chambers that increase in size upward in catenulate series. Locality 6C, USNM 340098, ×2. *B,* holotype showing irregular growth form with subspherical to tire-shaped chambers arranged in catenulate pattern. Pores show in silicified walls of lower chambers. Locality 3, USNM 340096, ×1. *D,* Silicified paratype showing irregular growth form and uneven chambers that become more nearly spherical upward. Locality 3, USNM 340097, ×1. *C, E, Amblysiphonella* (?) sp. *C,* silicified small sponge from the side showing catenulate form and segment of axial tube at top. Locality 11, USNM 340094, ×2. *E,* silicified small sponge from the side showing irregular form and size of the chambers. Axial tube ill defined. Locality 11, USNM 340095, ×2. *F, Girtyocoelia dunbari* King. Well preserved small sponge showing typical growth form and lateral canal tubes. Locality 3, USNM 340079, ×2. *G, K–N, Guadalupia minuta* n. sp. *G,* paratype showing rounded chambers along the side and irregular rounded chamber tops on the upper surface. Thickness of chambers is typical. Locality 6B, USNM 340091, ×2. *K,* paratype fragment from above showing irregular growth form and generally weakly silicified, rounded upper porous walls of chambers. Locality 6B, USNM 340090, ×2. *L,* holotype seen from the bottom showing irregular and commonly well-silicified lower chamber layer with coarse incurrent canal openings. Lateral chamber walls show at upper left. Locality 6B, USNM 340088, ×2. *M,* paratype, same as *G,* but seen diagonally from below to show shape of chambers, thickness of the sponge, and the irregular coarse lower layer of chambers in the undulating form. Locality 6B, USNM 340091, ×2. *N,* paratype seen from the side showing chamber walls, vesicula, and small size of the irregular lower chamber series. Locality 6B, USNM 340089, ×2. *H, Wewokella solida* King, a small specimen from the side showing characteristic enlarged spicule tracts with common 120° junctions. Locality 11, USNM 340077, ×2. *I, Cystothalamia nana* n. sp., holotype as seen from the side showing agglomerated subspherical chambers and small twiglike growth form. Locality 3, USNM 340086, ×2. *J, Vesicocaulis* (?) sp., a silicified fragment showing globose chambers and perforate spinose central tube. Locality 3, USNM 340080, ×2. *O–R, Apocoelia sphaera* n. gen., n. sp. *O,* holotype showing separated spherical chambers and interconnecting strawlike tubes and radial tube fragments.

Sponge involved with bryozoan and brachiopod fragments in silicified preservation. Locality 3, USNM 340081, ×2. *P,* two connected chambers and canal tubes with radiating pattern in silicified paratype, etched nearly free of matrix. Locality 3, USNM 340084, ×2. *Q,* silicified paratype showing characteristic spherical chambers and tubular connections and other radiating tubes, associated with bryozoans and *Guadalupia.* Locality 3, USNM 340085, ×2. *R,* silicified paratype showing two long tubes that probably interconnected chambers, and with short canal tubes radiating from typical spherical chamber. Matrix is bryozoan-brachiopod debris and is silicified so that details are obscured. Locality 3, USNM 340082, ×2.

and thoroughly fused to each other, they are separated by both vertical and radial canals 0.2–0.3 mm across. These openings are all rounded and exaggerate the enlargement of the basic skeleton of the sponge by secondary calcium carbonate. Many of the canals are vertically elongate where radial and vertical series merge or pinch and swell as they cross intersecting canals.

Length of overgrown hypercalcified spicules suggests rays up to 1 mm long although their details are certainly obscure. Only the interior part of the sponge may be preserved. There is no evidence of the small characteristic spicules of the dermal layer, such as seen, for example, in the Oklahoma material described by Rigby (1978, p. 714).

Discussion.—The general 120° convergence of the enlarged spicules suggests placing the fragment in the genus *Wewokella*. The canals, their orientations, and size of the skeletal elements are within the general range seen on type material of *Wewokella solida*, although the fragment we have here is small compared to the type material described by Girty (1911, p. 121; 1915, p. 17–18; Rigby, 1978, p. 712–715).

This is the first report of *Wewokella* in Permian rocks of South America. As a consequence, the small fragment is described and illustrated here. The strongly vertically-aligned parts of the skeleton clearly relate this form to *Wewokella* rather than to the somewhat more irregularly oriented skeleton of *Regispongia* (Rigby, 1978, p. 706–712).

Figured specimen.—USNM 340077, from the upper (?) Permian Palmarito Formation, Locality 11.

Order SPHINCTOZOA Steinmann, 1852
Superfamily APORATA Seilacher, 1962
Family CELYPHIIDAE De Laubenfels, 1955
Genus GIRTYOCOELIA Cossmann, 1909
GIRTYOCOELIA DUNBARI King, 1943
Figure 3F

Girtyocoelia dunbari KING, 1943, p. 33–34, Pl. 3, fig. 6; SEILACHER, 1962, p. 753.

