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AN UNUSUAL UPPER CRETACEOUS (SANTONIAN) HEXACTINELLID SPONGE FROM THE GREAT VALLEY SEQUENCE, WESTERN SACRAMENTO VALLEY, NORTHERN CALIFORNIA

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ABSTRACT—The new farreid hexactinellid sponge *Hormathospongia dictyota* new genus and new species, is described from the upper Santonian Dobbins Shale Member of the Forbes Formation of the Upper Cretaceous Great Valley Sequence from the west side of the Sacramento Valley, northwest of Sacramento. The relatively simple skeleton is composed of quadrangularly arranged hexactines with overlapping rays, an arrangement strikingly similar to the skeletal structure of early Paleozoic reticulosid hexactinellids. However, the California Cretaceous sponges clearly show those spicules embedded in siliceous beams that are united to form a solid dictyonal skeletal framework of only a single layer of regular mesh. Such an occurrence and stratigraphic relationships suggests that the dictyonine sponges had their origin from the simply spiculed reticulosid hexactinellids rather than from the more complex dictyo-sponges.

INTRODUCTION

SEVERAL EXAMPLES of an unusual hexactinellid sponge have been recovered recently out of the upper Santonian Dobbins Shale Member of the Forbes Formation in the Great Valley Sequence, where exposed on the western margin of the Sacramento Valley, along Sand Creek in Colusa County, northern California (Figure 1). The holotype and associated fossils were collected as float on a sand bar in Sand Creek. Subsequent collections suggest that the sponges probably came from a concretionary unit in the lower part of Dobbins Shale exposures (Figure 2), based on the in-place occurrence of a sponge fragment. Local exposure and stratigraphic relationships tie down the occurrence to within a few feet in the lower part of Dobbins Shale exposures along Sand Creek.

The Dobbins Shale Member of the Forbes Formation, named by Emerson and Roberts (1962), is what Pessagno (1976, p. 12) called "one of the few distinctive rock units in the Upper Cretaceous part of the Great Valley sequence." Haggart and Ward (1984, p. 618) described the Dobbins Shale Member as a "widespread mudstone unit of hemipelagic outer-fan to basin-plain deposits" reflecting a late Santonian transgressive event. The float examples were found near outcrops of the upper few meters of the Dobbins Shale near locality M6572 of Ward and Haggart (1981, fig. 1). The locality where sponge fragments were found in place is near their locality M6570-21.

Haggart and Ward (1984) summarized Late Cretaceous stratigraphy of the northern Sacramento Valley and compared sections exposed on the east versus the west side of the valley, including the rocks where the fossils occur along Sand Creek. The fossil were found approximately 30 m (100 feet) downstream from the Sand Creek Road crossing (Figure 1), approximately 45 m (150 feet) northeast of the ranch buildings. The probable source of the sponges is a concretionary mudstone, based on lithology and the occurrence of fragments of the sponges in that unit. That outcrop is approximately 90 m (300 feet) upstream from the crossing, or about 60 m (200 feet) northwest of the junction of the ranch access road with the Sand Creek Road. That locality is approximately 180 m (600 feet) west and 520 m (1700 feet) south of the northeast corner of section 7, T3W, R13N, on the Rumsey 1:24,000 topographic quadrangle, 1993 version, in Colusa County, California. The locality is at approximately 38°59′32″ North latitude and 122°13′05″ West longitude.

Haggart and Ward (1984, fig. 7) indicated that the Dobbins Shale exposed along Sand Creek is in the *Inoceramus schmidti* biozone, in beds of uppermost Santonian age, and in rocks equivalent to the upper part of the *Baculites capensis* and *Pseudoschloenbachia* sp. aff. P. *boulei* zones, as utilized by Matsumoto (1960).

The striking similarity of spicule makeup of the skeleton, in its simplicity and its resemblance to skeletal structure of early Paleozoic reticulosid hexactinellids, suggests a late Mesozoic Lazarus occurrence of that group, long thought to have become extinct at the end of the Permian. The skeletal structure is strikingly similar to that of *Protospongia* Salter, 1864, a common Cambrian sponge in Europe, North America, and Asia, or to *Phormosella* Hinde, 1887, from the Ordovician of England. The structure is decidedly less complex appearing than even that of *Cyathophycus* Walcott, 1879, and is certainly far from the complexity of that seen in middle and later Paleozoic dictyosponges from the Carboniferous and Devonian of Indiana and New York as described by Hall and Clarke (1899). Such skeletal simplicity emphasizes, again, the relative early development of dictyonine skeletal structure like that seen, for example, in the Upper Devonian sponges of the Holy Cross Mountains in Poland (Rigby et al., 1981; Hurcewicz, 1985), or from northwestern Europe (Fraipont, 1911; Termier et al., 1981). Such structures and stratigraphic relationships suggest that dictyonine sponges originated from simple reticulosids rather than from the much more complex dictyospongids.

