Precambrian-Cambrian transition problem in western North America: Part II. Early Cambrian skeletonized fauna and associated fossils from Sonora, Mexico

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ABSTRACT

A skeletonized fauna of possible Tommotian age (earliest Cambrian) has been discovered in the Caborca region, Sonora, in a unit considered approximately equivalent to the basal part of the Wood Canyon Formation of the Death Valley region. Probable metazoan traces occur about 900 m stratigraphically below the shelly fossils and may be among the oldest trace fossils known in the southern Cordillera. About 1,200 m stratigraphically below the shelly fossils, a new filamentous algal microbiota has been found in silicified wackestone from the El Arpa Formation. These new fossil occurrences, found within three stratigraphically correlated upper Proterozoic through Middle Cambrian sections from the Caborca region, have significant paleobiologic and biostratigraphic implications for the "Precambrian-Cambrian boundary" and Proterozoic paleobiology in western North America.

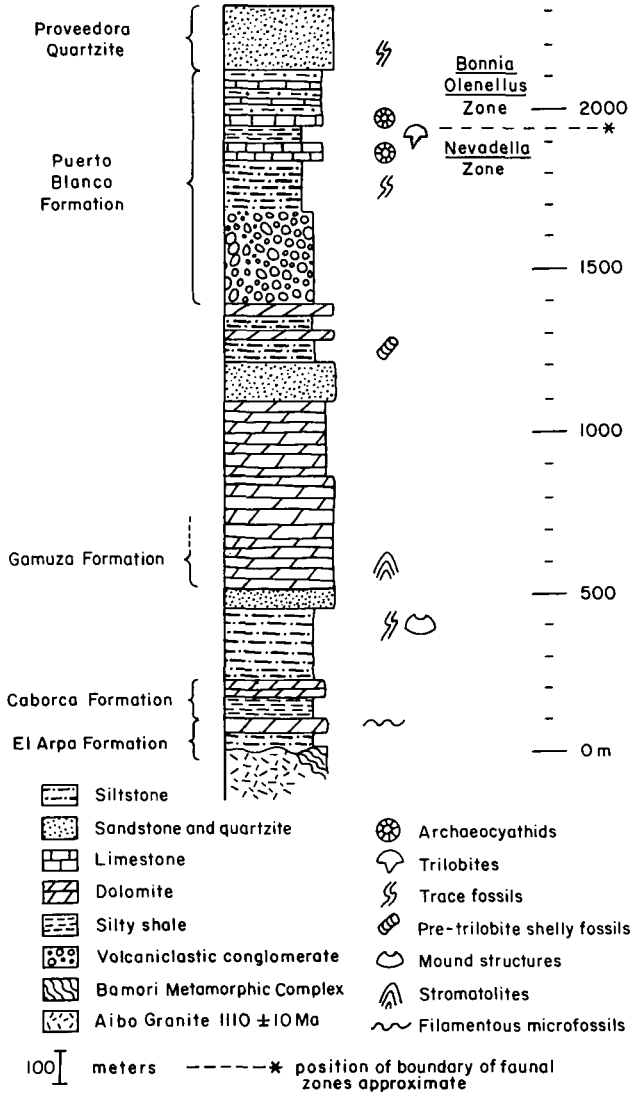

Figure 1. Composite stratigraphic section of upper Proterozoic and Lower Cambrian sediments in Caborca, Sonora region. Thicknesses based on sediment sequence in Cerro Rajon

INTRODUCTION

Though pioneering work on what is commonly referred to as the Precambrian-Cambrian boundary was done by Walcott (1910) in western North America, most of the research has centered in other regions of the world. We report here on pretrilobite shelly fossils of Tommotian character found about 270 m stratigraphically below the lowest occurrence of *Nevadella* Zone fossils. Trace fossils are found 900 m stratigraphically below the shelly fossils, with conical stromatolites occurring 150 m below the shelly fossils. The filamentous microbial fossils are found near the base of the section, about 1,200 m below the shelly fossils.

In reporting on fossils in pre-Cambrian and Cambrian strata near Caborca, Cooper and Arellano (1946, p. 609) were the first to hint at the possible significance of this region to study of the Precambrian-Cambrian boundary, suggesting that the boundary occurs along the Sonora Road northwest out of Caborca. In a survey of the stratigraphy in this area, Cooper et al. (1952) reported Early Cambrian fossils, but little work has been published since then on the Cambrian of Caborca. The 1,000+-m-thick Proterozoic section has attracted the attention of several geologists interested in the correlation of these units to Proterozoic sequences in southeastern California (Eells, 1972; Benmore, 1978). Stromatolites resembling *Jacutophyton, Conophyton,* and *Platella* have been described from the "Gamuza Beds," Gamuza

Formation of Longoria (1981) by Weber et al. (1979) and Cevallos (1981), suggesting to these authors a middle Riphean age for this part of the section. However, if the proposed correlation of the Gamuza Formation (Fig. 1) with the middle part of the Stirling Quartzite of southeastern California by Stewart et al. (in prep.) and the occurrence of trace fossils below and shelly fossils above the Gamuza turn out to be correct, a very late Proterozoic age (Vendian in Soviet terminology) is indicated for this stromatolite-bearing formation.