Description.—Two moderately complete specimens and additional chamber fragments of the species were collected from the upper Palmarito Formation. One of the more complete sponges is of the proximal approximately 20 mm and includes the basal five chambers, from the nearly complete base to the rounded top. The basal chamber is somewhat flattened, 1.5 mm across and the largest elliptical chamber is approximately 2 mm by 5 mm. All of the chambers are flattened, probably as a function of diagenesis rather than of original growth. Each chamber is ring-like and they increase in height from the basal chamber, approximately 3 mm high, up to the top chamber, which is 6 mm high. Chambers show considerable irregularity, however, and have an almost biserial appearance. For example, on one side of the specimen a chamber is 6 mm high but on the opposite side it is only 2 mm high.

Chamber walls are probably not porous, although the coarse silicification has left the surface somewhat dimpled with impressions 0.10 mm across. Thickness of chamber walls, 0.4–0.5 mm, is most evident in the upper, more mature part. Walls are only 0.2 mm thick near the pointed base of the sponge. Short tubular ostia, up to 2.0 mm long, occur on many fragments, but generally much of the tube has been broken off, leaving only the basal proximal portion. These ostia are 1.0–1.4 mm across at the base and extend abruptly out of the chamber wall, generally at right angles to the principal axis. They do not occur in linear series. For example, four ostia occur on one chamber, essentially at 90° to one another, but in the adjacent more distal chamber, only three ostia are present and in the more proximal lower chamber only two or three ostia are developed. Ostia are perforations 0.4–0.6 mm across in the walls of the sponge. Thicknesses of individual ostial tube walls are 0.15–0.26 mm, although exact original thicknesses are somewhat questionable because of possible modification during silicification.

The upper round end of each chamber is perforated by an ellipsoidal to circular oscular opening, 1.4 by 0.3 mm across. These openings are connected to a central tube that, in this specimen, projects into the fractured chamber below. The central tube is only partially silicified. Middle chambers are not broken so that continuity of the central tube through them cannot be totally documented.

Chamber-filling structures are apparently absent. Preservation is such, however, that it is difficult to definitely eliminate the possibility.

Discussion.—Size and development of tubular ostia in upper chambers of the Venezuelan sponges are of the same general proportions as in *Girtyocoelia dunbari* King (1943, p. 33–34), although the Venezuelan examples include juvenile stages and on the average are, thus, somewhat smaller. *G. beedei* (Girty, 1908a, p. 284) and *G. sphaerica* (King, 1933, p. 79) are smaller in general chamber dimensions and have distinctly smaller central tubes than the Venezuelan sponges. Similarly *G. oenipontana* Ott (1967b, p. 28), from the Triassic of Europe, is considerably smaller than either North American species, and is clearly different from the Venezuelan sponge.

Figured specimen.—USNM 340079, from the upper Palmarito Formation at Locality 3.

Genus VESICOCAULIS Ott, 1967
VESICOCAULIS (?) sp.
Figure 3J

Description.—One fragmental specimen from the Venezuelan collection is tentatively included in the genus. That fragment consists of one large subspherical chamber and part of another, for a total height of 14 mm. The more nearly complete chamber is approximately 11 mm in diameter and 8.5 mm high. These chambers are regularly arranged and are merely touching each other around the central tube, or may be slightly separated.

Walls of the upper chamber are 1.0 mm thick. The chambers are globular, slightly flattened at the top and have walls 1.0 mm thick. They are perforated by a distinct central tube that is cylindrical, pipe-like and 3.0 mm in diameter. The central tube connects to a somewhat elliptical opening, 1.2 by 2.0 mm across, at the top of the rounded chamber. At the other end, in the fractured center part of the sponge, the opening of the central tube is 1.8 mm across and tube walls are 0.3–0.4 mm thick.

Tubular ostia are not significantly developed on this specimen, but individual openings, 0.5–0.7 mm across, are evident around the chamber margin. Several have a slightly raised rim suggesting that ostial tubes may have been present but were broken, either in processing or prior to burial. These ostia are not opposite one another. On the more nearly complete chamber four ostia are evident in the preserved approximately one-half of the chamber wall. Ostia are generally at mid-height, although one opening is certainly near the upper shoulder of the subspherical chamber.

One flat cross-partition in the upper chamber suggests that the sponge had vesicular filling. The evidence is not conclusive.

The central tube appears spinose, perhaps because of perforation or irregular silicification. A series of closely spaced pores, 0.25–0.35 mm across, in the upper part are separated by approximately 0.1 mm of skeletal material. This suggests that the spiny lower part of the central tube may also be porous. Visible pores of the upper tube are circular to subpolygonal and are numerous. Four pores are clearly preserved in a vertical line 0.2 mm long up the tube. The central tube has a distinct wall, separate from the outer wall. Ostia in the chamber wall are generally isolated. The inner tube, on the other hand, has perforations.

Discussion.—Ott (1967b, p. 25–28) proposed the new genus and named the species *Vesicocaulis alpinus* and *Vesicocaulis depressus* from the Triassic Wettersteinkalk. Both of these species have considerable vesicular chamber fillings, almost to the point of confusing the isolated nature of the central tube. However, in the Venezuelan sponge, the vesicular filling is either poorly preserved or was initially sparse or nonexistent. The Venezuelan sponge appears to be transitional in general fabric from typical *Girtyocoelia,* in which the central tube is only distally perforated and the walls have opposed, very irregularly arranged, ostia. It is more closely related to *Vesicocaulis* (Ott, 1967b, p. 50–51) in which the central tube is considerably more perforate, although perhaps encrusted, and in which ostia through the wall may be more irregular. The gross shape of the sponge looks more like that of *Vesicocaulis alpinus* than the somewhat more depressed chambered and coarsely vesicular *Vesicocaulis depressus,* as illustrated by Ott (1967b, p. 65).