SYSTEMATIC PALEONTOLOGY

Class HEXACTINELLIDA Schmidt, 1870
Subclass HEXASTEROPHORA Schulze, 1887
Order HEXACTINOSA Schrammen, 1903
Suborder CLAVULARIA Schulze, 1885
Family FARREIDAE Schulze, 1885

Discussion.—Reid (1964, p. 1, 5) discussed nomenclature within the Farreidae and recognized a clear separation of those sponges from the simple Euretidae Zittel, 1877. Reid included within the Farreidae those hexactinellid sponges with a skeletal net of dictyonal framework that consists basically of only a single layer of meshwork, or in some forms, of a complicated structure of more than one layer. In such hexactinellids, the meshes of the skeletal net are formed in layers, and the skeletons commonly have layers arranged in rectangular patterns.

Reid (1964, p. 4) recognized four genera within the family.

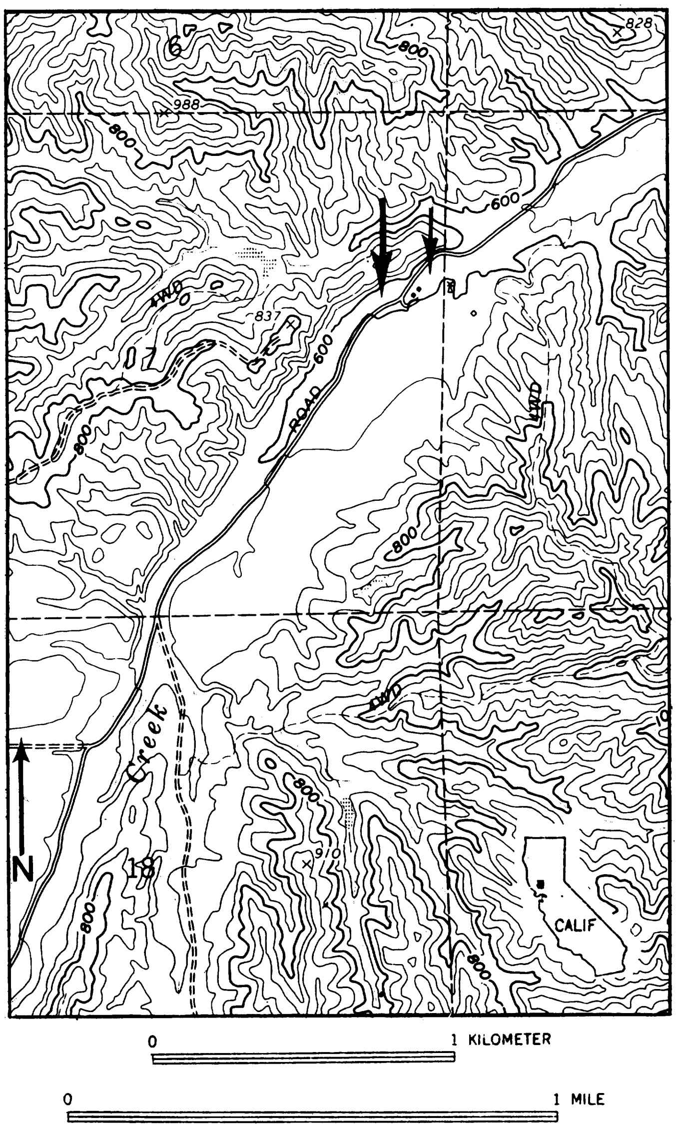


FIGURE 1—Index map to the sponge locality in the Upper Cretaceous (Santonian) Dobbins Shale Member of the Forbes Formation of the Great Valley sequence of California, on the Rumsey 1:24,000 quadrangle, Colusa County California. The small arrow indicates where the sponges were collected as float along Sand Creek, and the large arrow indicates the probable source outcrops of the sponges.