SKELETONIZED FAUNA

While measuring a stratigraphic section above a 1,110 ± 10 m.y. old granitic basement (Anderson et al., 1979) through to the Middle Cambrian in the southern Cerro Rajón (Fig. 1), two of us (McMenamin and Stewart) and Juan Manuel Morales-Ramirez came upon a rich accumulation of tubular and conical millimetre-size shelly fossils (first noted by A. R. Palmer and L. T. Silver in 1978) in strata considered to be approximately equivalent to the basal part of the Wood Canyon Formation of southeastern California and southwestern Nevada (Stewart et al., in prep.). The shells occur in a sandy dolomitic limestone about 120 m below a volcaniclastic conglomerate considered the basal unit of the Puerto Blanco Formation of Stewart et al. (in prep.). A nevadiid trilobite thorax found by A. R. Palmer about 200 m above the top of this volcaniclastic unit indicates an Early Cambrian (*Nevadella* Zone of Fritz, 1972) age for this part of the Puerto Blanco Formation.

After the initial discovery in the Cerro Rajón, similar accumulations of shelly fossils were found in the Cerros Pitiquito and Cerros Calaveras (Fig. 2). If similar shelly faunas from Nevada (Gevirtzman et al., 1982) and Death Valley (Langille, 1974) represent the same interval, pretrilobite shelly fossils were widespread in the southwestern Cordillera.

Four tubular morphotypes are present in the Caborca material: (1) smooth, single-walled fossils (Fig. 3a), the simplest forms, up to about 10 mm in length (broken) with tube diameters commonly in the 1.2 to 1.8 mm range; (2) smooth-surfaced, multiple-walled tubes (Fig. 3b) averaging 2 to 3 mm in diameter, with lengths up to 10 mm (broken specimens); (3) robust, irregularly annulated, single-walled tubes (Fig. 3c) averaging 2.4 mm in diameter and broken into lengths of less than 10 mm; and (4) a regularly annulated tube (Fig. 3d) 1.7 mm in diameter and broken to a length of 4.8 mm.

These tubes were probably originally calcitic and are now recrystallized calcite or dolomite (Cerros Calaveras) or weakly silicified (Cerros Pitiquito and Cerro Rajón). Although tubular calcitic fossils of latest Proterozoic or earliest Cambrian age are known from many continents, the shelly fossils from Caborca do not closely resemble any previously described genera. The regularly annulated tube (Fig. 3d) may be *Turcutheca*, a hyolithid from the Tommotian Stage (Lower Cambrian) of Siberia (Rozanov et al., 1969), although a diagnostic character for the genus (growth lines that curve toward the apex) was not observed on Caborca specimens. There is a superficial resemblance between the smooth-surfaced, double-walled tubes to cribricyathids described from the lowermost Cambrian Ust'kundatskii horizon of the USSR (Yankauskas, 1972), but the Caborca fossils lack the diagnostic cribricyathid wall structure. The Nevada fauna includes a fossil that closely resembles the irregularly annulated tube (Fig. 3c) from Caborca (P. W. Signor, in prep.), although the Nevada fossil tapers more strongly.

OLDER TRACE FOSSILS

About 900 m down-section from the shelly fossils in the Cerros de la Ciénega, trace fossils and unusual bed markings occur in a reddish sandy siltstone overlying an oolite breccia. These strata are considered equivalent to the Rainstorm Member of the Johnnie Formation known in southeastern California and southwestern Nevada (Stewart et al., in prep.). The Cerros de la Ciénega siltstone has the distinctive scratches and flute casts of the typical Rainstorm Member (Stewart, 1970), but in addition has traces of probable metazoan origin (Fig. 3e). One slab contains four subparallel traces in the plane of bedding