Figured specimen.—USNM 340080, from upper Palmarito Formation at Locality 3.

APOCOELIA n. gen.

Diagnosis.—Walls imperforate, individual chambers isolated or connected with tubular canals; chambers without filling structures; not catenulate or tubular.

Discussion.—The isolated chambers, connected by discrete tubes, characterize not only the genus but the species as well. Chamber walls of the sponges are thick, with isolated ostia, as in the Superfamily Aporata (Seilacher, 1962) but these Venezuelan sponges do not fit clearly into genera included there by Seilacher (1962) or Ott (1967b, p. 50–53). Genera in both the Thaumastocoeliidae Ott, 1967 and Celyphiidae DeLaubenfels, 1955 generally have chambers arranged in catenulate fashion. Many genera of the Celyphiidae also have central tubular structures or filling nets, clearly separating them from the simple Venezuelan genus. The Thaumastocoeliidae are somewhat more generalized but still have chambers arranged in catenulate series. *Apocoelia* has tubular ostia, like *Girtyocoelia* and *Celyphia,* but is not catenulate with a central canal like *Girtyocoelia* and lacks the complex canal structures and chamber filling of the somewhat separated chambers of *Celyphia.*

Ott (1967b, p. 16–17) proposed the new family Thaumastocoeliidae to include those aperforate sphinctozoan sponges in which the walls are sphaerolitic and in which the chambers generally lack filling structures. In the Venezuelan material, where walls have been intensively silicified, it is difficult to determine whether they were sphaerolitic, as in the Thaumastocoeliidae, or layered, as in the Celyphiidae.

Apocoelia is somewhat similar to *Sollasia.* Both are relatively simple sponges with isolated large openings in the walls and both lack filling structures. *Sollasia,* however, is a catenulate form and clearly separable from *Apocoelia.* Other genera in the Thaumastocoeliidae are also catenulate and have canal patterns significantly different from those in the Venezuelan genus.

Within the Celyphiidae, some representatives of *Celyphia* consist of somewhat isolated, noncatenulate chambers but the chambers have complex tubular filling structures that lead in from each of the irregular pores. Even though the chambers are somewhat isolated, they are certainly not interconnected with prominent tubes as in *Apocoelia.*

In some respects, individual subspherical chambers are like those of *Girtyocoelia* with walls pierced by isolated tubular ostia. However, *Girtyocoelia* is also a catenulate form with a prominent central tube.

Other genera included within the Celyphiidae by Ott (1967b, p. 50–51) have complex internal structures or unusual canal patterns decidedly different from those in *Apocoelia. Vesicocaulis* (Ott, 1967b) has a complex central tube and tubular filling in the chamber. *Follicatena* (Ott, 1967b, p. 20–22) is a pseudosiphonate form with ostial fields on flanks of the walls or in the top of the chambers, and commonly has many vesiculae filling the chambers as well.

Because critical fine-grained structures of the wall are not clearly evident, placement of the genus into either family in the Aporata is somewhat questionable. *Apocoelia* does share the elongate tubular ostia of *Girtyocoelia* and the somewhat isolated chambers of *Celyphia* and, hence, is here included as a primitive genus in the Celyphiidae with some reservation.

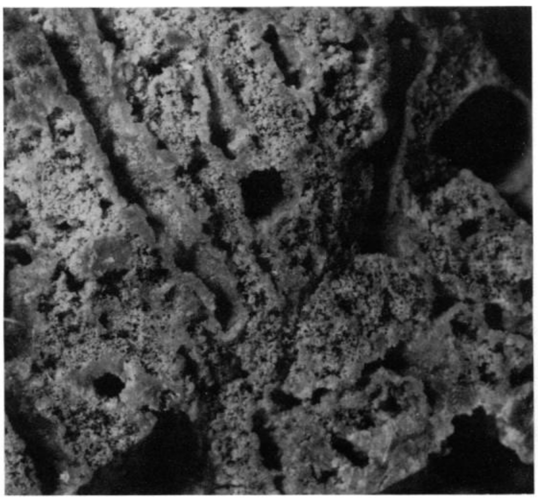
One might expect chamber isolation and tubular connection to be a primitive feature. It is transitional from the unconnected isolated chambers recognized as sphinctozoans by Peter Jell (personal commun., 1981) from the Cambrian of Australia. The Cambrian calcified spherical chambers may have been connected by noncalcified tubular structures, which had become calcified by the Permian.