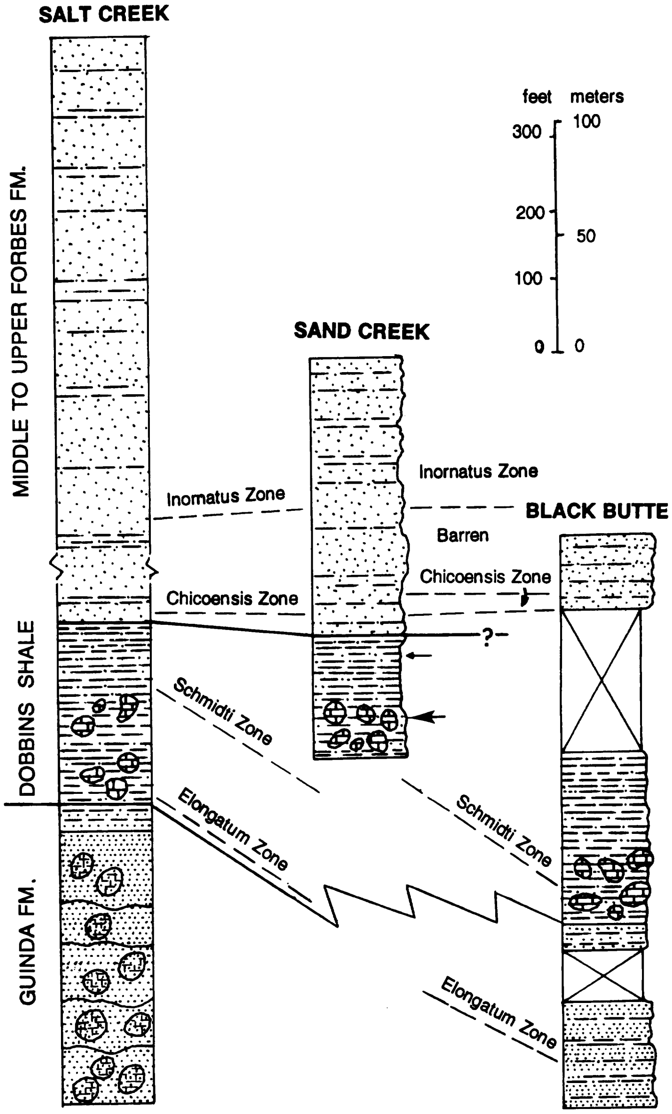
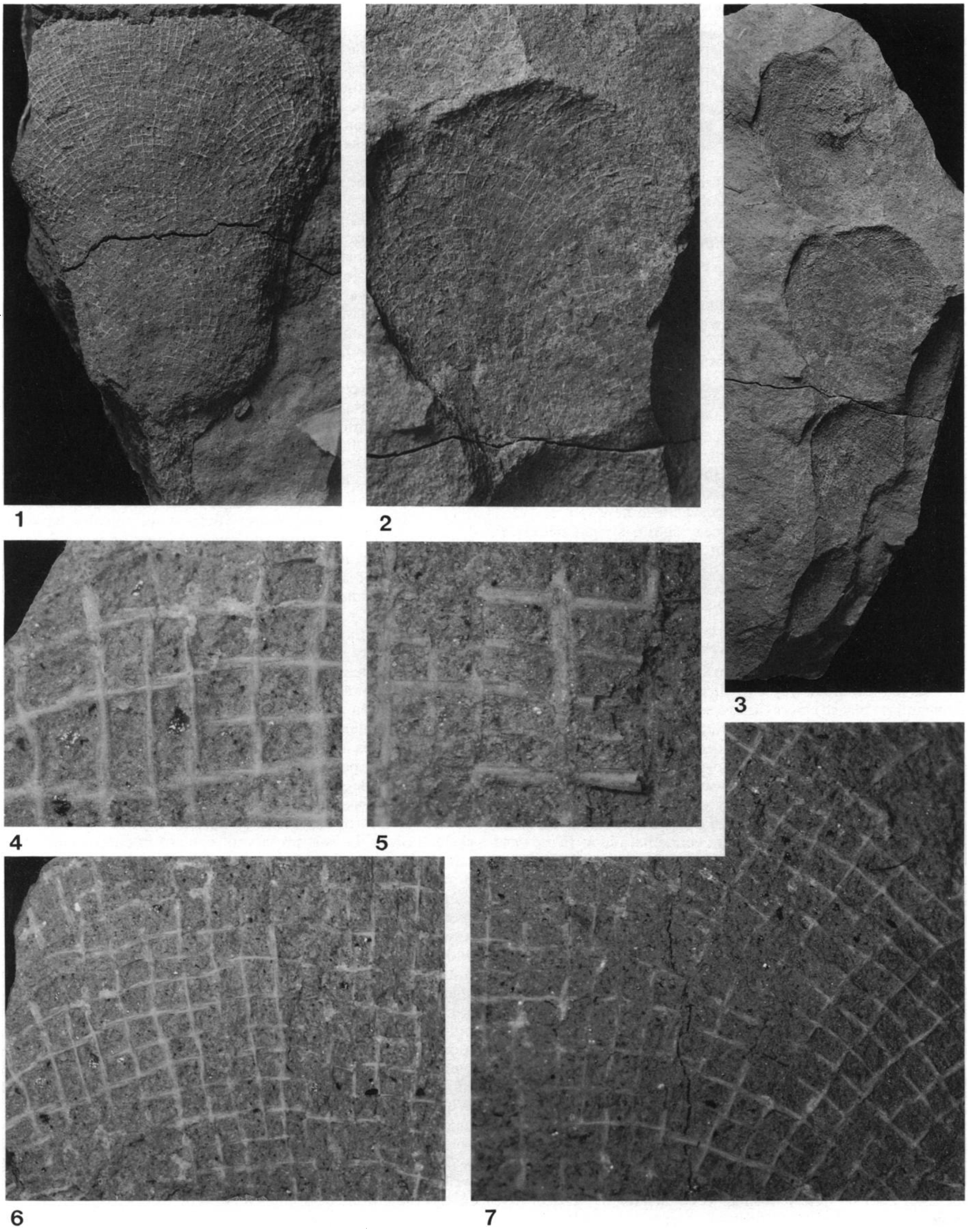


