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# Conical fossils from the Lower Cambrian of Eastern California

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Two new cone-shaped fossils from Lower Cambrian strata of eastern California are described and compared to hyolithids from the region. *Lathamoserpens sigel* n. gen., n. sp. occurs in both the Latham Shale in the Mojave Desert and the Poleta Formation of the White-Inyo region. *Lathamoserpens* is a large tubular fossil characterized by a central keel and a sigmoid shape. Although it resembles hyolithids, its taxonomic affinity is uncertain. The thin-walled conical fossil *Cambrorhytium fragilis*, first described from the Burgess Shale, also occurs in the Latham Shale; *C. fragilis* has been proposed to be a cnidarian polyp tube but lacks diagnostic features that allow this hypothesis to be tested. Both of these fossils are distinct from known hyoliths from the Latham Shale, which are tentatively assigned to *Nevadotheca whitei*.

## INTRODUCTION

The Latham Shale and the Poleta Formation are Lower Cambrian units exposed in the Basin and Range province of eastern California (Fig. 1). Both units have been intensively collected by paleontologists for their abundant, well-preserved fossils. The Latham Shale, exposed in the southern Mojave Desert, has yielded eocrinoids (Durham 1978), anomalocaridid appendages (Briggs and Mount 1982), unmineralized algae (Waggoner and Hagadorn, 2004) and an undescribed "segmented worm" (Mount 1980, Conway Morris 1998), as well as olenellid trilobites, inarticulate brachiopods, and early examples of articulate brachiopods and ptychopariid trilobites (reviewed in Mount 1974, 1980). In addition to olenellid trilobites, archaeocyathids, brachiopods, and trace fossils (reviewed in Nelson 1976, Onken and Signor 1988, Hagadorn et al. 2000b), the Poleta Formation of the White-Inyo region has yielded helicoplacoid echinoderms (Durham 1993), small shelly fossils (Onken and Signor 1988) and Ediacara-type soft-bodied fossils (Hagadorn et al. 2000a).

Together with correlative units in the Death Valley region (Hagadorn and Waggoner 2002), a number of undescribed, problematic conical fossils from these units have been reposited in museum collections. The purpose of this paper is to describe these fossils. We describe a sinuous tubular fossil *Lathamoserpens sigel* n. gen., n. sp., along with a new occurrence of the conical fossil *Cambrorhytium fragilis* (Walcott, 1911). *Lathamoserpens* is tentatively identified as an aberrant hyolithid, whereas *Cambrorhytium* is of uncertain affinities but may be a cnidarian polyp tube. Both are quite distinct from other known hyolithids from the Latham Shale, which we figure and tentatively identify as *Nevadotheca whitei* (Resser, 1938).

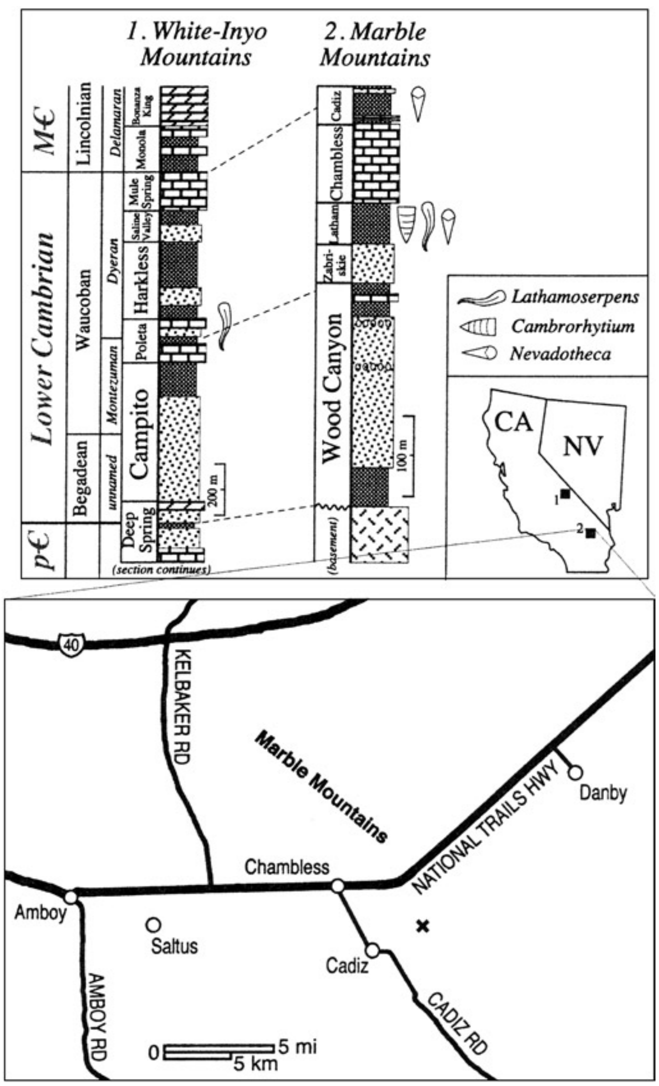



**Fig. 1.** Locality map and stratigraphic column. Stratigraphy follows Palmer and Halley (1979); series and stage names are those proposed by Palmer (1998). X indicates well-known collecting locality at the southern end of the Marble Mountains, the most probable locality for most of the fossils described in this paper.

