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Four New Species of *Forcepia* (Porifera, Demospongiae, Poecilosclerida, Coelosphaeridae) from California, and Synonymy of *Wilsa* de Laubenfels, 1930, with *Forcepia*, Carter, 1874

by

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Four new species of the marine sponge genus *Forcepia* (Porifera, Demospongiae, Poecilosclerida, Myxillina, Coelosphaeridae), are described and *Wilsa hymena* de Laubenfels, 1930, which is now designated as *Forcepia* (*Forcepia*) *hymena* (de Laubenfels, 1930), is redescribed on the basis of new material found in the collections of the Scripps Institution of Oceanography. As a result of detailed comparison of this material with de Laubenfels' type, *Wilsa* is synonymized with *Forcepia*. Heretofore, only one species of this group (*Wilsa hymena*) had been described from California. Full descriptions, figures and relevant morphological and habitat information have been included.

While the rich coastal waters along the California coast support a vast and varied invertebrate fauna, our knowledge of the organisms found in this region remains disappointingly poor. A prime example is the marine sponge fauna. Those studying sponges must rely largely on a publication from 1932 by de Laubenfels and a field manual on intertidal invertebrates last published in 1975 by Hartman as their main source of information. Scattered papers, of which only a few are recent, provide the remainder of the available information.

Five years ago, the David and Lucile Packard Foundation generously funded the author for a study of the sponges of California. That study has been completed (Lee, Elvin, Reiswig, in preparation). Over 250 species have been found in Californian waters, many of these new to science. The present paper represents the first of an anticipated series describing the newly discovered species.

In the past, sponges bearing forceps as microscleres have been variously placed in different taxa. From recent investigations by Van Soest (pers. commun.) and Hajdu and Vacelet (pers. commun.) forceps-bearing taxa are now largely relegated to the genus *Forcepia* Carter, 1874 (family Coelosphaeridae). An exception is the genus *Asbestopluma,* Norman, 1882 (family Cladorhizidae), which consists largely of abyssal sponges with forceps of different structure, not considered homologous with the forceps of *Forcepia.* The papers by the above mentioned authors are part of a worldwide effort to review and revise all presently used taxonomic categories through a re-examination of the type material on which these taxa are based. The papers will be compiled in the *Systema Porifera* to be published this year (Hooper and Van Soest, in press). The revision of *Forcepia* includes two newly defined subgenera, *Forcepia* and *Leptolabis,* the latter distinguished by the presence of basal acanthostyles and a hymedesmoid-like skeletal architecture. The California sponges described here all belong to the subgenus, *Forcepia.*

To date only two forceps-bearing sponges have been reported from California, *Asbestopluma lycopodium* (Levinsen, 1886) and *Wilsa hymena* de Laubenfels, 1930. The first is a member of the family Cladorhizidae, and will not be discussed here. The genus *Wilsa* was erected by de Laubenfels

in 1930 for a single forceps-bearing specimen. Recent review of newly found material suggests that this species belongs to the genus *Forcepia* and de Laubenfels' *Wilsa* is synonymized with *Forcepia.* Besides a redescription of *Wilsa hymena,* four new species of *Forcepia* are described in this paper.

Materials and Methods

Material examined in this study was predominantly taken from museum collections. Abbreviations for specimens in these collections are as follows: NHM, The Natural History Museum, London; CASIZ, California Academy of Sciences; BIC-SIO, Scripps Institution of Oceanography, Invertebrate Collection; SBMNH, Santa Barbara Natural History Museum; U.S.N.M., U.S. National Museum, Smithsonian Institution; YPM, Peabody Museum, Yale University.

Spicule preparations and cross-sections were routinely made according to the procedures of Hartman (1975). Slide preparations were mounted in Permount. All measurements, including spicules, were made with a stage micrometer directly through a compound microscope. Width measurements for megascleres were taken at the thickest point of the spicule shaft. Isochela lengths were taken from the apices of alae; length measurements of other spicules refer to maximum lengths. No less than 50 measurements were made for each spicule type and the data subjected to statistical analyses of range and mean. These measurements were displayed graphically to determine if distinct spicule size classes were present. Distinctive size classes are deemed legitimate only when these graphs show either non-overlapping, or distinct bi- or tri-modal distributions.

Spicule measurements are shown in this paper with the lowest size listed first and the greatest size listed last. In cases where only one specimen was measured, the mean is given in between these two extremes and underlined (234–<u>268</u>–295 μm). If more than a single specimen is measured then the range of means [from lowest to highest] is given and underlined (234–<u>259–271</u>–295 μm).

Spicules were prepared for the scanning electron microscope (SEM) as described above but mounted and dried on 1.5 cm round slides. These were mounted on stubs with double-sided tape, sputter coated with gold-paladium, and examined on an Hitachi S-520 scanning electron microscope.

Species Descriptions

Family Coelosphaeridae Hentschel, 1923
Genus *Forcepia* Carter, 1874
Wilsa de Laubenfels, 1930:27

***Forcepia* (*Forcepia*) *acanthostylosa* sp. nov.**
Figs. 1 and 2

Material. — **Holotype**: SBMNH 345543, U.S.A. California, San Miguel Island, Cuyler Harbor, Depth 10.7 to 12.2 m, Collectors: B. Scronce, M. Conboy, C. Carreon, and L. Bray, 19 February 1964. G. E. and N. Macginitie Port Hueneme Collection. **Paratype**: CASIZ 154368, U.S.A., California, Santa Barbara County, Santa Cruz Island, small cove midway between Chinese Harbor and Prisoners Harbor. Depth 10.3 to 12.2 m. Collectors: B. Scronce, M. Conboy, and L. Bray, 3 July 1963. G. E. and N. Macginitie Port Hueneme Collection.

Distribution. — Known only from two localities in southern California: San Miguel Island (holotype) and Santa Cruz Island (paratype).

Habitat. — Habitat descriptions were not included in the collection data.

Shape. — Holotype, thickly encrusting, 1.5–3.3 cm thick. Sponge irregular in shape, 6 cm long by 2.0–3.8 cm wide. The sponge appears to have encrusted a mat of bottom material, including algae, other invertebrates and sand. Paratype, thinly encrusting on a shell of the bivalve *Hinnites*

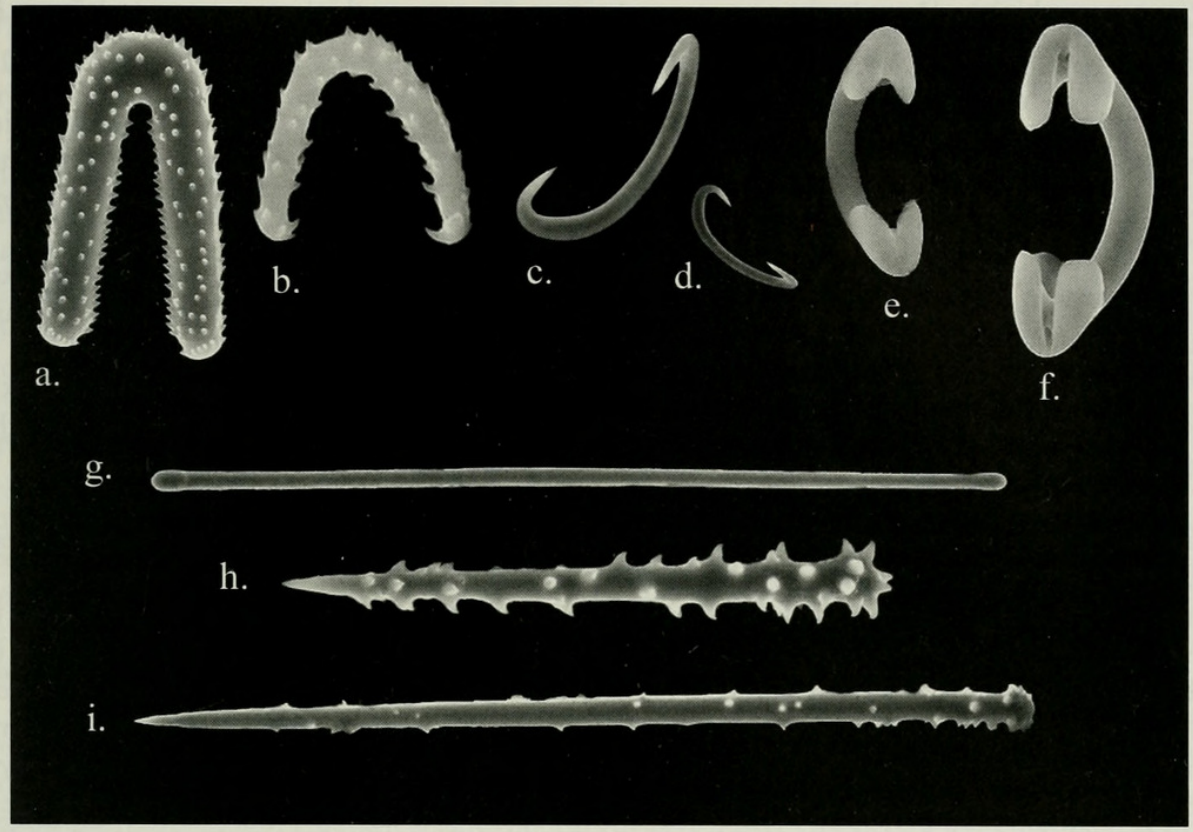

FIGURE 1. Scanning electron micrographs of the spicules of *Forcepia* (*Forcepia*) *acanthostylosa*, sp. nov. Holotype (SBMNH 345543) a. Forceps 4,000×, b. Forceps 7,000×, c. Large sigma 2,000×, d. Small sigma 3,000×, e. Small arcuate isochela 7,000×, f. Large arcuate isochela 4,000×, g. Substylote 500×, h. Small acanthostyle 1500×, i. Large acanthostyle 500×.