→

FIGURE 4—Photomicrographs of silicified lithistid demosponges from the Palmarito Formation of Venezuela. *A, Defordia digitata* n. sp., massive dense spicule structure with few canals is characteristic. Locality 3, USNM 340063, ×5. *B, F, Defordia verrucula* n. sp. *B,* horizontal section with minor radiating horizontal and vertical canals in dense skeleton. Locality 3, USNM 340072, ×5. *F,* diagonal section of paratype showing mix of chiastoclones (center arrow) and dendroclones (upper left arrow) that are arranged into short trabs. Locality 3, USNM 340071, ×20. *C, E, Jereina robusta* n. sp., paratype. Locality 6C, USNM 340075. *C,* horizontal section of a paratype showing large vertical canals (right) and smaller horizontal and vertical ones, all lined with dense silica, ×5. *E,* irregular crudely silicified spicules as seen in vertical section, with dense canal linings at right and left; small chiastoclone (arrow) in lower center, ×20. *D, Defordia foliata* n. sp., showing dimensions of skeletal tracts and intervening canals in crudely silicified paratype. Locality 6A, USNM 340066, ×5.


A


B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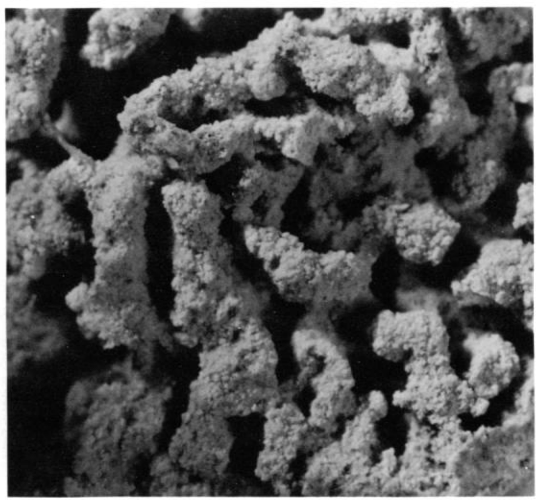
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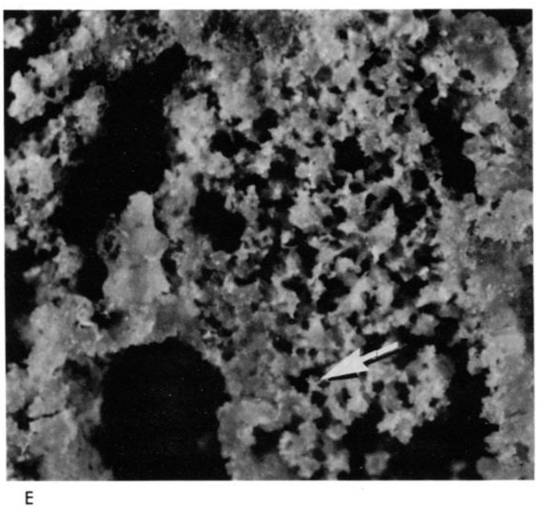
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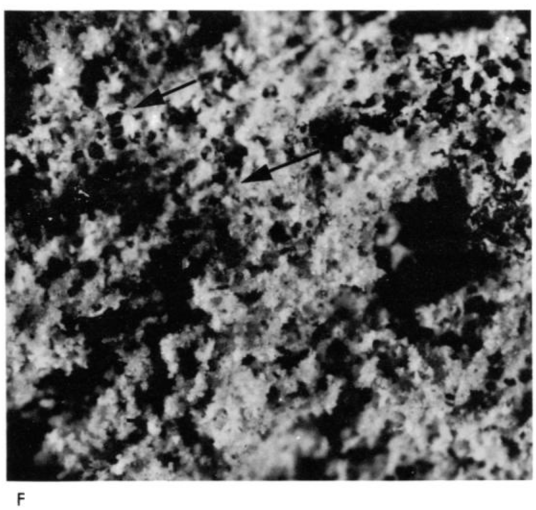
F

The Venezuelan sponges also appear as primitive sphinctozoans in lacking central filling structures, and in lacking a porous wall.

Etymology.—*Apo,* Greek, from or separate; *koilia,* fem., large hollow cavity of the body.

Type species.—*Apocoelia sphaera* n. sp.

Apocoelia sphaera n. sp.
Figure 3O–R

Diagnosis.—Isolated spherical chambers interconnected with tubular canals. Chambers hollow, lack filling structures and a central or axial tube; chambers 2.0–6.0 mm in diameter, most approximately 4.0 mm across. Lateral connecting tubes 1–8 mm long, most 4.5 mm long and 1.0–1.2 mm in diameter. Chamber and tube walls 0.10–0.25 mm thick. Except for tubular openings, chamber walls nonporous.

Description.—Numerous fragments are in the collection, ranging from isolated chamber fragments to sponges with two or three chambers, interconnected by more or less complete tubes. Subspherical to slightly ellipsoidal chambers are 2.0–6.0 mm in diameter, but most are 3.5–4.5 mm across. Chamber walls are thin, 0.05–0.25 mm thick, although the moderately coarse silicification has blurred details of the wall structure and some secondary thickening is possible. The walls lack pores except for the connecting tubes. Some subspherical chambers appear triangular from certain angles because three or four tubes lead from them. Chamber walls appear smooth although small structures may have been lost in the course of preservation.

Subcylindrical tubes branch from or interconnect the chambers. Four tubes commonly occur on single chambers, with three in a plane, 100–120° apart. The fourth commonly exits at right angles to that plane, although there is considerable variation. On some chambers there are clearly only two tubes that are part of the linear series. On three chambers as many as seven tubes are evident.