## GEOLOGY AND STRATIGRAPHY

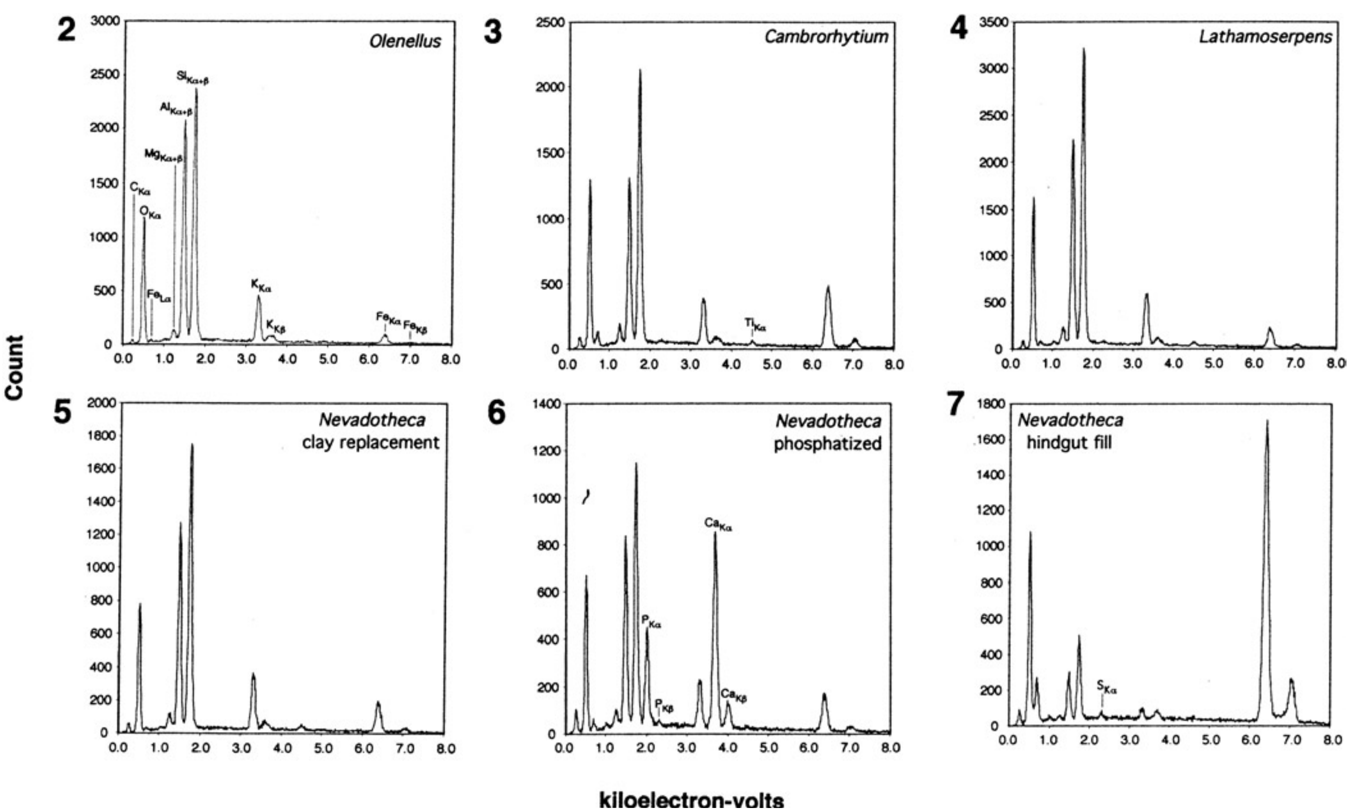
The fossils come from the Latham Shale and Poleta Formations in eastern California (Fig. 1). The Latham Shale is best known from exposures in the southern Marble Mountains and Providence Mountains, where fossils have been collected for nearly a century (e.g., Darton 1907, Clark

1921, Mount 1980). In the Marble Mountains, the Latham is approximately 25 m thick and is predominantly composed of greenish-gray, brown, and pink fine-grained siltstone and shale, with minor interstratified quartzite, silty sandstone and limestone (Hazzard 1954, Stewart 1970). Trilobites in the Latham Shale are from the *Bristolia* subzone of the *Bonnia-Olenellus* Zone, indicating that the Latham Shale belongs to the upper Dyeran Stage (Waucoban Series) of Laurentia, equivalent to the Toyonian Stage of Siberia (Palmer 1998). It correlates with the lower three members of the Carrara Formation of the Death Valley region, and with the upper Saline Valley Formation and Mule Spring Limestone of the White-Inyo region (Stewart 1970; Nelson 1976, Palmer and Halley 1979).

Latham Shale specimens have been examined from the collections of the Los Angeles County Museum of Natural History (LACMNH) and the University of California at Riverside (UCR). Unfortunately, historic museum collections of Latham Shale material often lack precise locality and stratigraphic information. The fossils described here have localities recorded only as "Marble Mountains" or "southern end of the Marble Mountains." These probably indicate the best-known trilobite collecting areas in the Marble Mountains, which are near a limestone quarry at the southern tip of the mountain range, approximately 2.5 miles (4 km) north and east of the settlement of Cadiz, south of the National Trails Highway (formerly U.S. Route 66). All available locality information is given in the Appendix.

The Poleta Formation is best exposed in the White-Inyo Mountains of eastern California. In this region, the Poleta is overlain by the Harkless and the Saline Valley Formations; the latter is temporally equivalent to the Latham Shale. The White-Inyo fossils described here are from the upper member of the Poleta Formation, which contains trilobites typical of the lowest portion of the *Bonnia-Olenellus* Zone (Nelson 1976). Thus the upper Poleta Formation may be placed in the lower Dyeran Stage, equivalent to the late Atdabanian-early Botomian Stages of Siberia (Palmer 1998). Fossils from the Poleta Formation are in the collections of the University of California Museum of Paleontology (UCMP); detailed locality information is in the Appendix.