FIGURE 2—Generalized stratigraphic section of the Forbes Formation, exposed along Sand Creek and correlation to sections exposed at Salt Creek and Black Butte, with the approximate stratigraphic level of the probable source of the sponges in calcareous nodules in the Dobbins Shale Member of the Forbes Formation shown by the large arrow. The small arrow indicates the stratigraphic level of rocks exposed by the sand bar where the sponges were found as float. Some of the thick middle Forbes Formation was deleted in the Salt Creek section to better show correlation with the Sand Creek section (modified from Haggart and Ward, 1984).

FIGURE 3—Type specimens of *Hormathosponia dictyota* new species, from the Upper Cretaceous Dobbins Shale Member of the Forbes Formation in the Great Valley Sequence, California. *1, 4–7,* Holotype, USNM 480458. *1,* Entire specimen showing one complete segment and a partial segment, below; skeletal structure is well exposed in the upward-and-outward arching dictyonine net. New vertical beams are inserted to accommodate upward expansion, and horizontal beams are arched strongly downward along the lateral slope, with beams discontinuing in moderately sharp edges of the lenticular specimen. Skeleton is light gray silica, ×2. *4,* Photomicrograph of upper left of Figure *1* showing principal hexactines with vertical and horizontal rays overlapping those of adjacent spicules, in a manner strongly reminiscent of early Paleozoic protosponges, but with overlapping rays encased in silica to form solid reticulate beams, ×20. *5,* Photomicrograph of central part of the holotype showing thick rays of hexactines encased in silica to form the beams; smaller spicules locally arrayed as in second-order quadrules like in Cambrian protosponges, ×20. *6,* Photomicrograph of upper left part of the holotype showing the nature of the skeletal net and lateral disappearance of horizontal rays in the left center, in same general area as shown in Figure *4,* ×10. *7,* Photomicrograph of the upper right part of the holotype showing upward expansion of the skeletal net, with insertions of additional vertical beams shown in the upper right, and disappearance of downward-arched horizontal beams in the lower right. Such skeletal structure shows the sponges were initially lenticular in cross-sections rather than circular and now flattened, ×10. *2, 3,* Paratype, USNM 480459, external mold from which the pendant-shaped segments have been removed in order to show the skeletal structure and the arrangement of the beaded to annulate sponge, flattened somewhat asymmetrically; *2,* enlargement of third segment showing the dictyonine skeletal net, with upward curvature of horizontal beams and upward divergence of the vertical beams. Mold impressions of minute distal rays show as dark pinpoint impressions at junctions of the beams in the central part of the photograph, ×2. *3,* External mold of nearly complete sponge consisting of four pendant-shaped segments, ×1.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He observed that fossil genera must be recognized on the basis of body form, because loose spicules have not been recovered from the fossil materials. *Farrea* Bowerbank, 1862, is a sponge that is, generally, an erect tube with irregular lateral tubular outgrowths, or a complex of dividing and anastomosing tubes. *Chonodictyon* Reid, 1964, is a funnellike sponge and *Phyllobrochis* Reid, 1964, is bladelike with irregular, folded, lateral margins resembling fronds of certain marine algae. He also included *Lonchiphora* Ijima, 1927, which consists of an undulating plate with terminally open stump-like outgrowths.