Tubes are 0.6–1.4 mm in diameter, at their thinnest, generally midway between connected chambers. Tubes expand slightly, increasing to as much as 2 mm across where they flare and merge with the chambers. Individual tubes range from approximately 1 mm to slightly over 8 mm long, with most 4–6 mm long where they clearly connect chambers. However, many tubes are broken and may not have connected chambers. Tubes less than 2 mm long may have been incurrent or excurrent openings, somewhat as tubular ostia in *Girtyocoelia* and related genera. Thicknesses of tube walls vary somewhat. They are generally 0.1–0.25 mm thick, although some as thin as 0.04 and as thick as 0.35 mm occur. In general, most tube walls are 0.25–0.35 mm thick near larger chambers and in larger diameter tubes but may be as thin as 0.10–0.15 in the smaller ones. Pores leading from the chambers into tubes are 0.5–0.8 mm across, although most are approximately 0.5 mm across at the chamber walls.

Because the fossils are fragmental it is difficult to define the entire structure of the sponge. Some fragments are linear series of two or three chambers and others obviously branch to form Y-shaped series.

Chambers apparently lack filling structures such as trabecula, reticula or vesicula. Chambers also lack any central structure that would interconnect tubes on opposite sides of the chambers, and as such, are certainly asiphonate. Individual sponges are not catenulate, in the sense of being continuous chains of chambers, but are composed of isolated, subspherical units interconnected with hollow, straw-like tubes.

Discussion.—Relationships to related sponges have been treated above in discussion of the genus.

It is uncertain whether chambers in *Apocoelia sphaera* increased in diameter ontogenetically, because only fragments are available, but certainly ontogenetic increase is suggested because of regular increase in size on a few specimens. Without more complete material, however, it is impossible to evaluate chamber size as either an ontogenetic or a specific character. Clear separation of chambers, tube dimensions and degree of separation are considered to be species characteristics.

Etymology.—*Sphaera,* Greek, sphere, referring to the round hollow discrete chambers of the sponge.

Type specimens.—Holotype USNM 340081, paratypes USNM 340082–340085, from upper Palmarito limestone at Locality 3. An additional fragment was collected at Locality 11.

Superfamily PORATA Seilacher, 1962
Family GUADALUPIIDAE Girty, 1908
Genus GUADALUPIA Girty, 1908
GUADALUPIA MINUTA n. sp.
Figure 3G, K–N

Diagnosis.—Undulating, platterlike or wavy encrusting *Guadalupia,* in plates 1.5–2.0 mm thick, with thin coarse lower layer of chambers and crescentic to subprismatic larger chambers in upper layer, both perforated; with minor vesicula in the coarse honeycomb-like upper layer.

Description.—Numerous fragments occur in the collections; some are up to approximately 35–40 mm across. Most, however, are only 10–20 mm across. Because the sponge is fragile, part of the breakage may have been before or during burial, but much of the fragmentation is unquestionably related to recovery and processing of the delicately silicified fossils.

The upper layer of large chambers is characteristically 1.5–1.8 mm thick, above a lower layer that is generally 0.1–0.4 mm thick. The coarse upper chambers are 0.7–0.11 mm across and have somewhat curved walls that parallel the outer rounded margin of the expanding plates. Some of the upper chambers are crescentic in cross-section, rather than subpolygonal, because of the way the curved sections were added during growth at the expanding sponge margins. More interior chamber sections, however, tend to be subcircular to slightly ellipsoidal.

Perforated walls between the large upper chambers are generally 0.08–0.11 mm thick. This is essentially the same thickness as the upper wall and as the bounding layer between the irregular, coarsely perforate upper and lower series of chambers.

Pores in the outer wall have been largely destroyed in the coarse silicification. However, some remnants of circular pores are evident in the outer chambers of a few specimens. These are 0.06–0.10 mm across, and are arranged so that 1–3 openings occur in each of the chambers. They appear to be spaced or separated from one another by about the same width of skeletal material as their diameter.

Vesicula are moderately common in about one-fifth of the upper coarse chambers. They are well-preserved bubble-like fillings that appear like cystophragms or diaphragms in bryozoans. Most vesicular partitions appear at about midheight in the chambers.

The lower layer of chambers or cells is undulating and irregular so that it appears almost botryoidal where the sponges seem to be raised above their substrate. Lower chambers are perforated and outlined by coarse cylindrical to occasionally branching canals 0.15–0.25 mm in diameter, with most approximately 0.20 mm across. They are separated by 0.2–0.6 mm of skeletal material and occur in crude linear patterns, although that alignment is probably related to accretion of chambers at the sponge margin rather than to some other linear control. Skeletal areas between the irregularly branching tangential canals arch downward and appear irregularly lobate. These undulating lobes are up to 0.6 mm in diameter and form the lower laterally cross-connected chambers. Chamber walls flex around the ostia to produce and subdivide the lobate lower series of chambers and the irregularity and thickness variations of the lower chamber layer. Walls of these wavy individual elements and stalactite-appearing projections are 0.1–0.2 mm thick.

Stalactite-like rows of skeletal material extend from the lower layer down to the substrate. These apparently supported the sponge above the substrate so that circulating water could flow in under the sponge, then up through the lower canals, and out through the upper coarse chambers. These stalactite-like pillars are irregular, in part peg-like or conical. They are up to 0.5 mm long and may be nearly as wide.