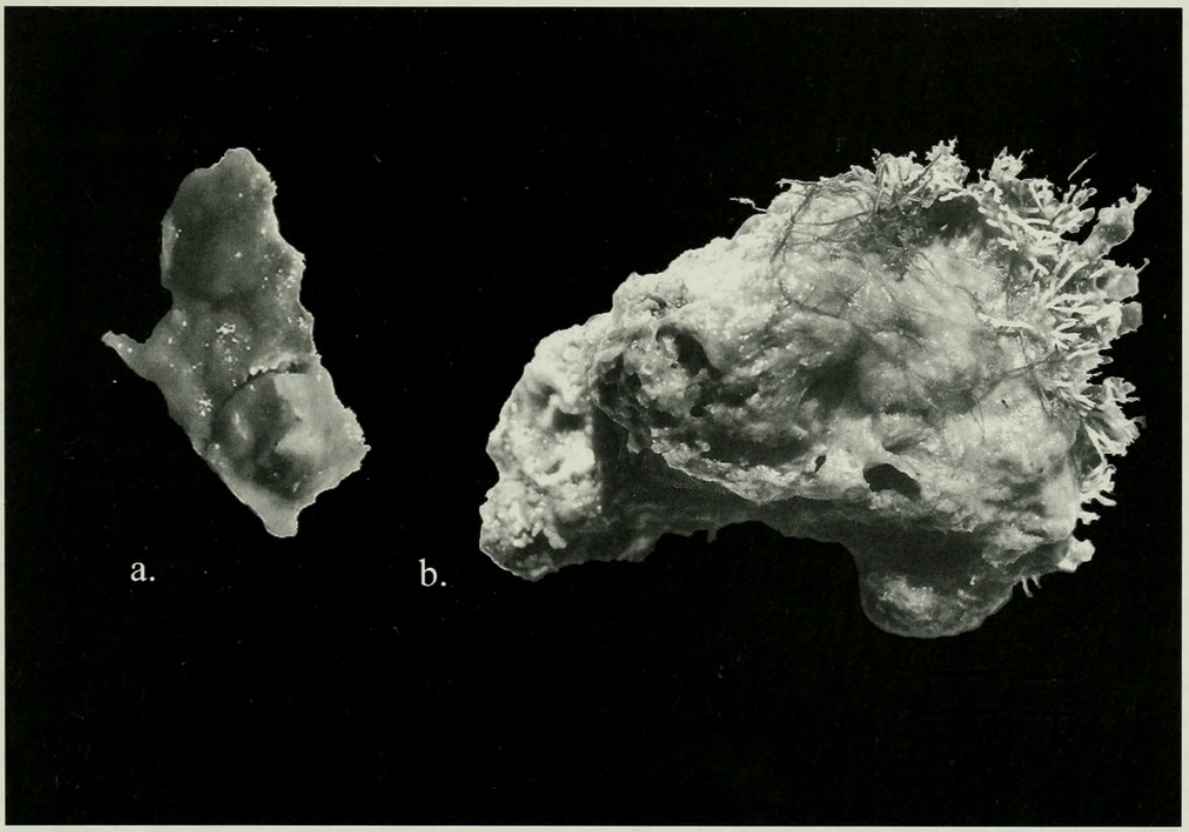

FIGURE 2. *Forcepia* (*Forcepia*) *acanthostylosa*, sp. nov. a. Paratype (CASIZ 154368), on fragments of *Hinnites multirugosus* 1.0–1.5 mm thick. b. Holotype (SBMNH 345543), dimensions.1.5–3.25 cm thick, 6.0 × 2.0–3.75 cm wide.

multirugosus, which had been broken into several pieces. The sponge thickness was up to 1.5 mm in a few places, but mostly 1.0 mm or less.

COLOR. — Live—yellow to orange; preserved in ethanol—light tan.

OSCULA. — On surface, randomly distributed on the holotype. Only one seen on the largest piece of the paratype. Oscula oval or nearly so, with no rims, but appear sunken below the surface. These range from 0.5 to 1.5 mm in diameter. A few large surface openings are also present. These are somewhat oblong and roughly 2.0 by 4.0 mm; they are probably not oscula.

TEXTURE AND SURFACE CHARACTERISTICS. — Texture firm, but soft, elastic to somewhat compressible. Surface smooth, opaque, somewhat irregularly lobate to verrucose. These surface features never of a high profile and prominent but usually of low profile and gently undulating.

ECTOSOME. — Made up of parallel tylotes to subtylotes very closely and tightly packed making the ectosome exceedingly firm. The thickness of this layer ranges from 182 to 200 μm. The strength of the ectosome almost always leads to the tearing of cross-sections.

CHOANOSOME. — Difficult to assess since the firm ectosome tends to drastically disrupt the choanosome in any cross-sections. Furthermore, presence of dirt, algae and other extraneous material (less noticeable in the smaller paratype) makes sectioning difficult. What is apparent in the choanosome is a very loose reticulation of acanthostyles of two size classes which often changes to a disorganized dispersal of the same. In many cases the choanosome becomes very thick, heavy and difficult to characterize. In the few relatively open spaces that do exist there is a plethora of microscleres of all kinds, with sigmas dominating in both numbers and size. Superimposed on the reticulation or disorganized dispersal of acanthostyles within the choanosome one can often find thick tracts varying from 46 to 72 μm, consisting mostly of acanthostyles of both size classes and, sometimes, tylostyles to styles. The smaller acanthostyles tend to be either echinating these tracts or involved in the formation of the reticulation. These tracts appear thickest near the ectosome and dominate the subectosomal area.

The paratype is relatively free of extraneous material. The holotype is completely invaded by dirt, algae and other material, making the overall structure difficult to determine. On occasion, areas of some cross-sections show a basal layer of spongin in which acanthostyles seem to have their heads imbedded but this is not at all clear.

MEGASCLERES. — Acanthostyles of two size classes. **Small**: 68–77–84–101 μm. × 2.4–3.9–5.8–7.3 μm (Fig. 1h). Spicule straight. Head tends to be flattened and covered with many spines. Many spines also on the upper third of the shaft. However, some spines occur almost to the tip. Spines large and robust. With the exception of those spines on the head, almost all are slightly recurved toward the head end. Tip spineless, sharply angled and pointed. **Large**: 181–220–236–265 μm. × 2.4–4.4–7.0–9.7 μm (Fig 1i). Spicules straight or with upper third slightly curved. Heads often flattened. Most spines are on the head and upper fifth of the spicule, a few occurring to near the tip. Spines mostly small, erect and sharply pointed. Those on the head tend to be crowded and may be blunt or irregular in shape. Tip free of spines, long and gently angled to a sharp point. Tylotes to subtylotes of a single size class. 195–227–233–258 μm. × 3.6–5.0–5.6–6.0 μm (Fig. 1g). Spicules straight, heads usually smoothly rounded but sometimes somewhat elongated. Frequently the shaft is gently tapered to one end, giving rise to a spicule with unequal ends, one smaller than the other. Sometimes one end is stylote while the other is subtylote.

MICROSCLERES. — Arcuate isochelae of two distinct size classes. **Small**: 22–26–29–36 μm (Fig.1e). Shaft thick and strongly curved. Alae small with edges gently rounded. The lateral alae attached to the shaft most of their length. **Large**: 46–51–58–68 μm (Fig. 1f). Shaft thick and strongly curved. Alae somewhat elongate with edges either nearly square (lateral alae) or somewhat pointed (frontal alae). Lateral alae clearly detached from the shaft for at least half their length.

Sigmas of two distinct size classes. Both occur in S and C configurations. **Small**: 26–38–47 μm (Fig. 1d). More or less even to slightly asymmetric curvature forming a medium arch. Tips thin,

sharply pointed and angled inwards. One end often twisted out of the plane of the other. **Large**: 53–68–72–78 μm (Fig. 1c). More or less even to slightly asymmetric. Much shallower arch. Tips thin, sharply pointed and angled inwards.

Forceps of two distinct size classes. **Small**: 7–10–11–13 μm (Fig. 1b). Legs not parallel but angled to about 30° from the median between the two equally long legs. Covered with spines with those at the tip of the legs largest and strongly recurved. Spines on the inner edges of the legs more strongly recurved than those on the outer edges. **Large**: 21–24–29 μm (Fig. 1a). Legs not parallel, slightly angled to about 10° from the median between the two equally long legs. Covered with numerous small, angled, erect spines, looking like the teeth of a saw. Those on the inner edge of the legs tend to be larger than those on the outer edges. The tips of the legs have caps delineated by a ring of small spines.

ETYMOLOGY. — The species is named *acanthostylosa* to recognize that it is the first *Forcepia* from California with acanthostyles.

REMARKS. — This species is the only *Forcepia* species with acanthostyles reported from the west coast of North America from Baja California to Canada. Only one *Forcepia* species has been noted from this region (Austin and Ott 1987). These authors describe a species similar to *Forcepia* (*Forcepia*) *japonica* Koltun, 1959, which has styles, but not acanthostyles. However the Canadian species was noted as having styles to acanthostyles with few spines. This species has only single size classes of all microsclere types and differs in almost all other respects.

Van Soest (pers. commun.) proposes two subgenera for this genus: *Leptolabis* for species with a hymedesmoid kind of structure, with the acanthostyles embedded in a basal layer of spongin, and *Forcepia* for those in which the styles or acanthostyles are structural megascleres making up the choanosomal reticulation. This new species appears to have most of its megascleres involved as structural elements in a reticulation. It has a thick choanosome showing a reticulate pattern and the observations of acanthostyles possibly embedded in a basal layer of spongin are too inconclusive to allow transfer to the subgenus *Leptolabis*.

***Forcepia* (*Forcepia*) *elvini* sp. nov.**
Figs. 3 and 4

MATERIAL. — **Holotype**: CASIZ 108399, U.S.A., California, Marin Co., Cordell Bank, approximately 20 miles due west of Pt. Reyes. Depth 82.3 m, Collectors: Swift, Smith, Hanna, September 1940.

