

AN UPPER MIOCENE HEXACTINELLID SPONGE FROM THE PUENTE SHALE, ORANGE COUNTY, CALIFORNIA

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ABSTRACT—Well-preserved, laterally flattened, farreid hexactinellid sponges of the new species *Farrea rugosa* have been recently discovered in the upper Miocene Puente Shale in the Peralta Hills in southeastern Anaheim, Orange County, California. This is the first farreid sponge reported from the Miocene of California and is one of the few Miocene sponges reported from North America. The cluster is of upward bifurcating, moderately complex sponges in which branches are regularly rugose and skeletons are each a single layer of dictyid net, with aborted proximal and distal rays in the otherwise laterally fused quadruded skeleton of original silica. The sponges occur in pinkish brown sandy siltstone in the limited exposure beneath older alluvium that blankets much of the local area.

INTRODUCTION

A NEARLY COMPLETE cluster of laterally flattened farreid hexactinellid sponges has been collected from the Upper Miocene Puente Shale, probably the Yorba Member, in the Peralta Hills area of eastern Anaheim, Orange County, California (Figure 1). These are the first farreid sponges recognized from the deep-water Miocene rocks of California.

The Puente Formation was named by Eldridge and Arnold (1907) for a sequence exposed in the Puente Hills, and at that time it included all Miocene siltstone and sandstone in the area. Daviess and Woodford (1949) divided the Puente Formation into four informal members, and somewhat later, Schoellhamer et al. (1954) subdivided the formation into four formal members. That member nomenclature was later utilized by Schoellhamer et al. (1981) in their geologic map of the Santa Ana Mountains, which includes the locality where the sponges described here were collected.

The geologic map (Schoellhamer et al., 1981, plate 1) shows the area of the locality as older Quaternary alluvium, apparently resting on the lower member of the Pliocene Fernando Formation, but the index fossils *Delectopecten peckhami* (Gabb, 1869) associated with the limited outcrop clearly indicate the sponge-bearing beds are of deep-water origin and of uppermost Miocene age. The fine-grained grey siltstone where the sponges were discovered also contains fish and fish scales, including a pipefish of the Syngathidae, *Sygnathus avus* Jordan and Gilbert, 1919; *Scopelogadus mizolepis* (Günther, 1878); *Eclipses* cf. *E. veterinus* Jordan and Gilbert, 1919; and *Physiculua* sp., and other micro-marine organisms. Mohnian-age (late Miocene) forami-

nifera include several species of *Bolivina* d'Orbigny, 1839, and single species of *Eponides* de Montfort, 1808, *Pseudoparella* Cushman and Ten Dam, 1948, and *Suggrunda* Hoffmeister and Berry, 1937, according to Richmond (1952). These beds were exposed in a shallow ditch at the time the collections were made, and this discovery suggests that the geology in the immediate vicinity of the Peralta Hills is somewhat more complex than that documented by Schoellhamer et al. (1981).

Schoellhamer et al. (1981, fig. 20) showed the Sycamore Canyon Member, the uppermost of four units in the Puente Formation, pinches out southwestward before reaching section 8, T. 4 S., R. 9 W., and the vicinity of the sponge locality. This suggests that the sponges came from the underlying Yorba Member (Figure 2). This conclusion is reinforced by the silty sandstone matrix in which sponges are preserved and the uppermost Miocene age of the fossils associated with the sponges.

Schoellhamer et al. (1981, p. D49) observed that the lower part of the Yorba Member is gray to pinkish-brown, indistinctly bedded to well-laminated siltstone, with sandstone interbeds in the Burrue Ridge area, and that the upper part of the member consists of pinkish-brown sandy siltstone that may appear structureless and weathers to irregular angular fragments. They observed that white to yellowish-brown limy concretions are common in the upper part of the sequence, perhaps concretions like that in which the sponges described here occur. Schoellhamer et al. (1981) apparently reached no conclusion about the depth of accumulation of the Yorba Member. The overlying Sycamore Canyon Member they reported (1981, p. D52) was probably deposited in "moderately deep water" and the infer-