The composition of selected fossil specimens was analyzed using energy dispersal spectroscopy (EDS; Figs. 2–7). Mineralized fossils from the Latham Shale are usually replaced by reddish, iron-enriched clays. A few mineralized fossils have patches that are rich in calcium and phosphorus, which prob-




**Figs. 2–7.** Representative EDS spectra for Latham Shale fossils. Spectra were recorded for 60 seconds from a 1-mm square region of each specimen, at a beam voltage of 20 keV. **2.** Olenellid trilobite fragment. **3.** *Cambrorhytium fragilis*: LACMNH 12866. **4.** *Lathamoserpens sigel*: LACMNH 12864, part; larger individual. **5.** *Nevadotheca* Cf. *N. whitei*: UCR 7271/5, reddish-colored portion of the specimen. **6.** *Nevadotheca* Cf. *N. whitei*: UCR 7271/5, black portion of specimen; note calcium and phosphorous peaks; **7.** *Nevadotheca* Cf. *N. whitei*: LACMNH specimen 12865, presumed hindgut fill; note prominent iron and sulfur peaks.

ably results from secondary phosphatization (Fig. 6). One specimen of a hyolith (Fig. 24) shows an elongated median structure with an irregularly pustulose surface, which is highly enriched in iron and less so in sulfur (Fig. 7). We interpret this as the result of iron sulfide precipitation, which is not typical for the Latham Shale as a whole. Pyrite and other sulfides precipitate under anaerobic conditions (e.g., Canfield and Raiswell, 1991), and we infer that the mineralization occurred in an anaerobic microenvironment within the conch, probably the hindgut (see below for further discussion). The Poleta Formation fossils appear to be similarly preserved, but they are on slabs which are too large for the EDS specimen chamber; their mineralogy was not determined.

## SYSTEMATIC PALEONTOLOGY

Linnaean ranks are not assigned to clades, except for genus and species ranks as required by the International Code of Zoological Nomenclature (ICZN 1999); see de Queiroz and Gauthier (1994) for discussion of unranked taxonomy.

?HYOLITHA Marek, 1963
?HYOLITHIDA Matthew fide Fisher, 1962
Genus: *LATHAMOSERPENS* new genus

**Derivation of name**—From the Latham Shale, + *serpens*, Latin for "serpent," referring to the snakelike shape of this fossil.

**Type species**—*Lathamoserpens sigel* n. sp.

**Diagnosis**—Large conical fossils with two or (rarely) three lateral curves in alternating directions within the same plane, giving a sigmoidal shape.

*LATHAMOSERPENS SIGEL* new species
Figs. 8–17
"similar to *Emmonsaspis cambrensis*" Firby, 1972, p. 504.
"might be inorganic" Conway Morris, 1993, p. 604.

**Derivation of name**—*sigel*, Old English name (meaning "sun") for the sixteenth rune of the Anglo-Saxon *futhorc*, or runic alphabet. The shape of the sigel-rune is very similar to that of this fossil.

**Holotype**—LACMNH 12862. LACMNH locality 200: Latham Shale, southern end of the Marble Mountains.

**Paratypes**—Two additional specimens from LACMNH locality 200, Latham Shale, Marble Mountains: LACMNH 12863 and12864. Specimen 12864 includes part and counterpart slabs: part slab of 12864 has two fossils preserved on upper surface; counterpart of 12864 has at least ten fossils preserved on multiple layers within the slab, which was sectioned for petrographic and EDS analysis. Two specimens from the Poleta Formation, White-Inyo Mountains: UCMP specimens 37451 (locality D-3961) and 39950 (locality D-3960).

**Measurements**—Specimen LACMNH 12862 (holotype): One specimen, part only. Length 125 mm; estimated uncurved length 130 mm; width at aperture 11.5 mm; apical angle 6°; two curves.

**Specimen LACMNH 12863:** One specimen, part only, almost all shell material exfoliated, narrow end missing. Length 83 mm; estimated uncurved length 85 mm; width at widest point 4 mm; apical angle est. 13°; three curves.

**Specimen LACMNH 12864:** Two specimens represented on surface of part slab; additional specimens occur in underlying layers, and in counterpart slab. Large: width at aperture 11.2 mm; apical angle 13°; two curves preserved;. Small: width at aperture 5.1 mm; apical angle est. 10°; two curves.