DISTRIBUTION. — To date only known from the type locality, Central California, Marin Co., Cordell Bank.

HABITAT. — Habitat information was not included in the collection data.

SHAPE. — Sponge, thick, encrusting, irregular but somewhat rounded; 3.7 cm at the widest point, 3.5 cm at the narrowest point; 1.5 to 2.5 cm high.

COLOR. — Color in life not recorded; cream white in ethanol.

OSCULA. — Difficult to interpret. Openings, 1–3 mm in diameter, round to nearly so with irregular distribution, abundant at, and flush with the surface. These appear to penetrate well into the interior of the sponge where smaller, round openings may be seen.

TEXTURE AND SURFACE CHARACTERISTICS. — Texture firm, slightly compressible. Surface superficially smooth, some areas with irregularly shaped lobes and others which appear layered with thin, flat plates. The edges of the lobes and plates are distinctly hispid; the general surface is likewise hispid, but to a lesser degree.

ECTOSOME. — (Fig. 4a). The ectosome consists of a very thin layer of tightly packed subtylotes from 24 to 36 μm thick; occasionally to 48 μm thick. Superimposed over the subtylotes is a layer approximately 24 μm thick, packed with microscleres of which isochelae of both size classes appear to dominate. The presence of the layer of isochelae and the smaller size of the subtylote as compared to

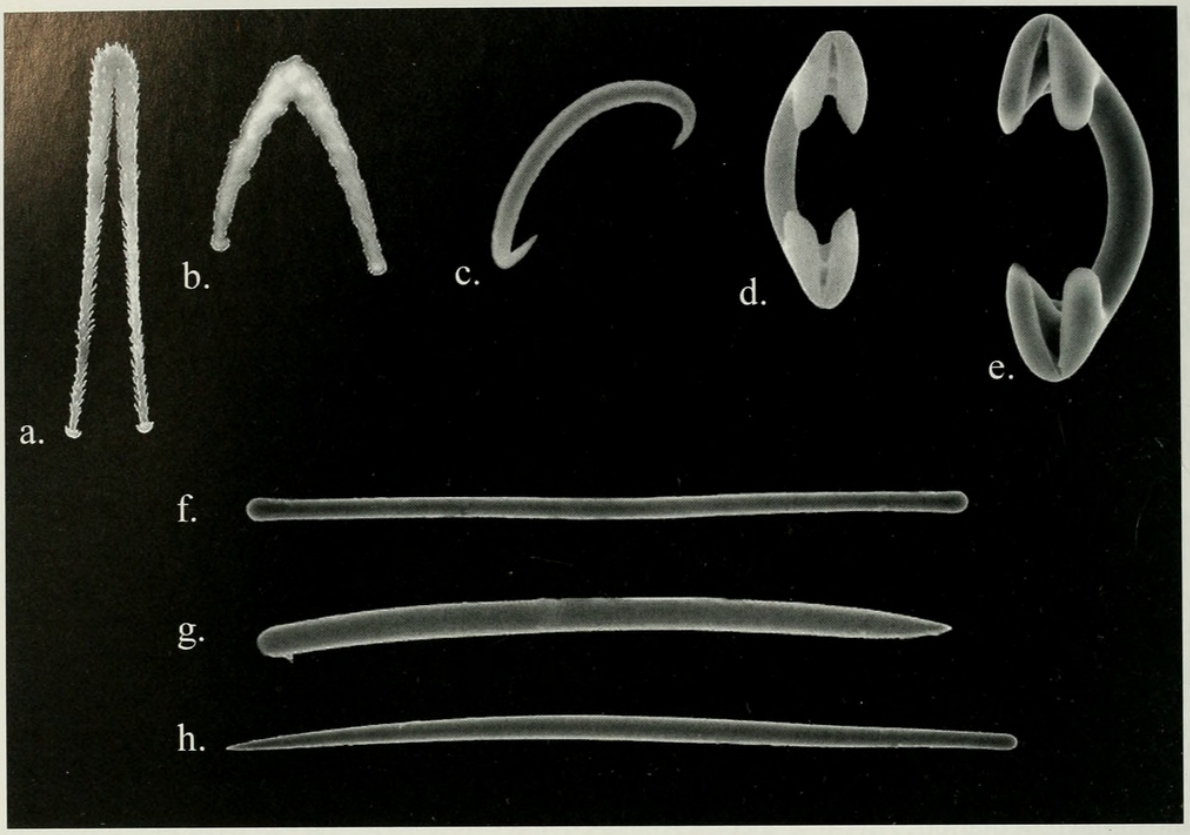

FIGURE 3. Scanning electron micrographs of the spicules of *Forcepia* (*Forcepia*) *elvini* sp.nov. Holotype (CASIZ 108399) a. Large forceps 2,000×, b. Small forceps 2,000×, c. Sigma 1500×, d. Small isochela 4,000×, e. Large isochela 2,000×, f. Substylote 500×, g. Style with spine 300×, h. Style 300×.

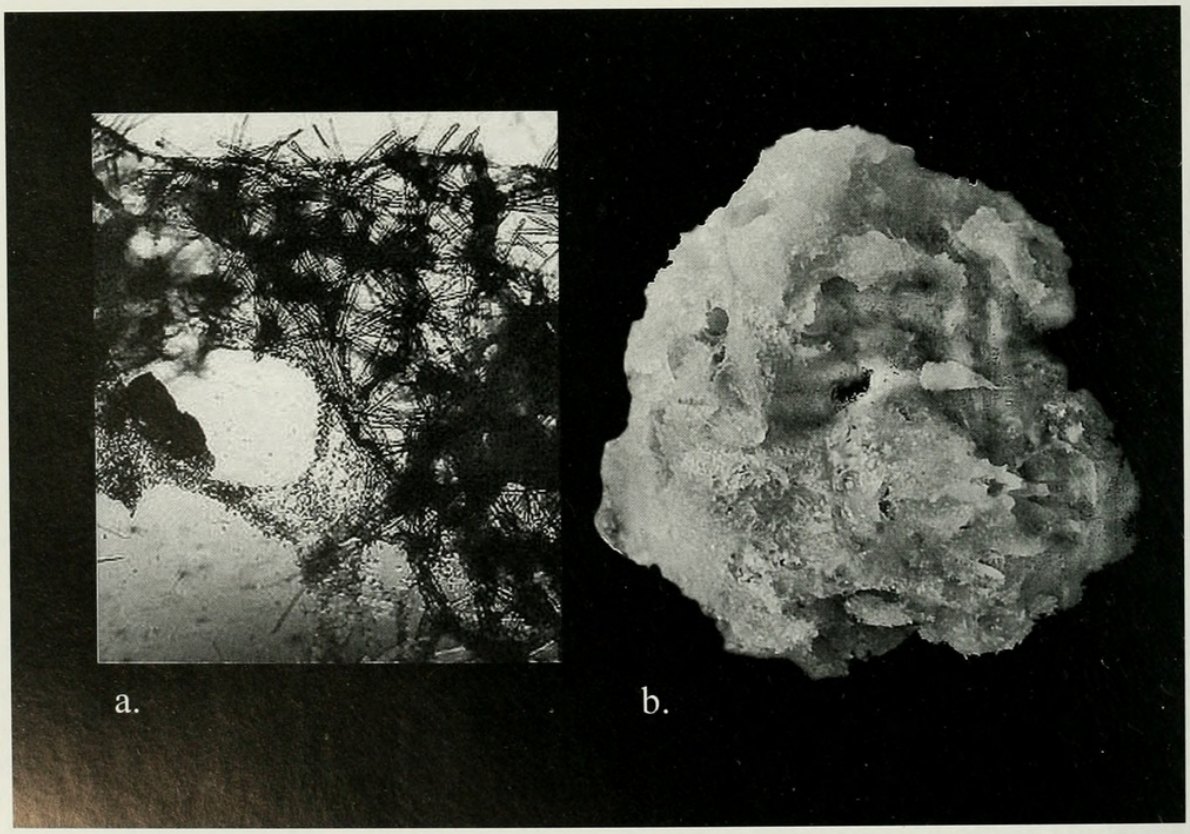

FIGURE 4. *Forcepia* (*Forcepia*) *elvini* sp. nov. a. Cross-section 40×. b. Holotype (CASIZ 108399), dimensions 3.5 × 3.7 cm × 1.5–2.5 cm high.

the styles in the choanosome make it difficult to see the subtylotes, such that one may initially assume that the ectosome is made up of microscleres only. The tips of the thick tracts of styles in the choanosome frequently push through the ectosome and form brushes on the surface.

CHOANOSOME. — (Fig. 4a). The choanosome is formed of a robust reticulation of styles. The reticulation is dominated by thick tracts, normally ranging from 121 to 133 μm but sometimes as thick as 182 μm. Superimposed over these tracts and connecting them is a reticulation of smaller tracts, 61 to 91 μm thick. The nodes of this reticulation are particularly thick and noticeable.

MEGASCLERES. — Styles of a single size class. 257–338–393 μm × 15–16–18 μm (Fig. 3g, h). Spicules almost always smooth, a few with a very small spine; almost always gently curved near the center. Shaft thick, slightly thicker near the center. Heads gently rounded, a few may approach a subtylostyle configuration. Point somewhat sharp.

Subtylotes of a single size class (Fig. 3f). 222–251–335 μm × 6–7–10 μm. Spicule smooth, straight to slightly undulate; shaft moderately thick, often slightly wider at one end. Heads very slightly inflated and smoothly rounded.

MICROSCLERES. — Arcuate isochelae of two size classes. **Small**: 16–19–21 μm (Fig. 3d). Shaft thin with well rounded, gentle arch. Alae somewhat smoothly pointed and well separated. Lateral alae directed rather sharply back towards the shaft; two thirds of their length is attached to the shaft. **Large**: 26–44–49 μm (Fig 3e). Shaft thick and strongly arched. Central ala somewhat narrowed with rounded but even more narrowed tip. Lateral alae wider and well rounded but short relative to length of shaft. One half of their length is attached to the shaft.