The lower part of the skeleton of the sponge is more massive and generally better preserved than the upper wall or middle chamber. The latter are the thinnest and the least well-preserved elements of the skeleton.

One fragment of the species from Locality 3 shows blister-like walls on the upper layer that rise 0.3–0.4 mm above the general surface of the sponge. Individual blisters are up to 2 mm across.

Sponges of the species have irregular shapes because they grew around and over irregularities. Some fragments are completely folded and have S-shaped or serpentine cross-sections.

Discussion.—The explanate growth habit of the species separates *G. minuta* from most tubular or branching species described from the Permian of West Texas, from genera such as *Cystauletes* King (1943) or most species of *Cystothalamia* Girty (1908a), as for example, *C. alveolaris* Parona (1933, p. 49–50), *C. cidarites* Parona (1933, p. 50), or *C. cylindrica* Girty (1908a, p. 81–82).

The explanate species, *Guadalupia williamsi* King (1943, p. 23–24) forms low cones, but has chamber layers or sheets 3–4 mm thick. It does have two layers of chambers, however, like the Venezuelan species. *Guadalupia zitteliana* Girty (1908a, p. 31) is a similarly flat species but has chambers 1 mm across forming a sheet as much as 10 mm thick. These species are generally much coarser and much thicker sponges than the delicate Permian form from Venezuela.

Guadalupia minuta appears much like *Polyphymaspongia explanata,* as described by King (1943, p. 25–26), but that sponge forms layers approximately 10 mm thick. In other aspects such as blister-like chambers and in having a double-layered structure the species are similar. Thus, the Venezuelan *Guadalupia minuta* forms the thinnest sheets thus far discovered and has a finer textured skeleton than other explanate species.

Etymology.—*Minuta,* Latin, fem., diminish, lesser, referring to reduced size of the sponge.

Type specimens and available material.—Holotype USNM 340088, paratypes USNM 340089–340093, from Locality 6B. Additional fragments were collected from upper limestones of the Palmarito Formation at Localities 3 and 6A.

Family CYSTOTHALAMIIDAE Girty, 1908
Genus CYSTOTHALAMIA Girty, 1908
CYSTOTHALAMIA NANA n. sp.
Figure 3I

Diagnosis.—Linear, twig-like series of agglomerated subspherical to blister-like chambers, 1.5–2.0 mm in diameter, forming branches approximately 5 mm across but with irregular profile. Walls perforate, pores generally 0.10 mm in diameter but occasional rare ones 0.2 mm across, both subcircular; separated by 0.05–0.15 mm of skeletal material. Central tube lacking.

Description.—Two short segments of the species, both approximately 11 mm long, are in the collection. The holotype has an average diameter of 4–5 mm, with considerable irregularity. It is composed of agglomerated, subspherical to subprismatically-packed chambers, each rising blister-like out from the general cylindrical "stem" of the sponge. Some chambers swell as much as 1.5 mm out from the general cone, although others are less than 0.5 mm high. At any one level, up to three or four chambers may occur in any transverse section. All are irregularly stacked and not arranged in rows, either horizontally or vertically. The sponge is like a long-stemmed cluster of grapes.

Chamber walls are 0.10–0.15 mm thick, where seen in broken sections. A central tube, characteristic of larger and sometimes branching members of the genus, is not developed. The chambers merely adhere to form an elongate cluster, typical of the species.

Pores are evident on most chambers and are characteristically 0.08–0.10 mm in diameter. They are circular, irregularly spaced in a nongeometric pattern, with neither vertical, horizontal, nor diagonal rows but they are packed such that the entire wall is open and porous. Individual pores are separated by 0.05–0.15 mm of skeletal material. The pores occupy approximately one-third of the wall space.

Occasional large openings, 0.20 mm across, occur but perhaps are only fractures in the silicified replacement. However, they may be large ostia rather than open pores. Where most evident, they occur in the central part of the blister-like chambers. Some are subtriangular, as though three adjacent pores were joined during the coarse silicification.

Filling structure is uncertain. One fractured chamber appears free of fillings, but another in the same specimen has irregular siliceous overgrowths that might represent discontinuous vesicula. Evidence is inconclusive.

Discussion.—The genus *Cystothalamia* was proposed by Girty (1908a, p. 89) from fossils collected in the Capitan Formation in the Guadalupe Mountains of West Texas. Girty (1908a, p. 88) also erected a family to include *Cystothalamia.* He noted that the most significant features of the family are the absence of a persistent tubular axis and the nonsegmented chamber-like structure of hollow cystiform units.

Cystothalamia nodulifera Girty (1908a, p. 89–90) is a somewhat cylindrical, but contorted, sponge with a diameter of 7–10 mm or more, which is slightly larger than the Venezuelan species. In addition, *C. nodulifera* has spout-like, tubular projections at crests of the small, irregularly spaced chambers, in addition to numerous small openings over the entire surface and it is vesiculate.