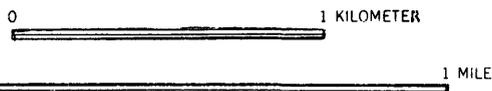
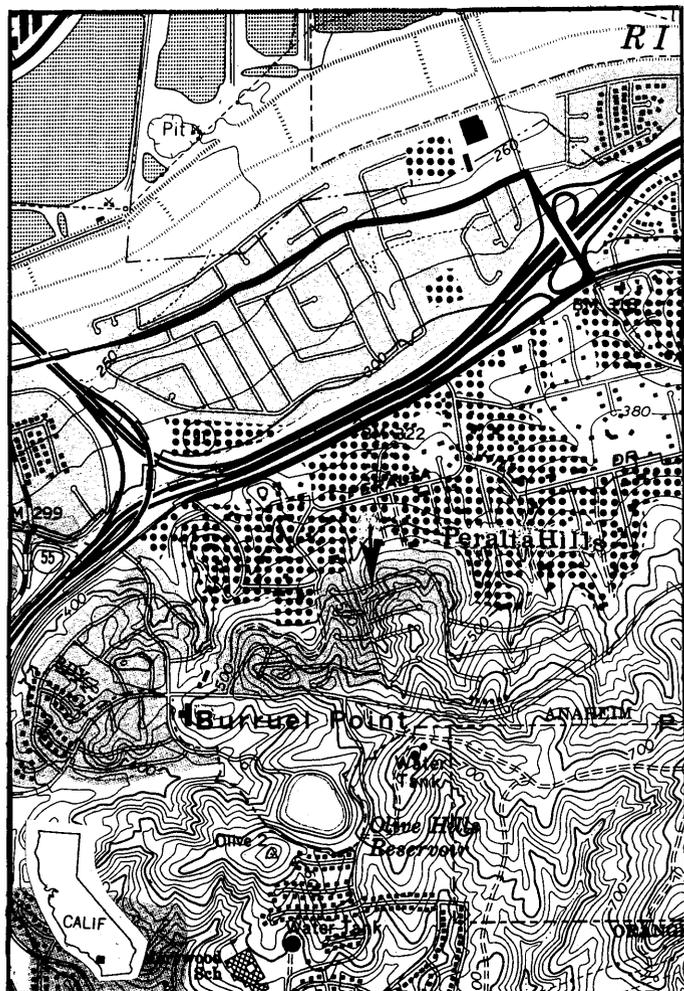


FIGURE 1—Index map of the sponge locality in the Peralta Hills region, in the northern part of the community of Anaheim, Orange County, California. Base map U.S. Geological Survey Orange 7 1/2-minute quadrangle, California, 1994 edition, scale 1:24,000. The locality, LACMIP 15677, is indicated by the tip of the arrow in the central part of the figure.

ence, thus, is that the Yorba Member was deposited in similar “moderately deep” slope to upper bathyal marine environments, based on stratigraphic and paleontologic data.

SYSTEMATIC PALEONTOLOGY

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

Description.—Dictyonal framework of lateral wall single paratangential layer of meshwork, through which dictyonal strands run longitudinally to end at skeletal margin; further meshwork, if present, constructed in one or more layers or in irregular manner and may be secondarily superimposed, either throughout body or from basal region to some distance short of margin.

SYSTEM AND SERIES		FOR-MATION	MEM-BERS	MAX. THICK.	DOMINANT ROCK TYPES	
TERTIARY	PLIOCENE	FERNANDO FORMATION	Upper Member	800	[Pattern]	
			Lower Member	670		
	MIOCENE	PUENTE FORMATION	Sycamore Canyon Mbr.	760	[Pattern]	
			Yorba Member	610		
			Soquel Member	885		
			La Vida Member	610		
		MIDDLE	TOPANGA FORMATION		690	[Pattern]
	Eocene(?) TO MIOCENE	Sespe and Vaqueros Fms. undiff.		915	[Pattern]	
	EOCENE	SANTIAGO FORMATION		820	[Pattern]	
	PALEO-CENE	SILVERADO Fm.		455	[Pattern]	
CRET.					[Pattern]	

FIGURE 2—Generalized stratigraphic section of Tertiary rocks in the Peralta Hills region of Orange County, California. Stratigraphic occurrence of the sponge in the Yorba Member of the Puente Shale of upper Miocene age is indicated by the arrow (modified from Schoellhamer et al., 1981).