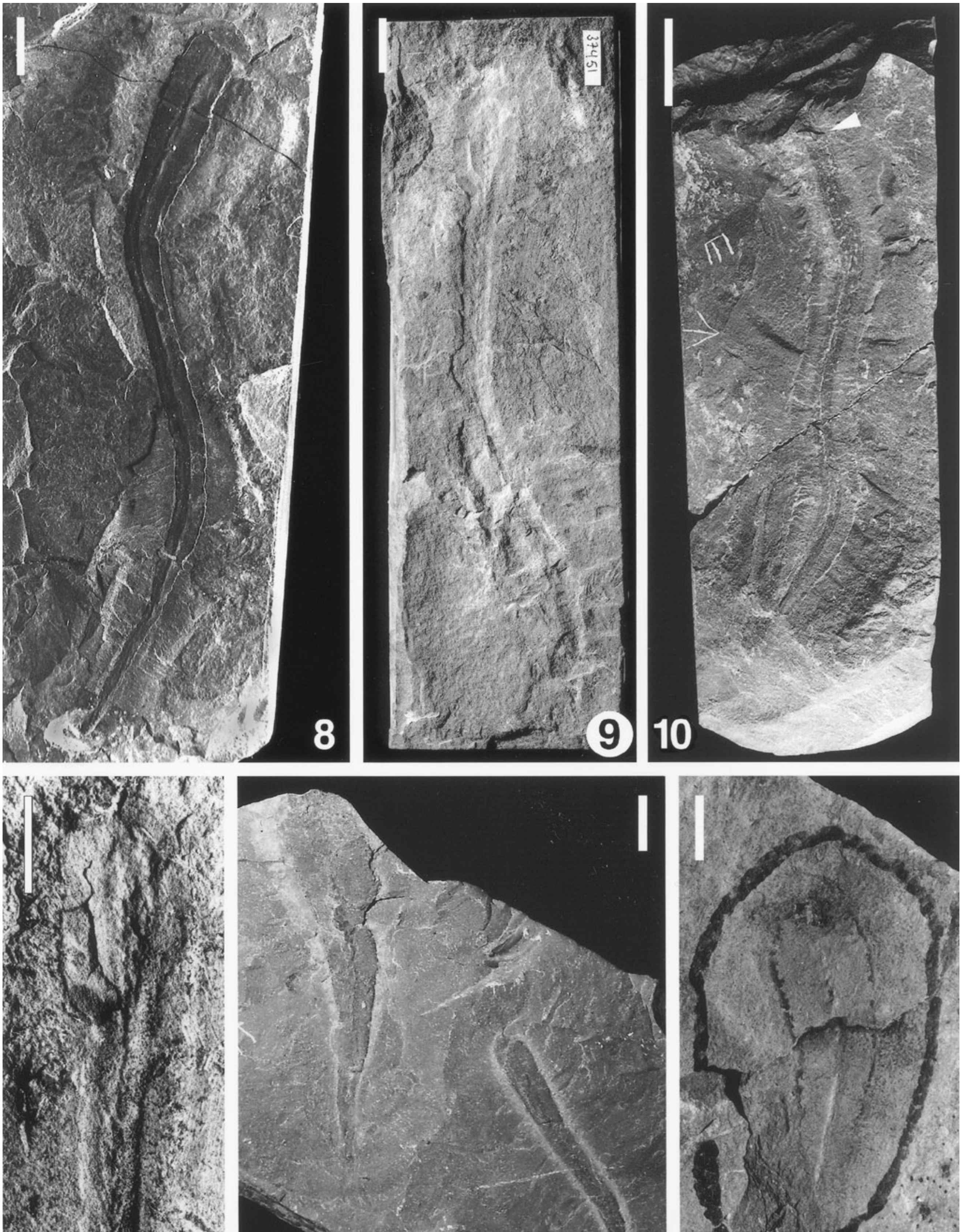
**Specimen UCMP 37451:** One specimen; apical angle est. 15°.

**Specimen UCMP 39950:** Partial specimen showing rounded end, keel, and one curve; almost all shell material exfoliated, but flakes of shell material present in a darker rim around the margins.

**Diagnosis**—Sinuous conical fossils, tubular in cross-section, with two or (rarely) three alternating curves subtending angles of 30–40°. Narrow terminus closed, rounded, nearly globular, curving slightly laterally. Keel runs nearly the full length of the specimen. Broad terminus semicircular; aperture indistinct.

**Description**—The specimens from the White-Inyo region were never figured or formally described (J. Durham, pers. comm. 1997), but were mentioned in an abstract (Firby 1972) as possible chordates, with a rounded "anterior" end, a narrow "posterior" end, a central "rod" identified as a notochord, and "chevron-shaped impressions." The specimens do superficially resemble the soft-bodied Cambrian chordate *Cathaymyrus*, which has a rounded anterior end and a sinuous shape tapering to a pointed posterior (Shu et al., 1996). Simon Conway Morris examined UCMP specimen 37451 and suggested that it was not a cephalochordate, and might not be organic (Conway Morris 1993). We have figured both specimens here for the first time (Figs. 12, 14, 16), and believe both to be conspecific with the fossils from the Latham Shale. The Latham Shale fossils retain relatively thick shells, although the mineralogy has been replaced by clay. UCMP 37451 is an impression in the matrix with no shelly material, but according to a note kept with UCMP 37451, an attempt to cast it damaged the "central rod" (see also Conway Morris 1993). This attempt at casting may also have exfoliated any shell material that was once present. We interpret the chevron-shaped rugose impressions on UCMP 37451 as external sculpturing on the conch; similar sculpture is known from Cambrian hyoliths (Malinky 1988). Such chevron-shaped sculpture is not visible on the Latham Shale fossils, and might indicate that UCMP 37451 should be placed in a different species, but it is also possible that the sculpture varied among individuals or was taphonomically altered. Until more specimens are found that can clarify the importance of this feature, we place the White-Inyo specimens in *Lathamoserpens sigel.*