Cystothalamia bavarica Ott (1967b, p. 36–38) is a cylindrical, stem-like form, up to 15 mm in diameter with chambers arranged around a 3–4 mm broad central tube. Chambers of *C. bavarica* are 2–3 mm in diameter, approximately the same as those in *C. nana* n. sp., but they are arranged in double layers around the central opening in the Bavarian form, in a structure and an arrangement quite different from those of the Venezuelan material. Thickness of the wall is slightly less in the Venezuelan species than in the Bavarian one, but pores in both are essentially the same size to slightly smaller in the Venezuelan sponge.

Ott described the new genus *Uvanella* and the new species *Uvanella irregularis* (Ott, 1967b, p. 38–40) for an agglomeration of perforate, asiphonate chambers arranged in grape-like clusters. The irregular lumpy form is distinctly different than the twig-like habit of the present species. The chamber size, small diameter, lack of a central tube, and overall growth form characterize the species.

Etymology.—*Nana,* Latin, fem., a dwarf.

Type specimens.—Holotype, USNM 340086, and paratype, USNM 340087, both from the upper Palmarito Formation at Locality 3.

Family SEBARGASIIDAE
Steinmann, 1882 (fide Ott, 1967)
Genus AMBLYSIPHONELLA
Steinmann, 1882
AMBLYSIPHONELLA (?) sp.
Figure 3C, E

Diagnosis.—Catenulate, subspherical to ring-like chambers with a porous wall surrounding a central tubular opening which is less distinctly porous than the outer wall; lacks tubular ostia. Nature of chamber filling uncertain.

Description.—One of the most instructive fragments of this sponge consists of three nearly complete chambers and a segment of the central tube. Chambers are subspherical to slightly ring-shaped, expanding upward from approximately 4 mm in diameter to a maximum diameter of 4.5 mm for the preserved chambers. Individual chambers are 3–4 mm high with sharp to slightly rounded indentations separating them.

Central tubular openings are approximately 1.5 mm in diameter where best exposed in the lower part of the specimen. The central tube appears to be retrosiphonate, that is a continuation downward from the upper flanks of the individual chambers. That part of the tube that extends below the general level of the chambers is a continuation into the fourth partial chamber below.

Walls of the chambers are perforated by numerous, irregularly but rather closely spaced pores. These are 0.10–0.15 mm in diameter, are circular, and are separated by approximately equal amounts of skeletal material where the skeleton is best preserved on the middle chamber, so that approximately one-third of the wall surface is pores.

Thickness of the wall is somewhat irregular in the silicification but is 0.15–0.2 mm thick. The wall of the central tube is 0.10–0.15 mm thick, where seen at the bottom. Pores in the central tube occur in more or less irregular vertical lines, but are not in any regular geometric pattern. There is little evidence of filling structures. Most chambers clearly lack vesicula, trabecula, or reticula, such as characterize other families of the Aporata.

Two somewhat more nearly complete, but less certainly indentifiable specimens also occur in the collection. One is a relatively small catenulate form that has lower chambers 2.5–3.0 mm across but upper ones that expand to locally irregular maximum diameters of approximately 5 mm.

The other specimen, approximately 22 mm long, has nine relatively complete chambers that show irregularity, from ones like underinflated automobile inner tubes to moderately subspherical chambers. Chambers are 2.5–4.5 mm high and have sharply indented boundaries that clearly define individual chambers. All of these have minutely porous walls, although pores in these particular small specimens are less clearly defined than in larger ones. Where best preserved they are 0.1–0.2 mm in diameter, with most 0.15 mm across. They are generally subcircular but somewhat coarse silicification has modified margins so that some appear to be irregularly polygonal. Thicknesses of chamber walls are difficult to determine accurately because of the coarse silicification, but appear to be 0.2–0.3 mm.

Branching is suggested in one of the specimens where pore structures show well. Chamber subdivision is somewhat more irregular, but of the same general proportion as in the other small specimen. The central tube in the branching form is unknown because of irregularity in fracturing and heavy silicification. However, the general form and pore size suggest a relationship of this small specimen to the larger more complete ones.

One small fragment of isolated chambers of the same general proportion does show a limited segment of the central tube that is 1.2–1.3 mm across. This same specimen shows that the upper round end of the chamber is perforated by a circular opening approximately 1.3 mm across. The characteristic porous nature of the wall shows distinctly in the fragments.

Discussion.—These fragmental sponges contrast with the girtyocoelids and *Vesicocaulis* in the collection in lacking the tubular ostia that are characteristic of those forms. In addition, walls of the chambers are distinctly porous, in contrast to the generally imperforate walls of the Celyphiidae and the Thaumastocoeliidae. However, the tubular opening is somewhat more distinct than in characteristic *Amblysiphonella* and related forms. The chambers are somewhat more subspherical than ring-shaped, such as those in typical *Amblysiphonella.*

Available material.—Figured specimens USNM 340094 and 340095, and one unfigured specimen were collected at Locality 11. An additional fragment was collected at Locality 3.