Meshes in layers, whether primary or secondary, commonly quadratic; where layers of meshwork superimposed, three-dimensional meshes typically cubic. Primary framework shows no special circulatory features, but simple ostia or pitlike epirhyses locally developed in meshwork of secondary origin.

In living members of family, sceptrules include clavules sometimes accompanied by sarules or lonchioles. Dermalia and gasteralia are pentactins, and uncinates typically are present (modified from Reid, 1958b, p. 1, 2).

Type genus.—*Farrea* Bowerbank, 1862.

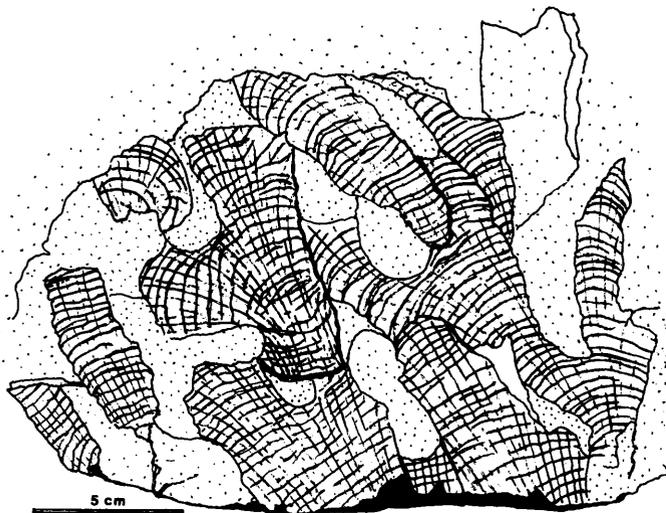


FIGURE 3—Line drawing of the flattened holotype of *Farrea rugosa* new species, LACMIP 12244, shows patterns and distributions of bifurcations and branches of the structure, as well as some of the wrinkles. Preserved edges of individual branches and bifurcations that appear to be part of a single larger branch are shown in somewhat heavier lines. Matrix between branches is lightly stippled. Bar scale at the base shows dimensions of the exposed sponge.

Genus FARREA Bowerbank, 1862

Diagnosis.—Body varies from plexis of branching and anastomosing tubes with oscula at ends of free final branches to erect tube with lateral branches or lateral oscula. Dictyonal framework single layer of meshes or three-dimensional in lower part or throughout. Secondary (extradictyonal) ostia may occur in three-dimensional frameworks. Basal expansion forms encrusting mass (modified from Reid, 1958b, p. 5).

Type species.—*Farrea occa* Bowerbank, 1862.

FARREA RUGOSA new species Figures 3, 4

Diagnosis.—Cluster of upward-bifurcating, tubular, branched sponges with regularly and transversely wrinkled unilayered dictyonal skeleton. Quadrules higher than wide, with most approximately 0.3 mm wide and 0.8 mm high, defined by beams 0.08–0.10 mm in diameter. Wrinkles 2–5 apart on branches 20–25 mm in diameter between bifurcations which occur at approximately 50 mm intervals.

Description.—Holotype is cluster of upward-bifurcating and anastomosing branches in moderately complex sponge; where best preserved, branches bifurcate at approximately 50 mm intervals. Interbranches subparallel to divergent as much as approximately 60°. Bases of divergent stems 20–25 mm wide diverging from sponge stems 50–60 mm across. Crotch between branches typically rounded and 15–20 mm in diameter near the base, and becomes wider upward.

Preserved sponge approximately 8 branches wide, but incom-

plete, and most complete branches divide two to three times; specimen approximately 20 cm across and 13 cm high, but incomplete on all edges.

Compressed holotype a series of overlapping branches with up to 2 cycles of branching. Neither base nor summit preserved or exposed in the flattened fragment. Individual branches lenticular and up to 4 mm thick in centers of lenses that have sharp, pointed, keel-like edges. Both upper and lower surfaces preserved on some sponges, but some with upper convex surface and others with only concave lower surface preserved, so both exterior and interior characteristics of the unilaminar skeletal net exposed.