Sigmas of one size class (Fig. 3c). 39–49–56 μm. Arch shallow, mostly eccentric with one end rounded, the other not. Tips sharp; the tip of the rounded end slightly bent inward, the tip on the opposite end sharply bent inward.

Forceps of two size classes. **Small**: 11–15–28 μm (Fig. 3b). Legs often unequal in length, noticeably thickest where they join; not parallel but angled to about 30° from the median between the two legs. Surface not spined but gently undulate. Small caps at the ends of the legs are but slightly inflated bulbs. **Large**: 36–49–55 μm (Fig. 3a). Legs equal to subequal, very thin except for where they join; nearly parallel, angled to about 10° to 12° from the median between the two legs. Both interior and exterior surfaces covered with spines, these pointed away from the tip of the foot. Spines sharpest and most numerous near tip of feet. Distinct saucer shaped caps present.

ETYMOLOGY. — This species is named after Dr. David Elvin, a sponge biologist, computer specialist, and a long time friend and colleague.

REMARKS. — This species appears to be unique, especially in regard to its two size classes of forceps. The larger appears very similar to those frequently seen in other species, showing numerous teeth on the legs on both exterior and interior surfaces. The smaller size class is quite different in that it has an undulating surface with no apparent spines at all. Noteworthy also, is the presence of tiny spines on some of the styles making up the distinct choanosomal reticulation.

***Forcepia* (*Forcepia*) *macrostylosa* sp. nov.**
Figs. 5 and 6

MATERIAL. — **Holotype**: CASIZ 146074, U.S.A., California MET Sta. 105. Catalina Basin, 33°10′N, 118°36′W, 1271–1280 m, 25′ otter trawl. January 29, 1981, 2400–0230. R/V *New Horizon*. Coll. K. Smith, S. Luke.

DISTRIBUTION. — This species is presently known only from its type locality, Southern California, Catalina Basin, California.

HABITAT. — Habitat information was not included in the collection data.

SHAPE. — Thick, massive, somewhat domed-bulbous, 5.0 by 3.5 cm and height to 23 mm.

COLOR. — Color in life unknown; light tan in ethanol.

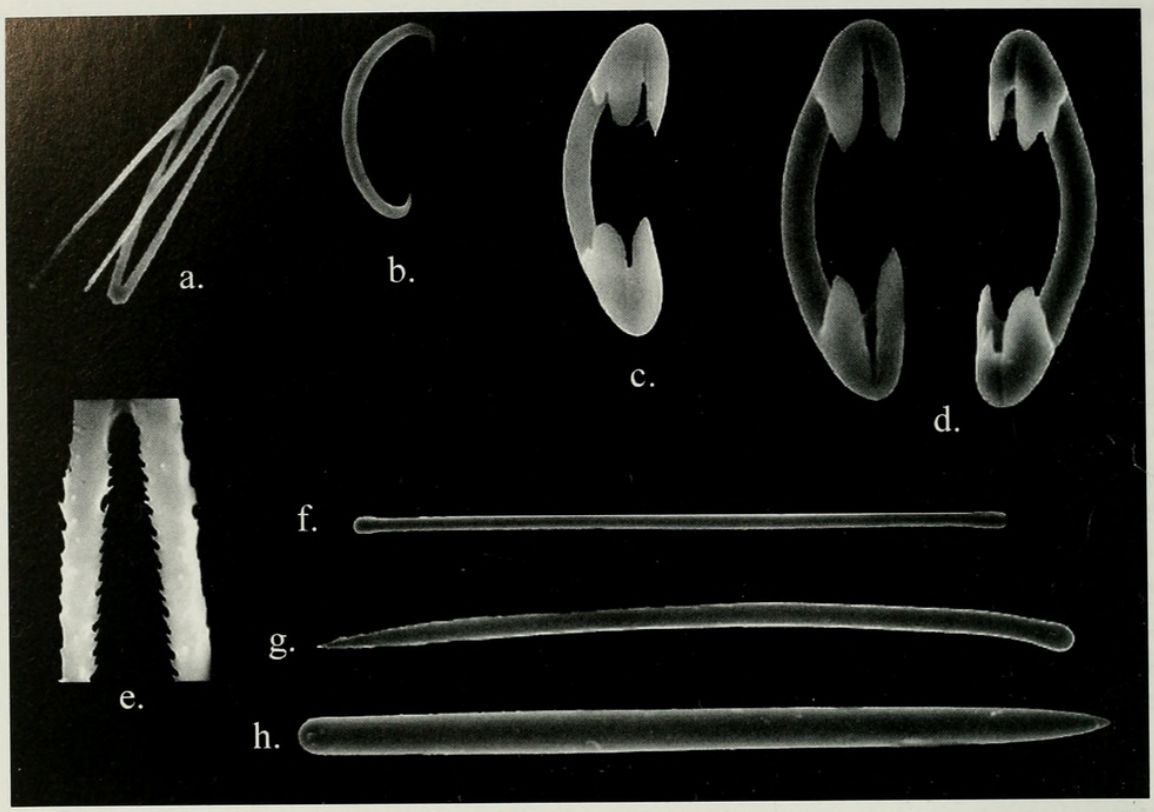

FIGURE 5. Scanning electron micrographs of the spicules of *Forcepia* (*Forcepia*) *macrostylosa* sp. nov. Holotype (CASIZ 146074) a. Forceps 1500×, b. Sigma 1500×, c. Small arcuate isochela 4000×, d. Large arcuate isochelae 2500×, e. Legs of forcep 5000×, f. Substylote 300×, g. Subtylostyle 300×, h. Style 300×.

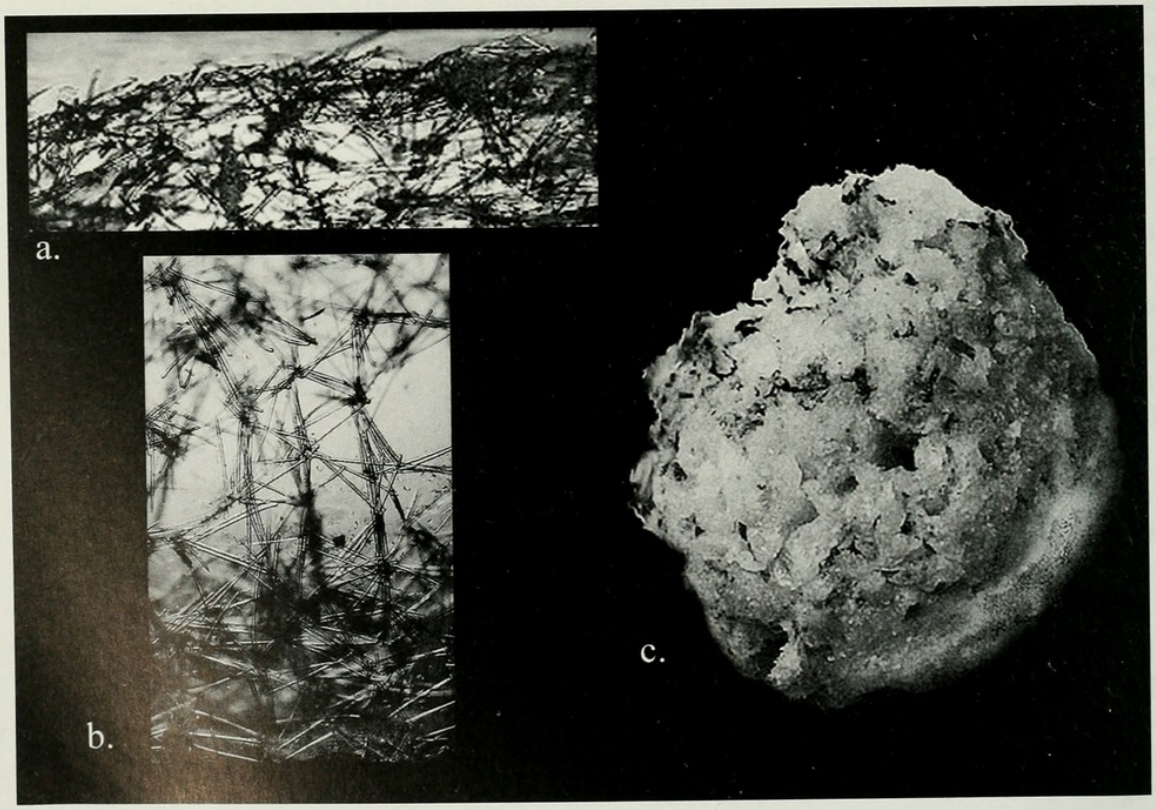

FIGURE 6. *Forcepia macrostylosa* sp. nov. Holotype (CASIZ 146074) a. Cross-section of the ectosome 40×. Note that the bundles of subtylotes are worn away except at the extreme right of the photograph. b. Cross-section of the choanosome, 80×. Note the ladderlike skeleton. c. Holotype, dimensions 5.0 × 3.5 cm, 23 mm high.

OSCULA. — Difficult to discern. May be situated below the surface where the platelike surface creates openings ranging from 3.0 to 12.5 mm or greater.

TEXTURE AND SURFACE CHARACTERISTICS. — Superficially smooth; some areas totally smooth, others layered with overlapping thin, flat plates. Consistency spongy, compressible.

ECTOSOME. — (Fig. 6a) Formed of a thin layer of packed subtylotes which is easily removable. The thickness is usually 48 to 60 μm, but sometimes reaches 72 μm. In places the ectosomal layer of subtylotes is worn away.

CHOANOSOME. — (Fig. 6b) The choanosome consists of a ladderlike reticulate skeleton with tracts of subtylostyles about 91 μm. thick. These tracts support a loose reticulation of thinner bundles ranging up to 24 μm thick of from 2 to 5 or more subtylostyles. The thick tracts and ladderlike reticulation becomes less obvious as the ectosome is approached. Near the surface, tracts may become bent almost parallel to the surface and the reticulation gets more confused, complicated and random.