Genus Colospongia Laube, 1865

Ott (1967a, p. 29–30) summarized characteristics of the genus *Colospongia* (Laube, 1865, p. 17) and placed it as the senior synonym for *Takreamina* Fontaine (1962, p. 205), *Waagenella* De Laubenfels (1955, p. E102), *Steinmannia* Waagen and Wentzel (1888, p. 979) and *Girtycoelia,* sensu King (1933, p. 79). The genus is characterized by perforate outer walls, typical of the entire Superfamily Porata (Seilacher, 1962, p. 784), and with more or less overlapping, subspherical chambers that lack a filling network but occasionally have vesicula. A central tube is missing in *Colospongia*; that is, the sponges are asiphonate, and chambers are generally arranged in catenulate or moniliform series. The commonly associated *Girtyocoelia, Vesicocaulis* and *Amblysiphonella,* as well as some forms of *Cystothalamia,* have a general central tube, which immediately differentiates them from *Colospongia. Girtyocoelia* and *Vesicocaulis* are also Aporata, in the sense that the chamber wall is not uniformly porous.

Colospongia monilis n. sp.
Figure 3A, B, D

Diagnosis.—Moniliform to catenulate, asiphonate sponges with chambers somewhat irregularly distributed, producing an undulating vermiform sponge, expanding from small conical tip to chambers approximately 1 cm in diameter and 8–9 mm high; wall pores 0.2–0.3 mm in diameter; chambers lacking filling net and vesicula.

Description.—Seven moderately complete specimens from three localities are in the collection. They range from fragments with three or four chambers to nearly complete specimens with twelve chambers. Conical forms, some with broken bases, have initial chambers approximately 4 mm in diameter and expand gradually to chambers 8–9 mm in diameter at fractured upper ends. Chamber heights, as well as diameters, are somewhat irregular, with smallest ones 3.0–3.5 mm high but largest ones 6–7 mm high. Separation of the chambers at the overlap or indented zones varies from sharp and angular to broad and rounded, in part depending upon the irregular axis of the sponge.

Lateral and terminal walls of each chamber are characteristically porous. Chamber interconnection is through pores of essentially the same size as those in the lateral walls. No general large central opening is evident between adjacent chambers or in the uppermost chamber.

Individual ostia are large, subcircular to slightly elliptical, and 0.2–0.4 mm across along the entire sponge; most are 0.25–0.30 mm in diameter. Those that are elliptical tend to be horizontally elongate, at right angles to the principal axis of the sponge, and occur most commonly in the lower rounded parts of the wall. However, marked elliptical ostia are rare. Ostia are not in lines or other predictable geometric patterns and are separated by 0.3–0.5 mm of skeletal material. They are so spaced that seven or eight occur along a vertical line and eight to nine along a horizontal line 5 mm long. Thus, in a 5 mm square, there are 70 to 80 ostia, occupying approximately one-third of the total wall space.

Ostia are somewhat smaller on the larger more nearly complete specimens, averaging 0.25–0.30 mm across, and are separated by 0.15–0.35 mm of skeletal material. As a consequence, numbers of ostia per square millimeter are somewhat greater than that noted above.

Some variations in the pore size may have been produced by vagaries of silicification. That factor is difficult to evaluate but the tendency has been to enlarge the skeletal segments and reduce the size of the pores.

Thicknesses of chamber walls range considerably, from 0.2–0.5 mm. Range of width-height index of the chambers is like that noted for the species of *Colospongia* by Ott (1967b, p. 29–35).

Discussion.—The large *Colospongia* from Venezuela is closely related to *Colospongia americana* (Girty, 1908a, p. 92–93) in general size, maximum chamber width and also in terms of general pore size, judging from the illustrations. I have not seen the original type specimen and Girty didn't mention the size of the pores. The Venezuelan specimens are also similar to *Colospongia benjamini* (Girty, 1908b, p. 286–287), described from the Allen Limestone of Chanute, Kansas, in having a general serpentine shape. In general size, irregularity, and shape of the chambers, the Venezuelan sponges are more like *C. benjamini* than *C. americana.*

King (1933, p. 81) noted that chambers in *C. benjamini* (Girty) are 10 mm or more in diameter and that the wall is perforated by a number of pores of uniform size. In addition, many segments show two or three large ostia. This would support the general conclusions by Ott (1967b, p. 29–30) that *Colospongia* may have double-layered walls, the outer of which has isolated, unbranched pores and the inner of which is perforated by up to three large ostia per chamber. In the specimen figured by King (1933, Pl. 8, figs. 1–2), pores generally appear to be approximately 0.4–0.5 mm across. This is similar to the size range seen in the Venezuelan specimens, but the porosity produced by pore packing in the Kansas specimen is such that many more pores occur per 5 millimeter square than in the Venezuelan material, because the pores are generally separated by 0.1–0.2 mm of skeletal material. In addition, two sizes of pores may occur in the Kansas species, with smaller pores approximately 0.01–0.02 mm across. Pore size and spacing appear more characteristic of *Colospongia typica* (King, 1933, p. 80, Pl. 8, figs. 3–5), although King noted that the pores are extremely irregular in arrangement and variable in size. Some of that variation may be related to processes of fossilization of the Wise County, Texas material, however. This is different than the Venezuelan material where there is considerable uniformity in size. In both species described by King, there is considerable regularity in the relatively straight, moderately uniform size of the chambers, which certainly contrasts to the irregularity seen in the Venezuelan material.

Etymology.—Monilis, Latin, fem., necklace or string of beads, referring to the bead-like form of the sponge.

Type specimens and available material.—Holotype, USNM 340096, and paratype USNM 340097 are from Locality 3, and paratype USNM 340098 is from Locality 6C, all from upper limestones of the Palmarito Formation.

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