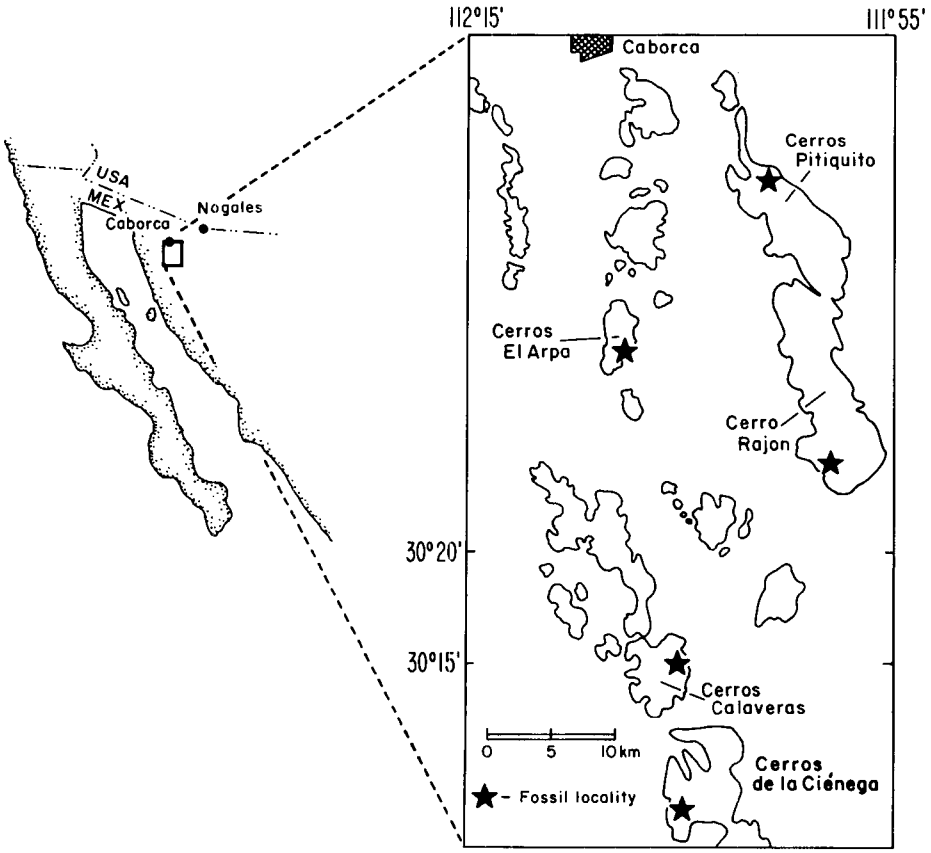

Figure 2. Location map showing ranges and fossil localities discussed in text.