Type genus.—*Farrea* Bowerbank, 1862.

Genus Hormathospongia new genus

Diagnosis.—Thin-walled, beaded to annulate hexactinellids composed of attached series of pendant-shaped sections or chambers, in upward expanding linear series; individual chambers bell-shaped or teardrop-shaped. Sponge wall a single layer of reticulate mesh of rectangularly arranged stauractines, fused into dictyonal framework by encasment of overlapping ray tips of spicules.

Discussion.—The beaded, annulate appearance of the sponge contrasts sharply to growth forms of other genera included in the family. The upward expanding chain of teardrop to pendant-shaped or flattened bell-shaped chambers or segments contrasts sharply to the irregular or funnellike to bladelike or platelike growths of other sponges in the family.

Type species.—*Hormothospongia dictyota* new species.

Etymology.—*Hormathos,* Greek, chain, string, necklace; *spongia,* sponge; calling attention to the beaded chamberlike form of the sponge.

Hormathospongia dictyota new species
Figure 3.1–3.7

Diagnosis.—Beaded to annulate sponge with sections or segments increasing in dimensions upward in irregular linear series, with skeleton a single layer of dictyonal framework. Roughly rectangularly placed stauractines form upwardly divergent linear series, with vertical strands curving laterally to become essentially normal to lateral margins, at edges of pendantlike sections. Horizontal rays of stauractines form horizontal elements near center, but curve strongly downward, becoming subparallel to lateral margins. Largest primary quadrules in medium-sized segments 0.5–0.7 mm wide and 0.6–0.8 mm high, with some variation, particularly where new elements added in upward expansion or where lost in lateral downward convergence of skeletal strands.

Description.—Holotype moderately well-preserved segment approximately 40 mm high, expanding upward from laterally rounded base approximately 10 mm wide to maximum width of 30 mm 15 mm below segment crest. Cross-section sharply ovoid with maximum flattened thickness approximately 4–5 mm in region of maximum width. Upper margin curved, parallel, semicircular trend of skeletal mesh.

Skeleton single-layered of paratangentially arranged stauractines, forming quadrate openings. Vertical rays and horizontal rays overlapping and locally encased in silica to form beams. Vertical rays in central part of segment wall form straight beams, but general structure upward-and-outward divergent so lateral extensions of central vertical strands meet sides essentially normally, in upward-and-outward divergent structure. Horizontal rays form strongly upward-arched beams, essentially horizontal in medial part of the chambers, but curve sharply downward laterally, approximately normal to extensions of vertical rays and become subparallel to keellike, sharply angular, lateral edges.

Rectangular quadrules in central or medial part of net 0.5–0.7 mm wide and 0.6–0.8 mm high; because of curvature of beams, quadrules still approximately 0.5–0.6 high and 0.6–0.8 mm wide, laterally, 5–6 mm in from edge where horizontal rays discontinue in the skeletal structure, where quadrules only 0.35–0.4 mm wide before alternating rays discontinue. Vertical rays inserted between upward-divergent beams to maintain essentially uniform skeletal dimensions as net expands upward. Those quadrules generally approximately 0.7 mm wide between subparallel vertical beams, which diverge abruptly to approximately 0.10 mm apart at levels of insertion of vertical rays of new spicules. First-order coarse spicules with ray junctions at corners of quadrules, and commonly with low, small "button" or node of aborted distal ray. No proximal ray impressions evident in unilaminar skeleton. Distal ray remnants 0.06–0.08 mm in basal diameter and high, where best preserved.