Surfaces of all branches regularly rugose, with wrinkles 2–5 mm apart, crest to crest, as rounded, undulating wavelike irregularities that generally arcuate upward. Degree of curvature increases from base of diverging branch up to near next bifurcation of branches. There individual wrinkles develop a median sulcus a few mm below where divergence occurs and each divergent branch develops its own upward-arcuate wrinkled surface. Wrinkles evident both on convex upward-arched surface and on concave inner surface of inside of skeletal net. Such wrinkles characteristic of species and relative regularity of wrinkle spacing prominent throughout complex intergrowth.

Skeletal net dictyonal and only single layer thick, in which aborted proximal and distal rays preserved only as short rounded nodes or remnants that project upward from intersections of beams or downward from those intersections. Such nodes visible both in molds of exterior and on exterior surface where siliceous spicules preserved, or similarly on concave gastral surface of net. Nodes 0.04–0.06 mm in diameter, but generally only 0.02–0.04 mm high, both in proximal and distal rays.

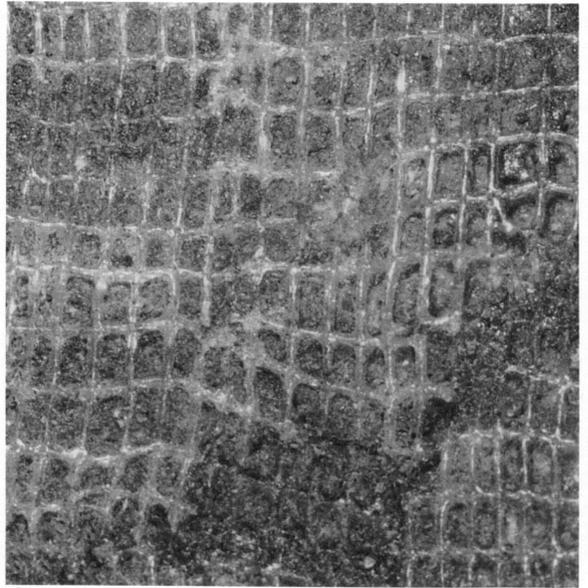
Regular dictyid net with prominent skeletal quadrules generally higher than wide and 0.6–0.8 mm high in most of skeleton, even across closely spaced wrinkles in net. Quadrules 0.2–0.4 mm wide, with most approximately 0.3 mm wide and 0.8 mm high. Quadrules defined by beams or strands generally 0.08–0.10 mm in diameter at their thinnest in midlength between junctions in both vertical and horizontal strands of net. In several areas, overlapping tangential rays of primary cores of spicules show in both vertical and horizontal beams. These cores generally 0.06 mm in combined diameter in zone of overlap so that encasing silica, which cements spicules into dictyid structure, generally 0.01–0.02 mm thick in center of beams, but thickens markedly toward ray junctions. Junctions approximately 0.20 mm across, diagonally, as somewhat swollen structures out of which nodes of proximal and distal rays extend short distances. Beams circular in cross section, except near ray junctions or spicule centers where oval in cross section, because thickened more vertically and horizontally than radially in proximal or distal directions. Junctions become somewhat quadrate in general pattern, although lacking lychniskid development.

Discussion.—The sponge occurs with numerous small, thin-shelled bivalves, *Delectopecten peckhami* (Gabb, 1869), and fish scales in a micaceous, silty, fine-grained sandstone in which most of the mica grains are parallel to the axes of flattening of the sponges. Such grains and flakes help define internal stratification in the argillaceous silty sandstone. No graded bedding