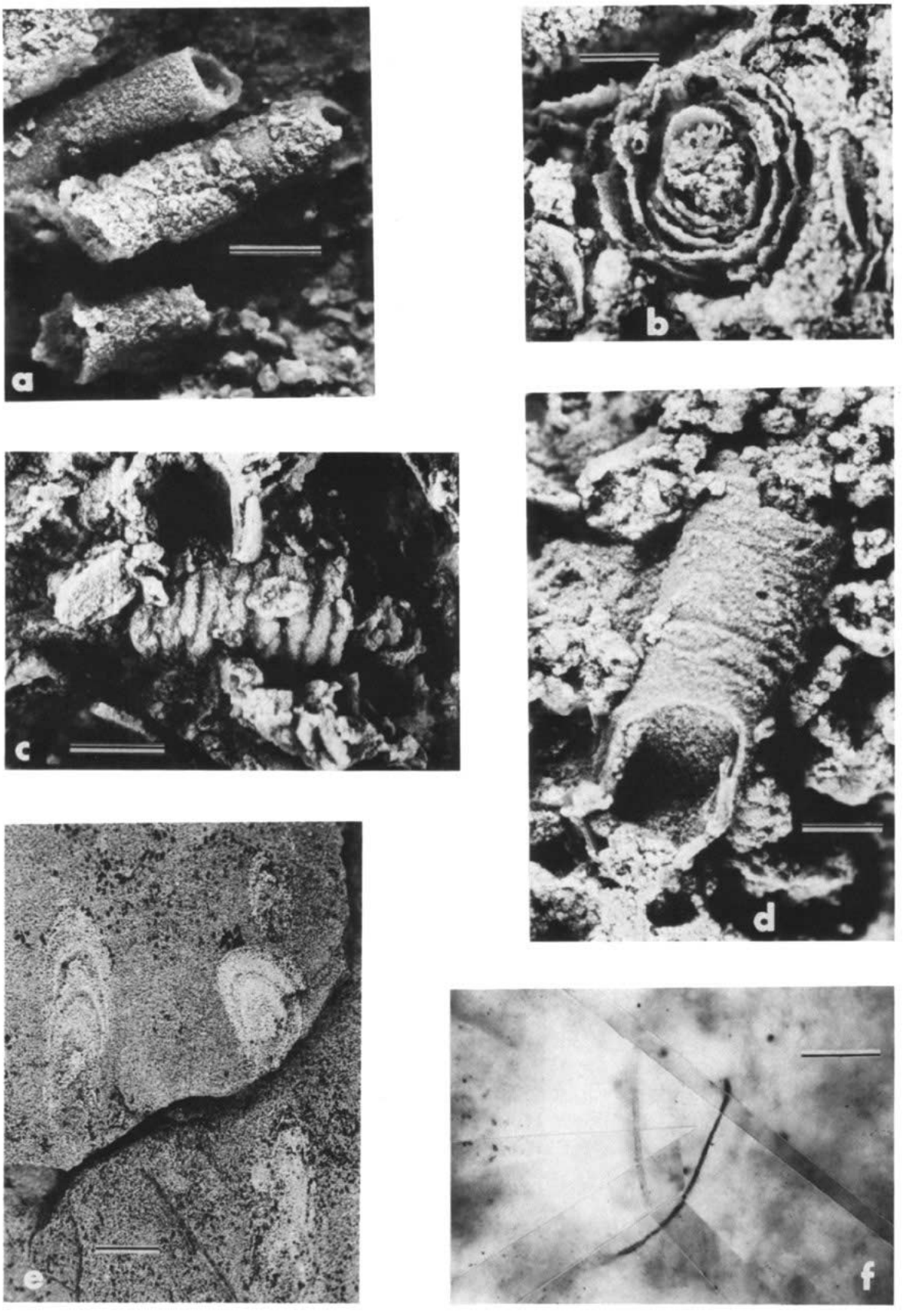

Figure 3. Fossils from Caborca region. a: Smooth, single-walled fossils from Cerro Rajón; specimen MM-82-84a; scale bar = 2 mm. b: Multiple-walled, probably tubular fossil from Cerro Rajón; specimen MM-82-41a; scale bar = 1 mm. c: Irregularly annulated tube from Cerro Rajón; specimen MM-82-84b; scale bar = 2 mm. d: Regularly annulated tube from Cerros Pitiquito; specimen MM-82-81a; scale bar = 1 mm. e: Bedding-plane traces from Cerros de la Ciénega; specimen MM-82-79a; scale bar = 1 cm. f: *Eomycetopsis*-like filaments from El Arpa Formation chert in Cerros El Arpa; specimen MM-82-62; slide MM-82-62a; millimetres from reference X = 26.3 × 10.4; scale bar = 25 μm.

(Fig. 3e). A somewhat similar trace has been reported by Hofmann and Aitken (1979; their Fig. 17c) from Proterozoic rocks of northwestern Canada, and may belong to the ichnogenus *Bergaueria*.

MICROFOSSILS

In the Cerros El Arpa, filamentous microbial fossils occur in black, silicified wackestone of the El Arpa Formation (of Longoria, 1981), the basal formation of the Proterozoic sedimentary sequence. Two types of filaments are present in the El Arpa cherts. The first are tubular, nonseptate forms, 2 to 3 μm in diameter, as much as 120 μm long, with well-defined, thin (<0.2 μm), dark walls (Fig. 3f). Aside from the lack of septae, these filaments closely resemble the late Proterozoic genus *Eomycetopsis* Schopf (1968). The other filament is larger, 4 to 6 μm in diameter, tubular, and nonseptate, with a thin (< 0.5 μm), indistinct dark wall. In some cases, the filaments are grouped into radiating clusters and form dense masses in the centers of grains. This filament type does not resemble any known fossil morph.

DISCUSSION AND CONCLUSIONS

The Caborca shelly fauna does not appear to have close affinities to faunas of similar age outside of southwestern North America. Phosphatic shelly fossils, common elements of many earliest Cambrian faunas, are currently unknown from the Caborca pretrilobite shelly bed, even though phosphatic protoconodont-like fossils and *Hyolithellus* have been isolated by acetic acid dissolution of the lowest archaeocyathid-bearing limestones in the Puerto Blanco Formation.

The traces found 900 m below the shelly fossils are significant because trace fossils of this presumed antiquity have not been reported from Great Basin upper Proterozoic units to the north. However, to the best of our knowledge, no similar trace fossils have been reported from rocks of late Proterozoic, or younger, age.

Acritarch-based correlation has been demonstrated to be a useful tool for Proterozoic–Early Cambrian biostratigraphy (Vidal, 1981) and may prove useful in the Cordillera (McMenamin and Awramik, 1982; Nyberg, 1982). However, preliminary search in shale and siltstone of these sections has failed to produce any acritarchs.

In summary, new paleontologic data recovered from the Caborca region will be important for understanding the paleobiology of the Proterozoic-Cambrian transition in western North America.

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Reviewer's comment

Adds significant knowledge about early metazoan history in North America.