The sinuous shape of *Lathamoserpens* is distinctive. It is possible that the curves of the organism were caused by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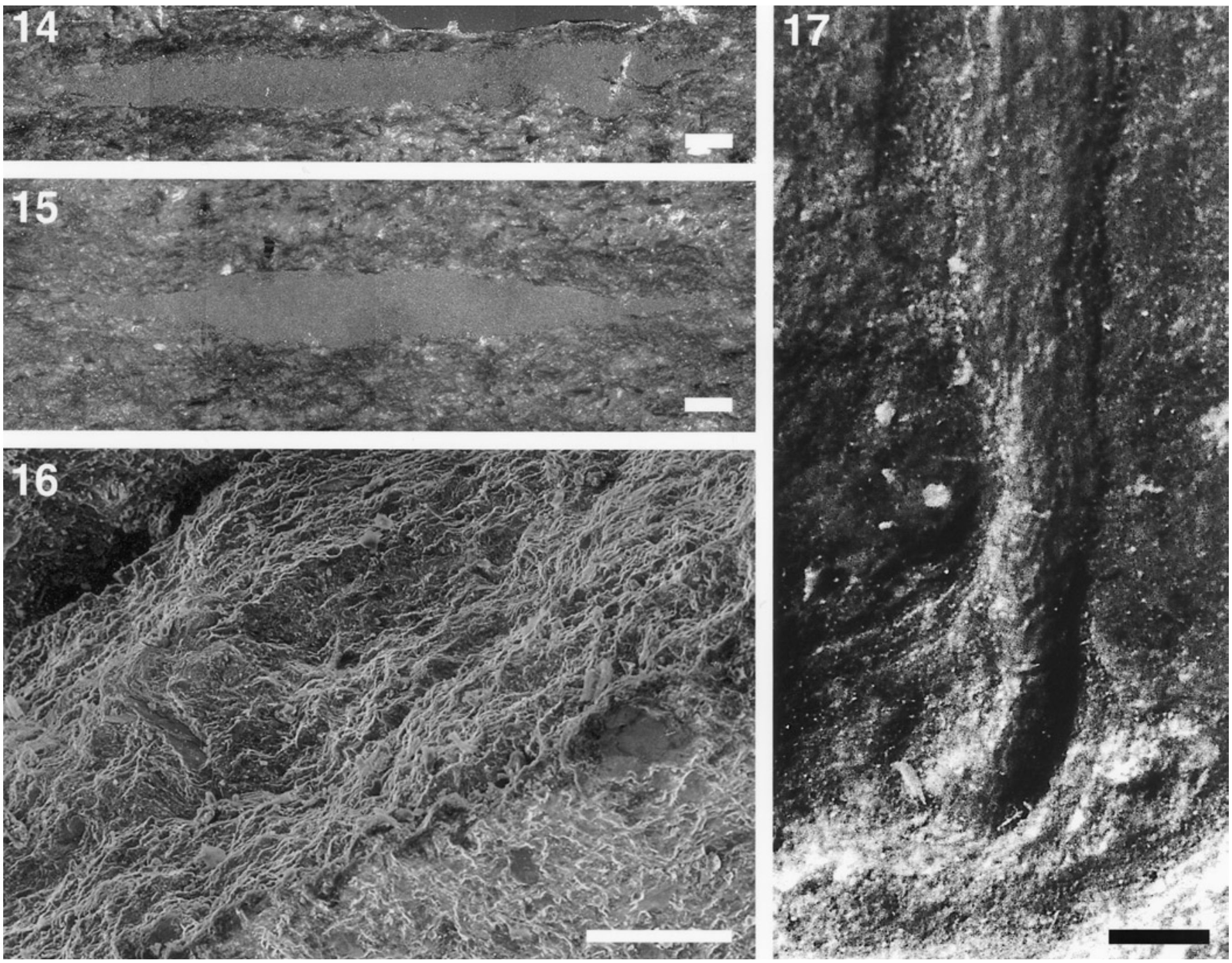
deformation, but *Lathamoserpens* had a relatively thick wall with presumed lamellar construction (Figs. 14–16 ). All *Lathamoserpens* specimens have evenly spaced curves, and with one exception (LACMNH specimen 12863; Fig. 10) there are always two curves at nearly equivalent points from the ends of the shell. The degree of curvature is consistent, both among curves on the same specimen, and among different specimens. No specimens are known that are uncurved, or that are sharply curved or bent, or that have curves of different degrees on the same conch. Finally, no wrinkles, tears, or cracks are present, such as would be produced by distortion of the organism. These observations imply that *Lathamoserpens* represents a mineralized shell, and that its sinuous shape reflects its shape in life, not taphonomic distortion of a flexible organism.

A few tubular Cambrian "small shelly fossils" have a

◀ **Figs. 8–13.** *Lathamoserpens sigel* n. gen., n. sp. All scale bars = 1 cm. **8.** Holotype specimen. LACMNH specimen 12862; locality 200-E. **9, 11.** UCMP type specimen 37451, locality D-3961, upper Poleta Formation; **9.** Original specimen. **11.** Latex cast of counterpart; closeup of anterior end, showing chevron-shaped lines centered on midline. **10.** LACMNH specimen 12863; locality 200; poorly preserved specimen with extra bend; arrow indicates fragment of shell. **12.** LACMNH specimen 12864; locality 200; slab with two individuals; the counterpart of this slab (not figured) was sectioned for petrographic study. **13.** UCMP type specimen 39950, locality D-3960; partial specimen from the upper Poleta Formation preserved in negative relief.




**Figs. 14–17.** Morphology of *Lathamoserpens sigel* n. gen., n. sp. **14–15.** Composite reflected light photomicrographs through cross-sections of *Lathamoserpens sigel* n. gen., n. sp., from two different fossils from specimen LACMNH 12862 (counterpart). Scale bars = 1 mm. **16.** SEM micrograph of a broken edge of *Lathamoserpens sigel* n. gen., n. sp. (LACMNH specimen 12864; part); oblique view; shell edge is at lower right, matrix below shell at upper left; note apparent multiple layers. Scale bar = 100 μm. **17.** Narrow end of type specimen of *Lathamoserpens sigel* n. gen., n. sp. (LACMNH specimen 12862) exposed by preparation, showing globular terminus bent to the left. Scale bar = 1 mm.

superficially similar shape to *Lathamoserpens*, such as the anabaritid *Cambrotubulus decurvatus* (e.g., Missarzhevskii 1989, Pl. 13, Figs. 9, 10) and members of the genera *Coleolella* and *Coleoloides* (e.g., Missarzhevskii 1981, Pl. 7, Figs. 6, 7, 10; 1989, Pl. 12, Fig. 6). One of our reviewers suggested that *Lathamoserpens* might also be compared with the latest Neoproterozoic shelly fossil *Wyattia*, which may also have a globular protoconch similar to *Lathamoserpens* (Taylor, 1966). The globular protoconch is also similar to those of the poorly known globorilids, which have been classified as hyoliths (Fisher 1962) but which may not belong in the clade (Marek and Yochelson 1976). However, although these "small shelly fossils" may reach over a centimeter in length, they are still far too small to represent juvenile specimens of *Lathamoserpens*. Furthermore, *Coleoloides* has several spiraling external ridges and does not taper, and *Cambrotubulus* and *Coleolella* are smooth externally. *Wyattia* has also been reconstructed as externally smooth, but it may be synonymous with the genus *Cloudina*, which is externally ribbed (Grant, 1990). None of these genera has the keel and rounded anterior terminus of *Lathamoserpens*.