MEGASCLERES. — Subtylostyles to styles of a single size class (Fig 5g, h). 268–499–593 μm × 18–20–22 μm. Smooth, most curved close to the head end. Shaft thick, of more or less even width except slightly wider just below the head. Tip hastate to tornote-like, often with a slight expansion of the shaft before narrowing to the tip.

Subtylotes of a single size class. 309–372–540 μm × 6–8–9 μm (Fig. 5f). Shaft thin, either straight or somewhat sinuous with heads abruptly and slightly expanded. Heads often unequal in size, the smaller set off by a slight constriction of the shaft.

MICROSCLERES. — Arcuate isochelae of two size classes. **Small**: 19–23–29 μm (Fig. 5c). Shaft with slight or moderate curvature. Alae only somewhat separated. Central ala is the longest; often angled or pointed. Lateral alae smaller, rounded and most often with an obvious, very small, rounded incipient ala next to the shaft. **Large**: 36–44–50 μm (Fig. 5d). Sharply arched. Alae well separated, thin and pointed, often sharply. Sometimes the central or lateral alae are bifurcated.

Sigmas of a single size class. 45–60–66 μm (Fig. 5b). Arch shallow, may be even or eccentric. Shaft moderately thick. Points very sharp with one bent out of the plane of the shaft.

Forceps of a wide range of sizes or more probably of a single size class, but may appear as multiple size classes. 9–50–87 μm (Fig. 5a, e). Shape highly variable, from V-shaped with legs nearly parallel to legs almost toxa-like. The most common form is long, slender, with legs nearly parallel. Spines small but obvious on inner edge, all pointing upwards. Outer edge with few, somewhat blunt spines with the exception of those on the upper edge where the legs join. Here the spines are erect, obvious and sharp.

ETYMOLOGY. — This species was named *macrostylosa* in recognition of the large size of its styles.

REMARKS. — This species is distinguished by the large size of its styles and tylotes and the extreme size range of its forceps. In some respects it resembles *Forcepia* (*Forcepia*) *topsenti* Lundbeck, 1905, which has large styles and tylotes and forceps of a similar range of shapes. However, in all other respects it differs. In *F. topsenti*, isochelae are of one size class, sigmas are significantly larger and surface features are quite different from those detailed for the new species.

***Forcepia* (*Forcepia*) *hartmani* sp. nov.**
Figs. 7 and 8

MATERIAL. — **Holotype**: CASIZ 53463, U.S.A., California, Monterey County, Pescadero Point, 17 Mile Drive, April 28, 1982. Three pieces. Depth, intertidal. Coll. W. Lee. **Paratypes**: CASIZ 53465, U.S.A., California, Monterey County, Point Lobos, March 1984. Coll. D. Chivers and W. Lee; CASIZ 35911, U.S.A., California, Sonoma County, Bodega Bay, Bodega Marine Labs, August 9, 1983. Two pieces. Depth 0.5 m, rocky intertidal; CASIZ 017311, U.S.A., California, Farallon Islands, Southeast Farallon Island, April 4, 1977. Coll. B. Bowman and C. Chaffee. Numerous pieces.

Depth intertidal, +0.4 m under overhang; CASIZ 35961, U.S.A., California, Sonoma County, Bodega Bay Marine Laboratory, August 9, 1983, open coast west of aquaculture building, Depth, intertidal, -0.5 m, rocky intertidal. Coll. S. Ward and A. Miller. **Other Material**: CASIZ 18, CASIZ 31, CASIZ 3662, CASIZ 4593, CASIZ 6923, CASIZ 20358, CASIZ 31282, CASIZ 35961, CASIZ 53411, CASIZ 53461, CASIZ 53464, CASIZ 59662, CASIZ 78254, CASIZ 108925, YPM 1540 and YPM 1697A.

DISTRIBUTION. — Present known range: Point Lobos, Monterey Co. to Bodega Bay Headlands and Farallon Islands, California. Type locality: Pescadero Point.

HABITAT. — Rocky intertidal, in deep pools or rocky overhangs from about + 0.4 m to encrusting rocks, -0.4–0.5 m.

SHAPE. — Thin to thick encrusting with a more or less flat surface. Incrustations up to 1.6 cm thick. Size of largest piece of holotype 4.8 cm long × 4.2 cm wide × 1.6 cm high. Incrustations may cover a much larger area.

COLOR. — In life, honey yellow, yellow gold, yellow, gold tan, buffy citron, buff; light tan in ethanol.

OSCULA. — Oscula numerous, 1.0 to 4.0 mm across, round or somewhat irregular with slightly raised membranous lips. In the thickest specimens the oscula tend to be within the surface grooves where their shape and the membranous lips may not be easily seen.

TEXTURE AND SURFACE CHARACTERISTICS. — Consistency slightly compressible, friable. Surface nodular and ridged, ridges somewhat hispid and delineating shallow grooves. In larger specimens the grooves are deeper.

ECTOSOME. — (Fig. 8a) Exceedingly dense, crustlike. Made up of tightly bound masses of tylotes to subtylotes parallel to the surface. Generally 85 to 91 μm in thickness but may reach over 200 μm in some places due to additional, looser, accumulation of tylotes underneath.

CHOANOSOME. — (Fig. 8a) A reticulation of wide tracts of styles with an overlying, looser, less structured reticulation of random styles and tylotes. The tracts range in size from small, 24 to 28 μm to large, 60 to 72 μm. Within the choanosome are large strands of tissue with massive numbers of microscleres, most notably sigmas.

MEGASCLERES. — Styles to subtylostyles of a single size class. 169–202–221–281 μm × 7–8–9–10 μm (Fig. 7e). These vary from straight to strongly curved, the curvature occurring on the upper 1/2 to 1/3 of the spicule. Most are simple styles but some may have tiny spines on either head or tip. Even when some spines occur, the spicules look more like a normal style than an acanthostyle. The shaft is equally wide throughout most of its length. The head is evenly and well rounded but may appear slightly swollen. The tip end often has a small indentation which temporarily reduces the shaft width just prior to a long, sharp, tornote-like tip. The appearance is as though the shaft was pinched inward before the tip, leaving a slight indentation.

Tylotes to subtylotes of a single size class. 137–166–185–205 μm × 4–5–6 μm (Fig. 7d). Mostly straight to very slightly bent. Shaft of even width or slightly wider centrally. The heads are distinctly tylote or strongly subtylote. There is a tendency for the swollen heads to be elongated, with nearly parallel sides. This is especially noticeable on the smallest spicules. Spicules with ends often unequal in size.

MICROSCLERES. — Arcuate isochelae of a single size class. 18–23–34–38 μm (Fig. 7b). Thick shaft with moderate curvature. Alae tend to be short, well separated, with rounded tips which may be slightly flared. Lateral alae fused to shaft 3/4 of their length.

Sigmas of a single size class. 30–42–48–55 μm (Fig. 7c). Sigmas with low arch and tending to be elongate with a relatively thick shaft. One end has a wider curvature than the other end and with a somewhat curved, sharp point. The opposite end is narrower and more compact, with a very sharp and sharply bent spine, usually bent out of the plane of the shaft.

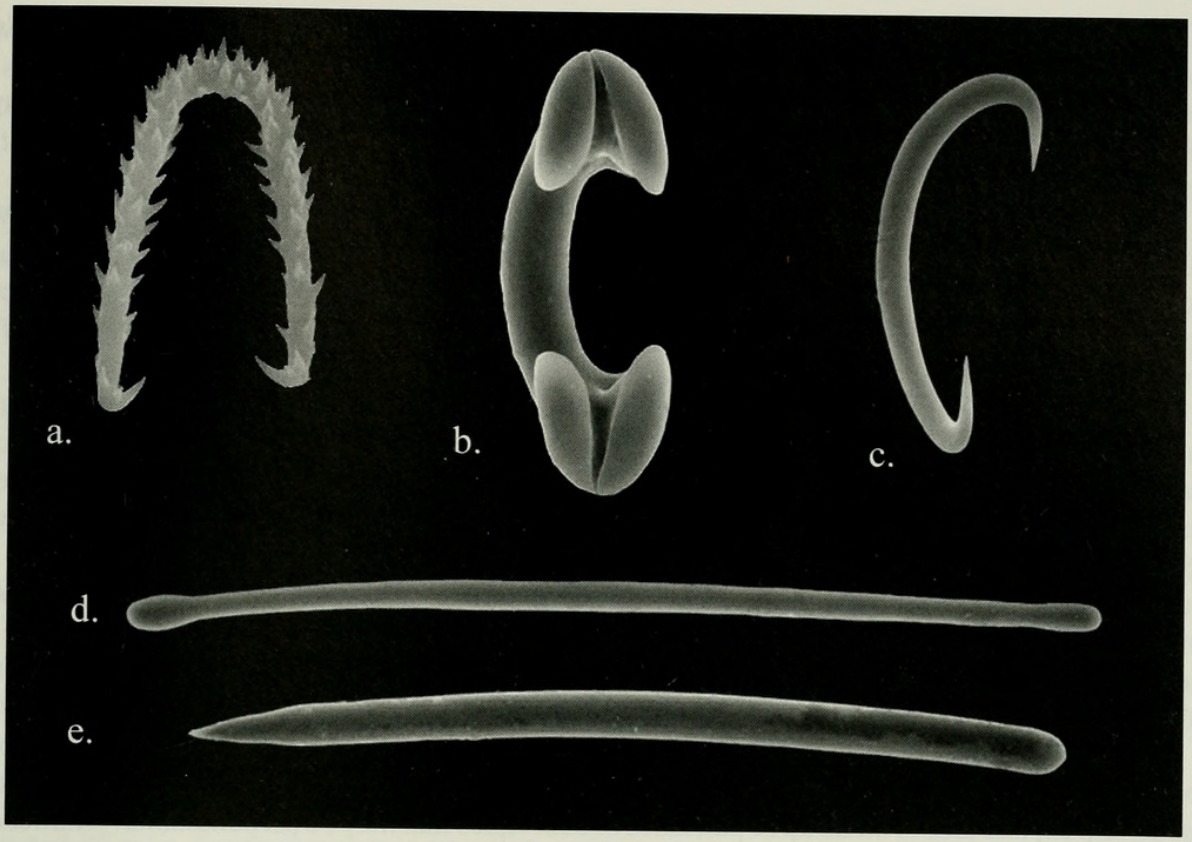

FIGURE 7. Scanning electron micrographs of the spicules of *Forcepia* (*Forcepia*) *hartmani* sp. nov. a. Forceps 10,000×, b. Isochela 3,000×, c. Sigma 2,000×, d. Tylote to substylote 700×, note the difference in the two ends, e. Style 500×.