Vertical rays with basal diameters of 0.05–0.06 mm and commonly 0.6–0.7 mm long, extending en echelon and subparallel to those of superjacent and subjacent spicules essentially to near ray junctions of those spicules. Rays gradually and smoothly narrow to sharp tips and overlap from one half to full length throughout skeleton. Horizontal rays with basal ray diameters of 0.05–0.06 mm and ray lengths of 0.4–0.5 mm overlap somewhat less than full quadrule width. These rays similarly taper smoothly to sharp points, 0.03–0.04 mm in diameter at midlength in zone of overlap.

Apparent small second-order spicules locally occur in interiors of first-order quadrules. These small spicules have ray lengths of only 0.10–0.14 and ray diameters of approximately 0.02 mm. They are also encased in silica cement.

Remnants of siliceous cement that fused overlapping rays of first-order spicules into beams preserved in several places and make solid cylindrical structures to 0.10–0.12 mm in diameter. These beams flare slightly to approximately 0.14 mm in diameter near ray junctions where best preserved.

Newly inserted spicules commonly smaller, with vertical rays 0.04–0.05 mm in basal ray diameter at junctions and up to 0.6 mm long, but horizontal rays only up to 0.4 mm long. Spicules moderately delicate but become normal-sized spicules two or three quadrules above and lateral to level of insertion.

Segments in paratype gently upward expanding bell- or pendant-shaped. Segments apparently added somewhat asymmetrically, offset from axes of preserved sponge, judging from curvature, or lack of curvature, of vertical rays in single layer of skeletal mesh. Lowest preserved segment in paratype approximately 18 mm tall; and succeeding segments approximately 25 mm tall; 30 mm tall; and 35 mm tall. Sponge originally more than 12 cm tall, but incomplete both at base and summit. Segment widths also appear to expand upward, but because sponge now partial molds and casts, only estimates of maximum full width possible; lower chamber maximum width estimated 15 mm, second chamber 25 mm, third chamber 40 mm, and fifth chamber 50 mm, based on curvature of skeletal units.

Upper chamber of essentially same general dimensions as holotype, but with skeletal net preserved as limonite and limonite-stained molds, but showing typical, reticulate, fused dictyonine structure. Quadrule and beam dimensions essentially same as that in middle and upper part of holotype segment. Whether osculum present at crest of each asymmetric segments unknown, because that part not exposed nor preserved in available sponges.

Discussion.—The unusual preservation of the holotype very well documents the basic skeletal makeup of the reticulate beams in the dictyonine structure very well. The sponge shows the hexactine-based stauracts with overlapping rays encased in silica to produce the cylindrical beams, rather than with a tip-to-tip articulation as inferred in some reconstructions. Reid (1958a, fig. 12a, b) showed the manner in which ankylosis occurs in unions of rays between spicules. Stages of development of that structure are clearly shown in the holotype and paratypes.

Material.—Holotype USNM 480458, and paratype, USNM 480459, from the Upper Cretaceous Dobbins Shale Member of the Forbes Formation of the Great Valley sequence, Coast Ranges of California, are deposited in the U.S. National Museum. Paratypes LACMIP 12245 and 12246 are deposited in Invertebrate Paleontology Collection of the Los Angeles County Museum, and reference specimens are in collections of the University of California, Davis, Department of Geology, Davis, California.

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REFERENCES

Bowerbank, J. S. 1862. On the Anatomy and Physiology of the Spongiade, parts 2, 3. Philosophical Transactions of the Royal Society, London, 152:747–836, 1087–1135.

Carter, H. J. 1873. On the Hexactinellidae and Lithistidae generally, and particularly on the Aphrocallistidae, *Aulodictyon,* and *Farrea,* together with facts elicited from their deciduous structures and descriptions respectively of three new species. Annals and Magazine of Natural History, Series 4, 12:349–373, 437–465.

Emerson, D. O., and R. Roberts. 1962. Map 3, Geologic map of Putah Creek. *In* B. D. Brooks, D. Rogers, P. Day, and T. Wooton, Field Trip 1, Sacramento Valley, California Division of Mines and Geology Bulletin, 181:368–380.

Fraipont, C. 1911. Une hexactinellide nouvelle du Dévonien belge (Calcaire frasnien), *Pseudopemmatites fourmarieri* g. et sp. n. Société Géologique de Belgique Annales, 38:197–206.

Haggart, J. W., and P. D. Ward. 1984. Late Cretaceous (Santonian-Campanian) stratigraphy of the northern Sacramento Valley, California. Geological Society of America Bulletin, 95:618–627.