Is *Lathamoserpens* a hyolithid? The shape of the broad end (implying presence of a ligula) and keel are common features within the Hyolithida. The dorsal rim of the aperture is not visible, which makes it difficult to assess whether *Lathamoserpens* had a hyolithid-like aperture, with a protruding, shelf-like ligula. This absence is not an obstacle to placing *Lathamoserpens* in the Hyolithida, because true hyolithids from the Latham Shale, preserved as compression fossils, also may not show the apertural margin (see below). *Lathamoserpens* is unusually large for a hyolithid, but is still within the known size range of Cambrian hyoliths, some of which are up to 20 cm long (Pojeta 1987). The apical angle of *Lathamoserpens* is unusually narrow (7°–11°); most hyolithids have apical angles greater than 20°. For example, Middle Cambrian *Haplophrentis* species and Lower Cambrian *Nevadotheca* species both range from 20° to 35° (Babcock and Robison 1988; Malinky 1988; this paper). However, *Hyolithes? attenuatus*, from the Upper Cambrian of Nevada, has an apical angle of 7°–10°, comparable to that of *Lathamoserpens* (Malinky 1988). Finally, although the shell has been replaced by clay minerals, the microstructure of a broken shell edge appears to be lamellar, consisting of many parallel layers (Fig. 16). If the clay replacement is a pseudomorph of the original structure, this would be consistent with known hyolithid shells, which have a crossed-lamellar fabric (Runnegar et al. 1975).

On the other hand, the multiple lateral curves of the conch of *Lathamoserpens* are very atypical of hyolithids, which are almost always bilaterally symmetrical. A very few post-Cambrian hyolith-like fossils have single lateral curves (Fisher 1962); some of these may be open-coiled gastropods rather than hyoliths (Marek and Yochelson, 1976). Weak lateral curvature occurs in some normally straight Cambrian hyoliths, but is inconsistently present and probably taphonomically induced (e.g., Babcock and Robison 1988, Fig. 7-4). We also do not know details of the shape of the aperture of *Lathamoserpens*, nor whether *Lathamoserpens* had an operculum and helens. In summary, although *Lathamoserpens* resembles hyolithids in several respects, it differs enough from them that we hesitate to formally classify it within the Hyolitha. If our tentative placement of *Lathamoserpens* in the Hyolitha is confirmed by further observations, the definition of the taxon may have to be expanded.

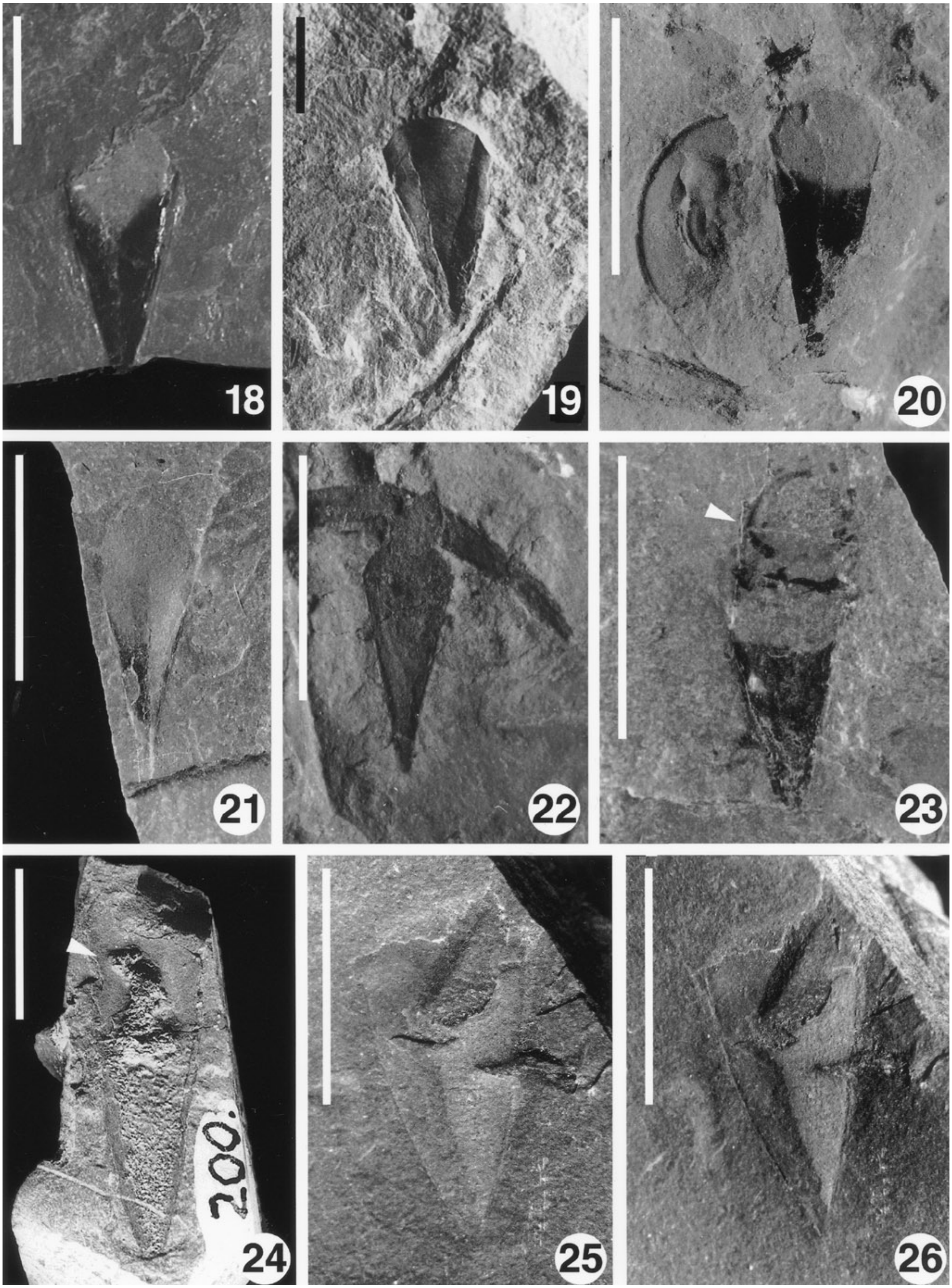
**Distribution**—Holotype and two figured specimens: LACMNH locality 200; Latham Shale, southern Marble Mountains, San Bernardino County, California. UCMP type specimen 37451: UCMP locality D-3961; UCMP type specimen 39950: UCMP locality D-3960; both from upper Poleta Formation near Westgard Pass, White Mountains, Inyo County, California.