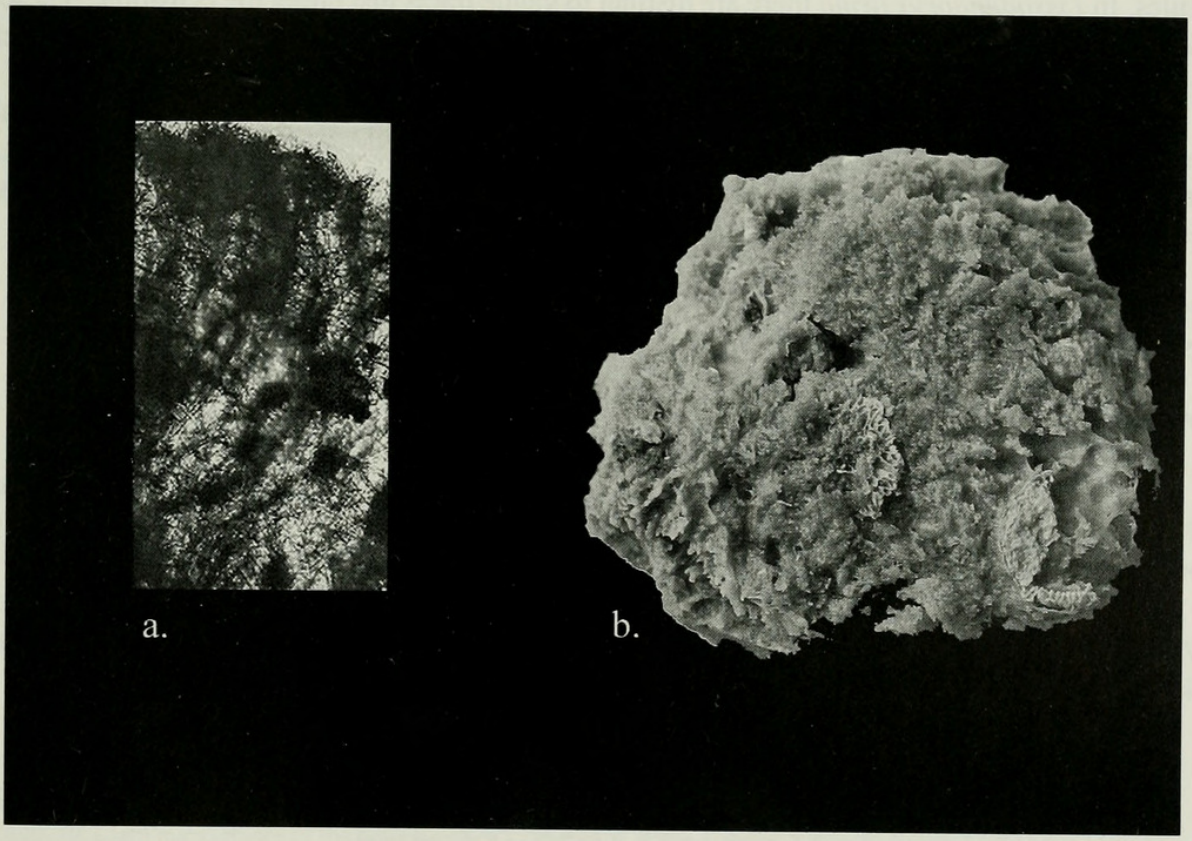

FIGURE 8. *Forcepia* (*Forcepia*) *hartmani* sp. nov. a. Cross-section 40×, b. Holotype (CASIZ 053463), dimensions 4.8 × 4.2 cm wide and 1.6 cm high.

Forceps of a single size class. 5–8–9–11 μm (Fig. 7a). These are generally horseshoe-shaped with a narrow to moderate range in the angle of the two legs from the median between them. The legs are heavily spined, the spines all curved upward and well spaced. There are three rows of spines seen on each side; one facing inwards, one along the middle of the leg and one on the outer edge. The tips of the legs are widened and set off by three large spines.

ETYMOLOGY. — This species is named after the sponge systematist and biologist, Doctor Willard Hartman. Hartman introduced me to the marvelous world of sponges and has been a colleague in producing the sponge chapter in the latest edition of the Light's Manual (Lee, Hartman, and Diaz, in prep.). Doctor Hartman has done much for our understanding of the systematics and biology of the Porifera. He has likewise become a valued friend.

REMARKS. — This species originally appeared in material reviewed in Hartman's 1975 description of *Lissodendoryx firma* where he described the occasional occurrence of forceps in this species. This is a very understandable error, likewise initially made by this author, since the spicule complement of these two species is so similar. In fact, it was only by separating out all supposed *L. firma* with forceps and comparing this group with those that had no forceps, that it became obvious that the forceps-bearing specimens were clearly different from *L. firma*. While the spicule complement (other than forceps) is superficially similar between the two species, the details of their structure differ significantly. Most important are the obvious but subtle differences in skeletal structure, especially in the nature of the ectosome and the details of the choanosomal tracts.

The ectosome of *Forcepia* (*Forcepia*) *hartmani* is exceedingly thick and tightly bound with tylotes to subtylotes parallel to the surface but with few, if any, spicules penetrating the surface. In *Lissodendoryx*, this area is made up of palisades of subtylotes that may be perpendicular, parallel or at an angle to the surface. Spicule penetration of the surface and the formation of brushes is common.

The choanosome of *Forcepia* (*Forcepia*) *hartmani* is made up of obvious, bold, thick tracts that form a reticulation over which can be found a looser, more random reticulation with many random spicules. In *Lissodendoryx firma* there are distinct to vague tracts just under the ectosome. These are far less dominant than those in *Forcepia*. Also, in *Forcepia* the choanosome is made up of a distinct reticulation of thin tracts. The deeper one looks, the more random the reticulation appears.

While these differences are consistent, they nevertheless are subtle. However, even more subtle is the occurrence of forceps. These microscleres are tiny in *Forcepia* (*Forcepia*) *hartmani* and are exceedingly difficult to find unless one is well aware that they may be present. Thus, the similarities between the two species can lead to a hurried, and incorrect, identification.

Forcepia (*Forcepia*) *hymena* (de Laubenfels, 1930) n. comb.

Figs. 9, 10, and 11

Wilsa hymena de Laubenfels, 1930 (Fig. 10)

MATERIAL. — **Holotype**: U.S.N.M. 21515, California, Monterey Co. Monterey Bay, May 9, 1929, Depth 700 m, Coll. E. F. Ricketts; **Paratype**: B.M. 29.8.22.62, California, Monterey Co., Monterey Bay, May 9, 1929, Depth 700 m, Coll. E. F. Ricketts. **Reference specimen**: BIC-SIO P-1366, BIC-SIO P-1367, CASIZ 146075, R-12. San Diego Trough, California. 32°34.5′N, 117°33′W, 1170–1216 m, 25′ otter trawl. Mud. October 29, 1970, 1900–2147. R/V *Agassiz*. Coll. F. Rokop, S. Luke.

DISTRIBUTION. — San Diego Trough to Monterey Bay, California.

HABITAT. — Possibly mud, 700–1216 m.

SHAPE. — Globular, massive; BIC-SIO P-1366, 5.3 × 2.0 × 3.5 cm. high. BIC-SIO P-1367, 2.1 × 1.3 × 0.8 cm. high, 1.7 × 1.5 × 0.6 high, and 3.0 × 2.0 × 1.4 cm high.