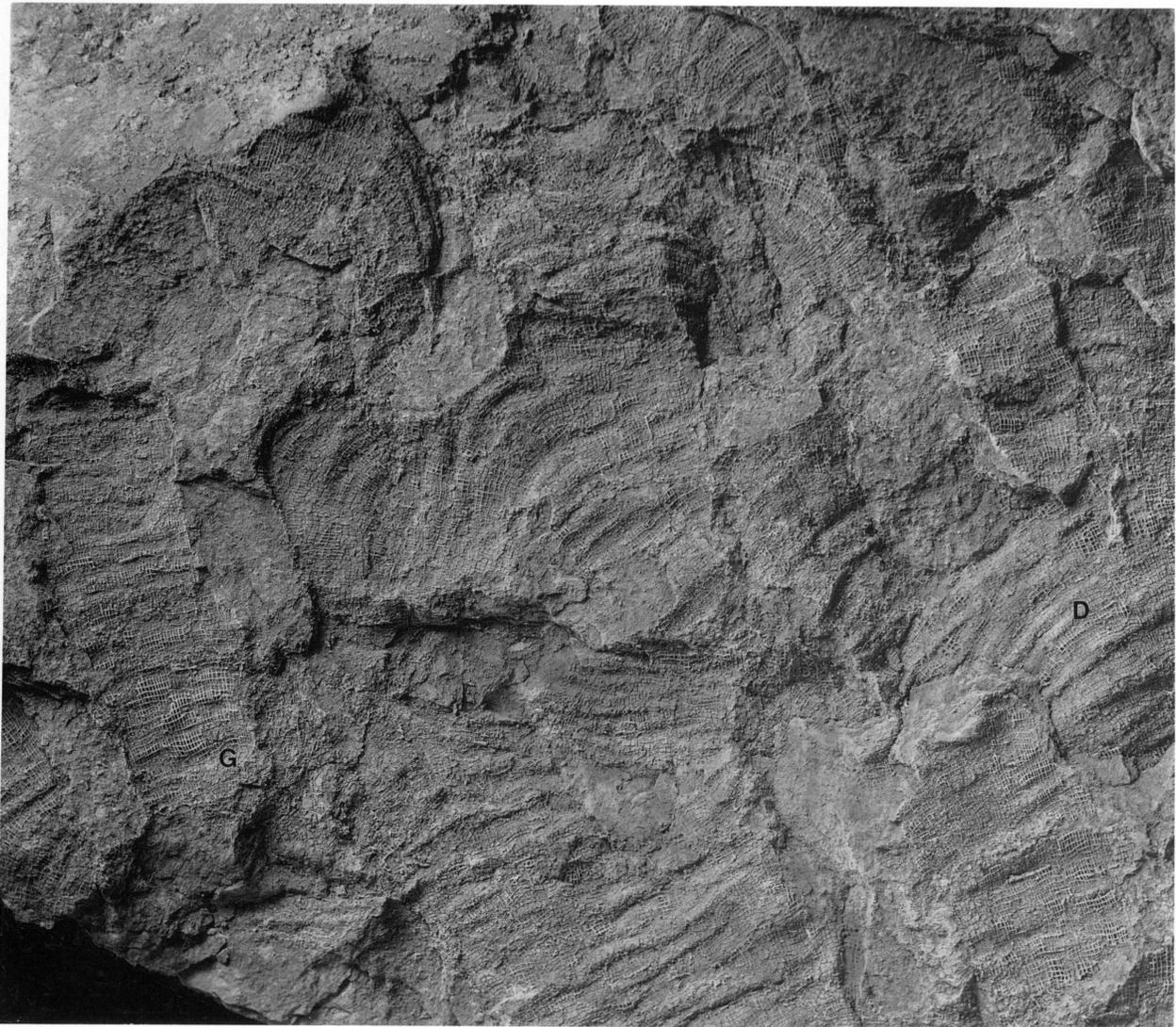
FIGURE 4—Holotype of *Farrea rugosa* new species, from the upper Miocene Yorba Member of the Puente Shale, Peralta Hills, Orange County California, LACMIP 12244. 1, Sponge cluster with the broken surface coated by a thin film of ammonium chloride to exaggerate the relief, $\times 0.5$. 2, Photomicrograph of part of the gastral surface of the holotype showing nature of the skeleton, expression of the wrinkles, and general dimensions of the vertically elongate quadrules characteristic of the species, $\times 10$. 3, Most of the holotype showing branching structure and wrinkled sculpture of the unilaminar dictyid skeleton. A partial gastral surface (G) is exposed in the lower left and a dermal surface (D) in the right center, $\times 1$.