HYOLITHA Marek, 1963
HYOLITHIDA Matthew fide Fisher, 1962
Genus: *NEVADOTHECA* Malinky, 1988
Cf. *NEVADOTHECA WHITEI* (Resser, 1938)
Figs. 18–24

**Material**—Six figured specimens.

**Discussion**—Hyolithids have been figured previously from the Latham Shale by Mount (1980), who assigned them to the species *Hyolithes whitei* (Resser 1938). *H. whitei* was made the type species of the genus *Nevadotheca* by Malinky (1988; see this paper for full synonymy and taxonomic discussion). *Nevadotheca* is now known from several species distributed throughout the Cambrian of North America (Malinky 1989). We have figured several specimens of these hyolithids from the Latham Shale for comparison with the two new species described here. It is difficult to identify hyoliths from flattened specimens. *Nevadotheca*, for instance, is diagnosed in part by a high, inflated dorsum, which is not visible in flattened specimens (Malinky 1988). Nevertheless, all of the specimens figured here correspond closely to *Nevadotheca whitei* in those features that can be seen. Like *Nevadotheca*,

➤ **Figs 18–26.** *Nevadotheca* Cf. *N. whitei* and *Cambrorhytium fragilis*; all specimens from the Latham Shale except as noted. All scale bars = 1 cm. **18.** *Nevadotheca* Cf. *N. whitei*, with dark phosphatized area; UCR locality 4079/158. **19.** *Nevadotheca* Cf. *N. whitei*, well-preserved specimen in ventral view; UCR locality 7895/4. **20.** *Nevadotheca* Cf. *N. whitei*, specimen associated with partial olenellid trilobite cephalon and dark phosphatized area; UCR locality 7527 (Cadiz Formation). **21.** *Nevadotheca* Cf. *N. whitei*, with dark phosphatized area at lower left;; UCR locality 7271/5. **22.** *Nevadotheca* Cf. *N. whitei*, poorly preserved specimen associated with possible trilobite spine; UCR locality 7527 (Cadiz Formation). **23.** *Nevadotheca* Cf. *N. whitei*, arrow indicates rim of operculum, displaced up and to the right; UCR locality AE731. **24.** *Nevadotheca* Cf. *N. whitei*, incomplete specimen with infilled gut (arrow); LACMNH specimen 12865, locality 200. **Figs. 25–26.** *Cambrorhytium fragilis*, LACMNH specimen 12866, locality 200. **25.** Specimen illuminated from lower left. **26.** Specimen illuminated from top.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they have a short, broadly rounded ligula, with at least faint transverse sculpture, but no lateral sulci or strong ribs. Two of our figured specimens (Figs. 23, 25) come from shales in the lower Cadiz Formation (UCR locality 7527). They are not significantly different from the Latham Shale specimens, and are also referred provisionally to *Nevadotheca whitei.*

Several specimens are preserved with black areas of calcium phosphate on the wall (Figs. 18, 20, 21). Phosphate is not usually seen in other originally calcareous fossils from the Latham Shale, such as olenellid trilobites. Its presence suggests a complex diagenetic history for these fossils. One specimen (UCR AE731; Fig. 23) retains its operculum, displaced about one millimeter from the original opening. The preservation of this specimen is not good, but associations of hyolith conchs and opercula are rare (Marek and Yochelson 1976) and the operculum of *Nevadotheca* has not been described (Malinky 1988, 1989). The outline of the operculum suggests that the dorsum of this specimen was high and inflated, which is typical for *Nevadotheca* (Malinky 1988).

One of our specimens (LACMNH 12865; Fig. 24) contains an elongated, irregularly textured, mineralized structure near the midline of the conch, which is straight closest to the aperture and curves to the right towards the apex. The rest of the conch contains a zone of granular mineral overgrowths that does not extend as far as the edges of the conch. The granules and midline structure are enriched in iron and sulfur, unlike any other fossils examined in this study. An anaerobic microenvironment within the conch, or within a hollow internal organ of the animal, could promote precipitation of iron sulfides, in part as a product of decay, as long as sufficient iron is present (Canfield and Raiswell, 1991). Hyolithids had a gut with a highly folded segment, usually regarded as the intestine, and a straight segment usually considered to be the rectum, terminating at the presumed anus, near the aperture of the conch (Runnegar et al. 1976; Pojeta 1987; Babcock and Robison 1988; Kruse 1997). We hypothesize that the midline structure in this specimen is a partially pyritized hindgut fill, because its location and curvature is consistent with the known gut anatomy of hyolithids. Its shape is consistent with the prediction of Marek and Yochelson (1976) who suggested that hyoliths would be expected to produce fecal strings rather than pellets. As such, this is potentially important because it provides information on soft-part anatomy: fewer than ten instances of soft-part preservation in hyoliths are known (Kruse 1997). Together with the occurrence of the operculum described above, the specimen described here suggests that with further collecting, additional exceptionally preserved hyoliths, perhaps with soft-tissue impressions, might be found in the Latham Shale.