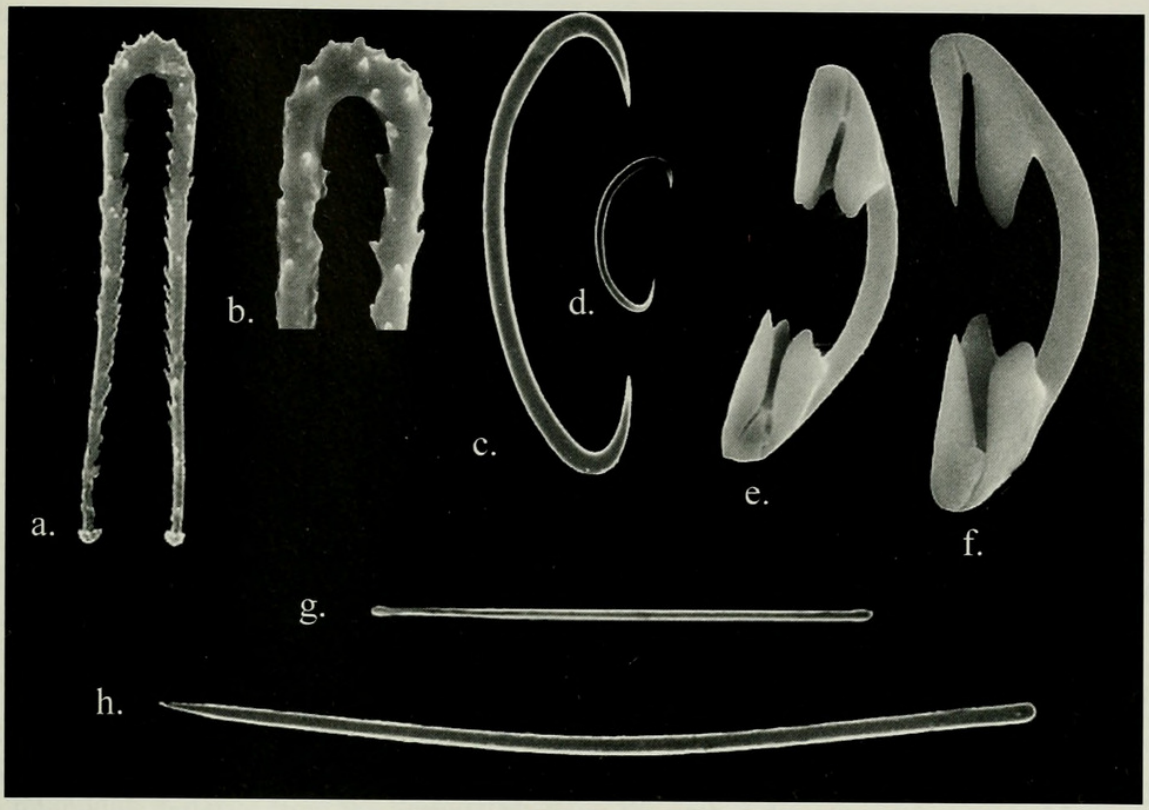

FIGURE 9. Scanning electron micrographs of the spicules of *Forcepia* (*Forcepia*) *hymena* (de Laubenfels, 1930). a. Forcep 5,000×, b. Forceps upper end showing fewer and smaller spines, c. Large sigma 500×, d. Small sigma 500×, e. Isochela 3,000×, f. Isochela 4,000×, g. Substylote 400×, h. Style 200×.

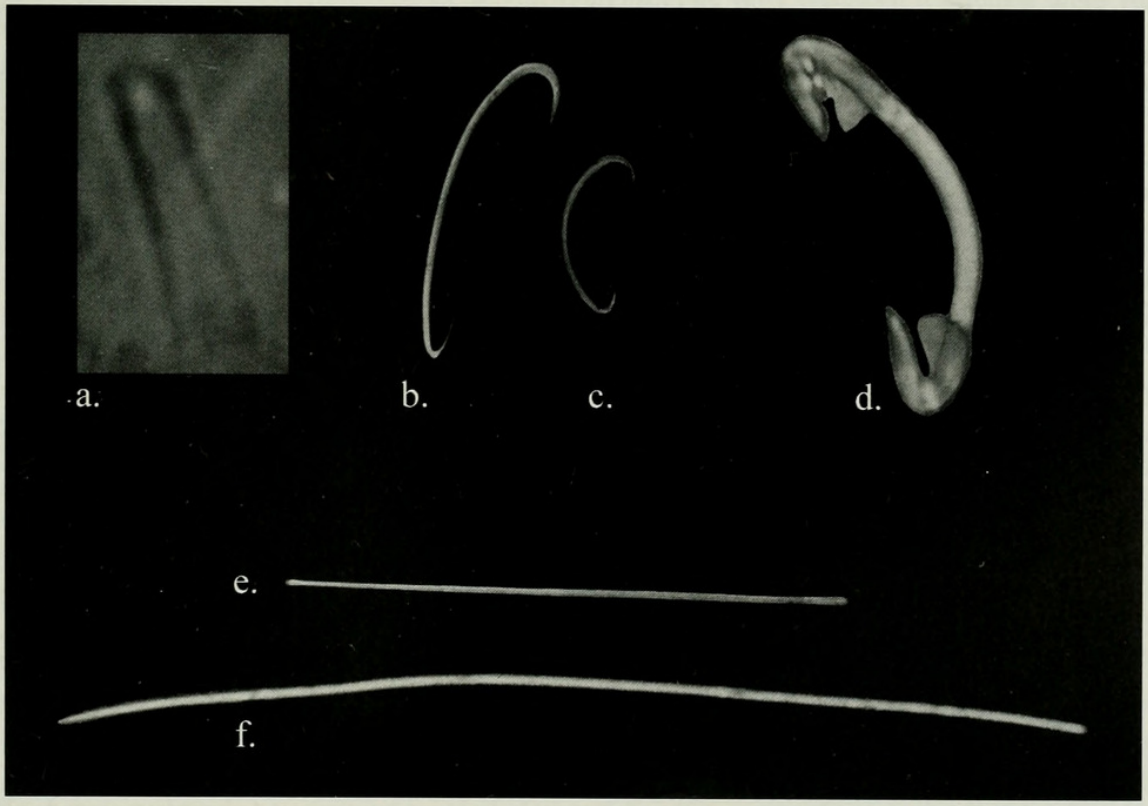

FIGURE 10. Light micrographs of the spicules of de Laubenfels' *Wilsa hymena*, 1930 (Holotype USNM 21515). a. Forceps 600×, b. Large sigma 500×, c. Small sigma 500×, d. Isochela 600×, e. Substylote 400×, h. Style 200×. Note: The quality of these images was largely influenced by the poor condition of de Laubenfels' slides.

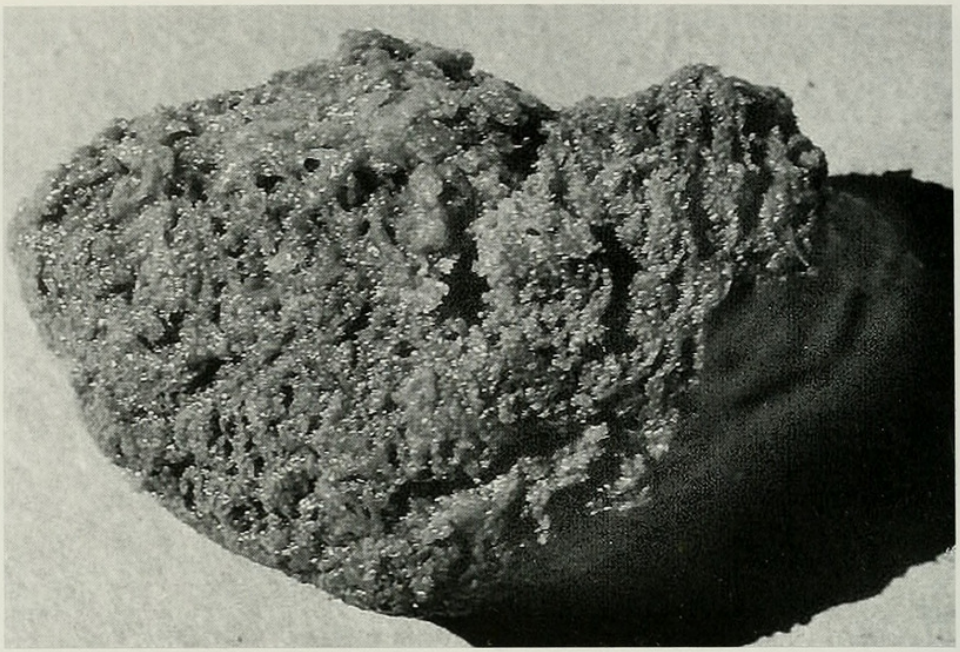

FIGURE 11. *Forcepia* (*Forcepia*) *hymena* (de Laubenfels, 1930). Reference specimen CASIZ 146075, dimensions 5.3 × 2.0 cm wide × 3.5 cm high.

COLOR. — In life, not recorded for reference specimen; holotype recorded as "pale drab." Dark tan to brown in ethanol.

OSCULA. — Numerous, round to somewhat elongate or irregular, 1.5 to 4.0 mm across. Flush with surface or somewhat recessed, no lip or rim.

TEXTURE AND SURFACE CHARACTERISTICS. — Soft, compressible, spongy. Surface with some areas superficially smooth but mostly slightly roughened, verrucose. Surface with shallow grooves delineated by smooth ridges and small rounded conules.

ECTOSOME. — The ectosome is delineated by a dermal membrane, 48 to 72 μm thick which contains microscleres in abundance, especially the macro-sigmas. Below is a compact bundle of subtylotes reaching up to 96 μm in thickness. The subtylotes are tightly bound together and parallel to the surface.

CHOANOSOME. — The choanosome is dominated by a rugged reticulation of styles between tracts of styles. The larger tracts range from about 45 to 95 μm thick. Smaller tracts of more loosely bound styles may also be found, these ranging from 19 to 24 μm. The entire choanosome appears as a very rugged, almost random reticulation with more or less parallel tracts running through it. The choanosome is also packed with sand grains and detritus. The combination of a soft, compressible texture with the presence of sand grains and detritus made it impossible to obtain good cross-sections. Accordingly, the structure detail had to be pieced together from observations of numerous slides of varying quality.

MEGASCLERES. — Styles of a single size class. 533–601–697 × 13–14–16 μm (Figs. 9h, 10f). Smooth, width even throughout. Most somewhat curved near middle. Tip tornote-like with sharp point.

Subtylotes of a single size class. 273–327–448 × 5.5–6.9–7.0 μm (Figs. 9g, 10e). Straight, smooth, slightly wider near center. Ends mostly subtylote, or tylote with head somewhat elongate. Frequently ends unequal, one subtylote, the other tylote, and of different sizes.

MICROSCLERES. — Arcuate isochelae of a single size class. 24–38–48 μm (Figs. 9e, f; 10d). Strong arch with alae long and well separated. Frontal ala long, narrow and sharply pointed, often divided into two or three small or independent alae. Lateral alae longer, attached to shaft by 1/2 to 3/4 of

their length and curved toward the shaft with a narrowed but rounded tip. Lateral alae tend to have hints of additional divisions, but these are never complete but seen only at the outer edge. Frequently, one end differs from the other relative to such divisions.