1



2



3

is apparent on a megascale, but rocks appear to have been deposited in slope to upper bathyal environments.

Whether the original sponges were circular or lenticular in cross section is impossible to confirm because of the flattened condition of all branches. Sharp edges, however, suggest collapse of more or less circular tubelike branches, and certainly not modification of the skeletal net to produce a strong, sharp, keeled edge, as in other farreid sponges where lenticular branches seem well established.

Reid (1958b, p. 4) observed that fossil genera and species of sponges in the Farreidae must be differentiated on body form alone, because distinctions among living forms, which are based on microscleres, are not practicable in paleontology, considering that the small spicules are so poorly known. Reid, (1958b, p. 4) recognized four genera within the family. The moderately complex *Farrea* Bowerbank, 1862, consists of erect tubes with lateral branching outgrowths, or a cluster of bifurcating and anastomosing tubes, or of some intermediate growth forms. *Chonodictyon* Reid, 1958b, is funnel-like with *Farrea infundibuliformis* Carter, 1873, as the type species. Bladelike sponges with folded lateral margins he included in *Phyllobrochis* Reid, 1958b, with the type species *Farrea laminaris* Topsent, 1904. The fourth genus, *Lonchiphora* Ijima, 1927, consists of undulating plates with terminal stumplike outgrowths.

Reid (1958b, p. 5–10) recognized three species of *Farrea* and one of *Chonodictyon* in the Upper Cretaceous hexactinellids from the British Isles. *Farrea oakleyi* Reid, 1958b, consists of divided and anastomosing tubes 4–8 mm wide, separated by interspaces of similar widths, in a skeletal structure different and certainly much finer textured than the Miocene sponge described here, although the skeletal mesh is of approximately the same general dimensions.

Farrea cf. *oakleyi* Reid, 1958b, is a fragment in which the rounded, interconnected, tubes are 8–16 mm wide, again much smaller than the broad, upward bifurcating branches shown here in the Miocene sponge. *Farrea tatei* Reid, 1958b, is also a species with simple anastomosing or branching tubes that are small, 4–6 mm wide in general, but with flattened tubes up to 11 mm across. These are also considerably smaller than the relatively coarse, wrinkled, branching form from the California Miocene.

Chonodictyon(?) sewerbyensis Reid, 1958b, was interpreted to have been funnel-like with flat or slightly convex sides, but the extreme base is missing in the type specimen. The relatively simple sponge included in the species has a growth form distinctly different from that of our sponge. If one interpreted the three fragments shown in the holotype of *C.(?) sewerbyensis* as parts of divergent, but broken branches, its growth form might appear similar to our sponge. The Miocene sponge is considerably more complex, however, and has a distinctly and regularly wrinkled surface, in contrast to the smooth skeleton shown in *C.(?) sewerbyensis*.

Reid (1958b, p. 6) noted that *Farrea oakleyi* Reid, 1958b, was the first Cretaceous species of the genus described in which the skeleton was a single layered structure. Other species, such as *Farrea clarkei* Schrammen, 1912; *Farrea halli* Schrammen, 1912; *Farrea densa* Moret, 1926, all have three-dimensional skeletal meshworks and, consequently, differ not only from the species described by Reid, but the sponge described here as well. Meshworks in species described by Schrammen and Moret are all considerably finer textured than the moderately coarse sponge described here.

Locality.—Los Angeles County Museum of Natural History locality 15677, from the upper Miocene Puente Shale, in the Peralta Hills, in a shallow ditch in a small gully which penetrated through the Pliocene Fernando Formation into the underlying Puente Formation. The locality is 0.5 km (0.3 miles) north-

northeast of Olive Hill Reservoir, as shown in Figure 1, part of the Orange, California 7 1/2-minute quadrangle, 1994 edition, scale 1:24,000. The sponges came from approximately 250 m west and 640 m south of the northeast corner of section 8, T. 4 S., R. 9 W., and 117°49'13" West longitude and 30°50'24" North latitude. The holotype, LACMIP 12244, is deposited in Invertebrate Paleontology collections at the Museum.

Etymology.—*Rugosus*, Latin, wrinkled, in reference to the transversely wrinkled regular surface expression of the skeletal net.

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