**Distribution**—LACMNH locality 200, UCR localities AE731, 4079, 7271, 7895: Latham Shale, Marble Mountains, San Bernardino County, California. UCR locality 7527: Cadiz Formation, southern end of the Marble Mountains, San Bernardino County, California.

?Cnidaria

Genus Cambrorhytium Conway Morris and Robison, 1988

**Type species**—*Cambrorhytium major* (Walcott, 1908).

**Diagnosis**—"Tubicolous metazoan. Tube elongate, gradually expanding from apical point to smooth aperture; wall apparently unmineralized and organic in composition, growth by incremental additions producing more or less regular annuli. Operculum lacking." (Conway Morris and Robison 1988, p. 18)

Cambrorhytium fragilis (Walcott, 1911)

Figs. 25–26

*Selkirkia fragilis* Walcott, 1911, p. 120, p. 122, pl. 19, fig. 8

*Selkirkia fragilis* Walcott, 1912, p. 190

*Selkirkia fragilis* Howell and Stubblefield, 1950, p. 12

*Selkirkia fragilis* Conway Morris, 1977, p. 37, p. 87

*"Selkirkia" fragilis* (Walcott) Briggs and Conway Morris, 1986, p. 177.

**Material**—One specimen, LACMNH 12866.

**Diagnosis**—"Tube with variable rate of expansion and transverse annulations, length ranging to 65 mm, original composition organic and probably unmineralized." (Conway Morris and Robison 1988, p. 19)

**Description**—Conical fossil with slightly convex lateral outline; apex tapers to a blunt point; length to width ratio about 1.8 to 1. Wall very thin, weakly annulated; original composition unknown.

**Discussion**—One conical fossil from the Latham Shale has features that distinguish it from hyoliths. Its thin wall (partially exfoliated in the only specimen), lack of a keel, straight aperture with no ligula, and curved outline with a low length-to-width ratio is unlike either *Lathamoserpens* or *Nevadotheca*, or for that matter like most hyolithids. The lack of a ligula could place the specimen in the Orthothecida, but orthothecid hyoliths are typically more slender and have thicker, mineralized walls. A very similar conical fossil from the Lower Cambrian Maotianshan Shale was figured and tentatively referred to the Hyolitha (Chen et al., 1996, Fig. 174), but has not been formally described.

The specimen closely resembles *Cambrorhytium*, a conical fossil described from the Burgess Shale with a curved lateral outline and a thin, presumably organic wall. The fine annular striations on the Latham Shale fossil are diagnostic for *Cambrorhytium*. The Latham Shale specimen has a lower length-to-width ratio than either the type species, *C. major* from the Burgess Shale, or the unnamed species of *Cambrorhytium* described from the Lower Cambrian Chengjiang biota of China (Chen et al. 1996, p. 78; Chen and Zhou 1997, pp. 30–32). Its proportions and overall outline are much closer to those of *C. fragilis* (Walcott 1911; Conway Morris and Robison 1988). Our fossil differs from *C. fragilis* in only one significant feature: the apex of the type specimens of *C. fragilis* is typically slightly curved, whereas that of the

Latham Shale specimen is straight. We place the Latham Shale specimen into *C. fragilis* but acknowledge that further specimens are needed to assess the taxonomic importance of the apex.

Although *Cambrorhytium* cannot be firmly assigned to any major metazoan clade, the morphology and preserved soft parts of *C. major* are consistent with a cnidarian affinity for the genus (Briggs and Conway Morris 1986; Conway Morris and Robison 1988, Chen and Zhou 1997). Unfortunately, the Latham Shale specimen adds no new information on the affinities of the genus.

**Distribution.** LACMNH locality 200; Latham Shale, southern end of the Marble Mountains, San Bernardino County, California.

## ACKNOWLEDGMENTS

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## APPENDIX: LOCALITY INFORMATION

**LACMNH 200:** "Classic trilobite locality," southern end of the Marble Mountains, San Bernardino County, California. Collected 1951–1955, various collectors.

**LACMNH 2472:** SE 1/4 SE 1/4 NE 1/4 sec. 11, T. 5 N, R. 14 E. Southern end of Marble Mountains, San Bernardino County, California. Collected 1971, E.C. Wilson, S.P. Applegate, P. Kirkland, and others. Wilson and Kirkland quarried 20–30 ft. above base of Latham Shale, Applegate near top of formation.

**LACMNH 3924:** as 2472, but 15–20 ft. above base of Latham Shale.

**LACMNH 6075:** Marble Mountains. Collected 1960–1962, Melvin Webster.

**UCR AE73-1:** Latham Shale, Marble Mountains.

**UCR 4079:** Latham Shale, Marble Mountains.

**UCR 7271:** Latham Shale?, Marble Mountains.

**UCR 7527:** Cadiz Formation. 800 ft. west and 1600 ft. south of the NE corner of sec. 11, T 5 N, R 14 E. East flank of hill 1645 (Danby 15' quad), elevation 1240 ft.; southern end of Marble Mountains., San Bernardino Co., about 10 ft. above base of formation. Collected March 1974, Jack Mount.

**UCR 7895:** Latham Shale, Marble Mountains.

**UCMP D-3960:** "*Helicoplacus* locality," Upper Poleta Formation. Sec. 33, T. 7 S, R. 35 E. Westgard Pass 7.5' quadrangle, White-Inyo Mountains, Inyo County, California.

**UCMP D-3961:** Steep slope on southern edge of gorge approximately 1 km east of Westgard Pass road, and 1.3 km northeast of northern entrance to Cedar Flats campground. NE 1/4 SW 1/4 Sec. 33, T 7 S, R 35 E, Westgard Pass 7.5' quadrangle, White-Inyo Mountains, Inyo County, CA.