Sigmas of two size classes. **Small**: 60–77–99 μm (Figs. 9d, 10c). Somewhat elongate, with relatively deep and eccentric arch. Both ends with tips moderately bent inwards in the same plane as the shaft. **Large**: 169–208–243 μm (Figs. 9c, 10b). Elongate with moderate arch. Arch not eccentric but with one end with a rounder curvature than the other and a sharp point which is only moderately bent. The other end with a point more obviously bent. Both points in the same plane as the shaft.

Forceps of a single size class. 11–19–26 μm (Figs. 9a, b;10a). Legs long, parallel to about 2/3 the distance from the tips where they are very slightly angled outwards. Wide spines which point upwards, mostly on the inner side of the legs. Many fewer spines on the outer edge. The legs terminate in saucer-like caps. Spines on upper edge where the legs join, fewer and smaller than elsewhere.

REMARKS. — In 1930, de Laubenfels described a new genus and species, *Wilsa hymena*, from a single specimen found on the macerated skeleton of a hexactinellid sponge. The specimen had an intact ectosomal membrane containing abundant macro-sigmas. The choanosome was so enmeshed with the hexactinellid on which it was residing that its structure could not be determined, although some styles were found. Adjacent to the specimen and presumably contaminating it with its spicules, was a specimen of *Lissodendoryx kyma*. De Laubenfels described *Wilsa* as containing styles, palmate isochelae, macro-sigmas, sigmas of a smaller size class, and forceps. The forceps were described through light microscopy as appearing smooth with only the faintest traces of spination. In addition to these spicules, de Laubenfels noted the presence of some tornotes and arcuate isochelae.

In reviewing material from the Scripps Museum the author discovered in a mixed lot, several pieces of a sponge that were obviously in the genus *Forcepia*. On preliminary examination it was found that in many respects this material matched de Laubenfels' *Wilsa hymena*. While it was possible to get reasonable cross-sections and scanning electron micrographs from the Scripps specimen, this was not the case for the holotype of *Wilsa hymena*. The only material available were two de Laubenfels microscope slides, one of which had little material on it. Fifty measurements were taken of each spicule type for both the *Wilsa* type (U.S.N.M. 21515) and the Scripps material. The spicules from these are compared in Table 1. Note that the de Laubenfels measurements are designated by an asterisk. Spicule widths for the de Laubenfels type are not given.

The palmate isochelae noted by de Laubenfels may well have been a contaminant. However, most all of the isochelae seen on the de Laubenfels slide appeared to be arcuate. The arcuate isochelae were thought to be a contaminant from *Lissodendoryx kyma* which de Laubenfels noted was living adjacent to his specimen. Interestingly, the isochelae of *L. kyma* and those measured from the Scripps specimens totally overlap in size range. Close comparison of the morphologies of the spicules that are shared between the de Laubenfels type and the Scripps specimens show them to be very close or identical.

De Laubenfels erected the genus *Wilsa* for this single species, noting that it was most similar to *Esperiopsis forcipula*, Lundbeck, 1905. *Esperiopsis forcipula* was later transferred to *Leptolabis* (Topsent, 1904). In recent work for the *Systema Porifera*, Van Soest (pers. commun.) designated this species as *Forcepia* (*Forcepia*) *forcipula* (Lundbeck, 1905). There is indeed a close resemblance between the two species, but it is clear that they are not the same. Among some of the differences, the macro-sigmas of *Forcepia* (*Forcepia*) *hymena* are much larger and it has only a single size class of isochelae, not two.

Given our present understanding of this group of sponges and the fact that the genus *Wilsa* was erected for a single, incomplete and contaminated specimen, *Wilsa* is hereby synonymized with *Forcepia* and de Laubenfels' holotype should be referred to *Forcepia* (*Forcepia*) *hymena* (de Laubenfels, 1930). Since de Laubenfels' holotype is both incomplete and contaminated, the reference specimen may act as a subsidiary source of information on this species.

DISCUSSION

Five species of *Forcepia* are now known to occur in California. Four of these are newly described herein; the fifth represents the assignment of *Wilsa hymena* de Laubenfels, 1930 to *Forcepia* and a redescription based on newly found material. The family Coelosphaeridae Hentschel, 1923, to which these species belong, may be generally distinguished by having an ectosomal tangential crust of smooth diactinal (usually tylote) spicules, a reduced choanosomal skeleton composed of a reticulation of smooth or acanthose styles, with or without tracts and having sigmas, arcuate isochelae, and no toxas. The genus *Forcepia* is the only forceps-bearing genus in the family. In addition, the ectosomal spicules are always tylote or subtylote, the choanosomal spicules may be styles and may have ectosomal spicules (tylotes or subtylotes) involved as well. In encrusting forms, one may sometimes find a hymedesmoid structure replacing the reticulation, or elements of both. Van Soest (pers. commun.) has used choanosomal skeletal structure to erect two subgenera. Species with a hymedesmoid arrangement and acanthostyles with their heads embedded in a basal spongin layer are placed in the subgenus *Leptolabis*. Those with styles or acanthostyles which are involved in a choanaosomal reticulation are placed in the subgenus *Forcepia*.

In the genus *Asbestopluma* (family Cladorhizidae) some species also contain forceps but these are structurally different than, and considered non-homologous with, the forceps of *Forcepia*. In addition, *Asbestopluma* differs from *Forcepia* in other significant ways. *Asbestopluma* tends to be abyssal, with erect stalked growth forms and basal root adaptations. The upper part is penniform or with side branches; the skeleton with a spicule axis divided into parallel fibers. Megascleres are styles or subtylostyles in the axial and extra-axial skeleton and minutely spined tylostyles to tylostrongyles in the coat of the stalk. Microscleres may be large, asymmetric palmate isochelae, sigmas, and forceps.

The California species of *Forcepia* are quite distinctive and can be readily separated.

KEY TO THE SPECIES OF *FORCEPIA* FROM CALIFORNIA

1a. Monacts are acanthostyles . . . . . *Forcepia* (*Forcepia*) *acanthostylosa* sp. nov.
1b. Monacts are styles, subtylostyles or tylostyles 2

2a. Isochelae of 2 distinct size classes 3
2b. Isochelae of 1 distinct size class 4

3a. Tylotes small to moderate, 222–335 μm. Forceps of 2 distinct size classes, 11–28 μm, 36–55 μm . . . . . *Forcepia* (*Forcepia*) *elvini* sp. nov.
3b. Tylotes large, 309–540 μm. Forceps either of many size classes or of wide range, 9–87 μm . . . . . *Forcepia* (*Forcepia*) *macrotylota* sp. nov.

4a. Styles small, 169–281 μm. Sigmas 1 size class . . . . . *Forcepia* (*Forcepia*) *hartmani* sp. nov.
4b. Styles large 533–697 μm. Sigmas of 2 size classes, the larger being of exceptional size 169–243 μm . . . . . *Forcepia* (*Forcepia*) *hymena* (de Laubenfels, 1930)

Of the species discussed, most need no further explanation as they clearly possess the usual characteristics of *Forcepia* and have no circumstances surrounding them that would complicate their taxonomic placement. However two species, *Forcepia* (*Forcepia*) *hartmani* and *Forcepia* (*Forcepia*) *hymena* do merit further discussion.

As noted earlier, *F.* (*Forcepia*) *hartmani* was originally described as a forceps-bearing variant of *Lissodendoryx firma*. Once forceps-bearing specimens were separated from those without, it was clear that the two could be readily separated in other ways as well. Both genera are in the family Coelosphaeridae and are closely related. In addition, their spicule complements other than forceps are amazingly similar. In a like manner, while their skeletal structures are distinct, they are close enough in detail to be confused if not examined carefully. To complicate these problems, the forceps in *F.* (*Forcepia*) *hartmani* are extremely small and not easily seen unless specifically sought for, or sub-

TABLE 1. Comparison of the spicule complement of *Wilsa hymena* de Laubenfels, 1930 (holotype) with *Forcepia* (*Forcepia*) *hymena* (BIC-SIO 1366). All measurements in micrometers (μm); measurements by de Laubenfels (1930) with asterisk (*). Underlined = mean.

Morphological feature	*Wilsa hymena* (holotype)	*Forcepia* (*Forcepia*) *hymenia* (BIC-SIO 1366)
Smooth styles	(330–600 × 10–15)* 436–<u>619</u>–770	533–<u>601</u>–697 × 13–<u>14</u>–16
Subtylotes (not noted or interpreted as tornotes)	255–<u>300</u>–333	273–<u>327</u>–448 × 5.5–<u>6.9</u>–7.0
Palmate isochelae	17–20*	not seen
Arcuate isochelae in ectosome	19–<u>26</u>–39	24–<u>38</u>–48
Macro-sigmas	approx. 250* 205–<u>220</u>–239	169–<u>208</u>–243
Sigmas	55–75* 55–<u>75</u>–108	60–<u>77</u>–99
Forceps	10–12* faint spination 8–<u>15</u>–21	with shallow spines 11–<u>19</u>–25
Acanthostyles (not mentioned)	47–<u>53</u>–62	not seen
Small styles (the larger with microspined heads)	present	not seen
Dermal membrane	30–70*	48–72

jected to SEM analysis. Given these similarities, the geographic and depth distributions given for this new species are probably incomplete. Accordingly, it will be important that current museum specimens and newly collected material be carefully reviewed and the distribution data amended.

Forcepia (*Forcepia*) *hymena* is a prime example of the problems that can be generated by formally describing a new species on the basis of a tiny fragment, which is admittedly contaminated. The type of *Wilsa hymena* is sufficiently minuscule that further examination cannot take place without its destruction, leaving it virtually useless. Only two slides were available of this material, with but one being of any substantial use. It is always difficult to try to redescribe a species as poorly represented as this one. However, extensive comparisons appear to strongly match those of the original material. Noteworthy is the fact that *Wilsa hymena* as specifically described by de Laubenfels has never been recorded since.

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