Hall, J., and J. M. Clarke. 1899. A memoir on the Paleozoic reticulate sponges constituting the family Dictyospongiidae. New York State Museum Memoir, 2, 197 p.

Hinde, G. J. 1887. A monograph of the British fossil sponges, Part 1. Palaeontographical Society, London. p. 1–192.

Hurcewicz, H. 1985. Frasnian sponges from Wietrznia and Kowala, Gory Swietokrzyrkie Mts. Kwartalnik Geologczny, 29:271–300.

Ijima, I. 1927. The Hexactinellida of the Siboga Expedition. Siboga Expeditie. M. Weber, (ed.), Uitkomsten op zoologisch, botanisch oceanographisch et geologisch gebeid versameld in Nederlands Oost-Indie, 1899–1900. E. J. Brill, Leiden, 6:1–138.

Matsumoto, T. 1959–1960. Upper Cretaceous ammonites of California. Memoirs of the Faculty of Science, Kyushu University, Series D (Geology); Part 1, 7:91–171; Part 2, Special Volume 1, 172 p.; Part 3, Special Volume 2, 204 p.

Pessagno, E. A. 1976. Radiolarian zonation and stratigraphy of the Upper Cretaceous portion of the Great Valley Sequence, California Coast Ranges. Micropaleontology, Special Publication 2, 95 p.

Reid, R. E. H. 1958–1964. Upper Cretaceous Hexactinellida of Great Britain and Northern Ireland. Palaeontographical Society, London. 1958a, Part 1, p. i–xlvi; 1958b, Part 2, p. xlvii–xlviii, 1–26; 1961, Part 3, p. 27–48; 1964, Part 4, p. xlix–cliv.

Rigby, J. K., G. Racki, and T. Wrzolek. 1981. Occurrences of dictyid hexactinellid sponges in the Upper Devonian of the Holy Cross Mts. Acta Geologica Polonica, 31:163–168 (issued February 1982).

Salter, J. W. 1864. On some new fossils from the Lingula Flags of Wales. Geological Society of London Quarterly Journal, 20:233–241.

Schmidt, O. 1870. Grundzüge einer Spongienfauna des Atlantischen Gebietes. Wilhelm Engelmann, Leipzig, 88 p.

Schrammen, A. 1903. Zur Systematik der Kieselspongien. Mitteilung Roemer-Museum Hildesheim, Number 19, 21 p.

Schulze, F. E. 1885. The Hexactinellida, p. 437–451. *In* T. H. Tizard, H. W. Moseley, M. A. Buchanan, and J. Murray. Narrative of the cruise of H.M.S. Challenger with a general account of the scientific results of the expedition. Reports of the Scientific Results of the H.M.S. Challenger, Narrative, Volume 1, Part 1.

——. 1887. Ueber den Bau und des System der Hexactinelliden. Abhandlungen der Königlich Preussichen Akademie Wissenschaften für 1886, 97 p.

Termier, H. G., Termier, and H. H. Tsien. 1981. Spongiaires des Calcaires recifaux du Frasnien de l'Ardenne. Bulletin Société Belge de Géologie, Bruxelles, 90:287–288.

Topsent, E. 1904. Spongiaires des Açores. Results de la Camp Science Prince Albert I, Monaco, 25, 280 p.

Walcott, C. D. 1879. Fossils of the Utica Slate. Transaction of the Albany Institute, 10:18–19.

Ward, P. D., and J. W. Haggart. 1981. The Upper Cretaceous (Campanian) ammonite and inoceramid bivalve succession at Sand Creek, Colusa County, California, and its implications for establishment of an Upper Cretaceous Great Valley sequence ammonite zonation. Newsletters on Stratigraphy, Gebrüder Borntraeger, Berlin and Stuttgart, 10:140–147.

Zittel, K. A. von. 1877–1878. Studien ueber fossile Spongien; 1 Abteilung, Hexactinellidae; 2 Abteilung, Lithistidae; 3 Abteilung, Monactinellidae, Tetractinellidae und Calcispongiae. Abhandlungen Königlich Bayerischen Akademie der Wissenschaften, Mathematische-Physicalischen Klasse, 13, Abteilung 1, 1877, p. 1–63; Abteilung 2, 1878 p. 65–154; Abteilung 3, 1878, p. 3–48 (93–138).

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