Wilson, E. C.
1991

J. Paleont., 65(5), 1991, pp. 727–741

0022-3360/91/0065-0727$03.00

PERMIAN CORALS FROM THE SPRING MOUNTAINS, NEVADA

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ABSTRACT—Rugose and tabulate corals from the Lower Permian (Wolfcampian, Leonardian) Bird Spring Group in the Lee Canyon section of the Spring Mountains, Clark County, Nevada, are referred to eight genera and ten species. New taxa are *Fomichevella nevadensis* n. sp., *F. waltersi* n. sp., *Mccloudius parvus* n. sp., and *Paraheritschioides richi* n. sp. The fauna is most similar to the shelf fauna in eastern Nevada, but there are significant similarities to corals from the Antler Highland embayments of central Nevada and southern Idaho and to faunas of the same age in northern California and northern British Columbia. The paleogeography is interpreted as shallow water near the east side of the mouth of a south-opening coastal sea, bordered on the east by the continent and on the west by the Antler Highland. Corals migrated south along the western shores of the Antler Highland and mixed with the shelf fauna, perhaps with some corals crossing from Tethys to the coast. The modern eastern Pacific tropical coral faunas, which have several hermatypic coral genera and species derived from the western Pacific in the Pleistocene, may occupy a somewhat similar geography near the mouth of the modern Gulf of California.

INTRODUCTION

THIS STUDY reports the stony coral fauna from the Lower Permian part of a thick section in the northern Spring Mountains, Clark County, Nevada. The section is north of Lee Canyon and has become important because the fusulinid fauna from it was reported relatively early (Rich, 1961). Investigation of the coral fauna was undertaken chiefly to determine whether or not it might shed some light on the diverse and seemingly isolated coral subprovinces of western North America, considered by some workers to be evidence for formerly widespread terranes.

PREVIOUS WORK

Rich (1960) first noted this section in a report of a Pennsylvanian *Chaetetes*. Later, Rich (1961) described the section more than 7,000 feet (2,134 m) in thickness north of Lee Canyon from which the *Chaetetes* was collected and referred it to the Bird Spring Formation. He figured and identified the fusulinids from the Morrowan (Pennsylvanian) to Leonardian (upper Lower Permian) stages. The non-fusulinid bearing part of the section ranges downward to the Upper Mississippian (Chesterian). Later, Rich (1963, 1964, 1969) included data obtained from the section in several studies on the petrography and in one report (Rich, 1962) on a terrestrial plant from the Mississippian part of the section. Barosh (1968) noted thick sandstone units in the upper part of the Lee Canyon section that were more similar to formations in east-central Nevada than to the Bird Spring Group (elevated from formational rank by Langenheim et al., 1962), suggested that correlation was possible using some corals and the lithology, and implied that use of the formational names Riepe Spring Limestone, Rib Hill Sandstone, and Arcturus Formation might be extended from east-central Nevada to the Lee Canyon section. This intriguing suggestion has not been subsequently followed and the Upper Pennsylvanian–Lower Permian part of the Bird Spring Group has not been divided into formal formations for a number of reasons. Therefore, formational names have not been applied to the lithologic units in this study.

REGIONAL GEOLOGY

The Spring Mountains are in the Basin and Range Geomorphic Province, an area of generally north-south trending, block-faulted mountain ranges separated by valleys. Sedimentary rocks representing some Precambrian, all of the Paleozoic, and part of the Mesozoic are present. Paleozoic marine sedimentary rocks predominate. Major NE-SW trending thrust faults and generally EW trending strike-slip faults affect palinspastic restoration of the study area. Stewart (1980) described the regional geology of Nevada and Longwell et al. (1965) that of Clark County, which includes the Spring Mountains. Burchfiel et al. (1974) mapped and discussed the geology of the Spring Mountains.

STRUCTURE AND RELATIONSHIPS

The Lee Canyon section occurs in a generally NW dipping block with beds dipping from 25 to 40 degrees. It has normal faults of minor displacement and is truncated by a larger normal fault (Rich, 1961). Higher parts of the Lower Permian occur northeast of the fault at the top of the Lee Canyon section and include coral-bearing beds.

STRATIGRAPHY, AGE, AND CORRELATION

The Permian part of the Lee Canyon section is 1,616 m thick (Figure 1). As first recognized by Barosh (1968), it has three lithologic units: a lower limestone sequence (238 m thick), a central sandstone sequence with some thin limestone beds (1,037 m thick), and an upper sandstone–limestone sequence (341 m thick). The Lee Canyon section begins with the occurrence of the lowest colonial rugose coral (LACMIP loc. 1255), which occurs in the lower part of the Zone of *Pseudoschwagerina* and slightly above the occurrence of *Triticites creekensis* as cited by Rich (1961), a species described by Thompson (1954) from the Camp Creek Shale (Permian) near Santa Ana, Texas. This species was used by Cassity and Langenheim (1966) to define the base of the Wolfcampian in the Arrow Canyon Range of eastern Clark County, Nevada, a usage extended here to the Lee Canyon section.

The middle sandstone sequence lies entirely within the Zone of *Pseudoschwagerina*. Mills and Langenheim (1987) cited lithologic similarities of Rich's (1961) description of this sequence to the "platy limestone member" of the Wamp Spring section in the Las Vegas Range to the northeast.

The upper sandy limestone sequence has a primitive *Parafusulina* sp. at about 150 m above the contact with the sandy sequence and therefore indicates the Zone of *Parafusulina* and the Leonardian Series. This is strengthened by the occurrence of *Schwagerina gumbeli* and *S. crassitectoria* in several overlying beds, two species placed in the Zone of *Parafusulina* of the Great Basin by Brill (1963).

The coral genera and species are typical of the western North American Lower Permian, with the exception of the three new species for which geographic and stratigraphic ranges are as yet unknown. The correlation of the corals with other formations is discussed in the following section.

OCCURRENCE AND COMPARISON OF RELATED PERMIAN CORAL FAUNAS

Figure 2 summarizes the common occurrences of the Lee Canyon Permian corals with some other important Permian coral faunas from western North America. The Lee Canyon coral fauna is most closely related to the Early Permian coral fauna of the shelf area in east-central and southeastern Nevada. The shelf faunas were described chiefly by Easton (1960), McCutcheon and Wilson (1961), Wilson and Langenheim (1962), Langenheim and Langenheim (1965; an important list), and Stevens (1967). There are five species in the Lee Canyon section that also occur in the eastern Nevada shelf fauna, and they occur in the same stratigraphic sequences in both areas.

Corals from the Antler Highland embayments of north-central Nevada have not been studied extensively, although Hoare (1964, 1966) described corals from the Sunflower Formation and Sando (1985) described a coral from the Upper Pennsylvanian Oquirrh Formation of Power County, southern Idaho, that may have been deposited in an embayment on the eastern side of the Antler Highland. *Cornwallatia tabularia* (Hoare, 1964) from the Sunflower Formation also occurs in the Lee Canyon section and has not been reported elsewhere. *Paraheritschioides* Sando, 1985, was originally described from the Oquirrh Formation. A new species of this genus occurs in the Lee Canyon section. These two taxa correlate the Lee Canyon section corals to the Antler Highland embayment fauna.

Permian corals of the eastern Klamath Mountains, northern California area, were described chiefly by Meek (1864), Langenheim and McCutcheon (1959), Wilson (1982), Wilson (1985), and Stevens et al. (1987). Corals of the Lee Canyon section share two tabulate species and two rugose genera with the McCloud Limestone of the eastern Klamath Mountains. One of the genera (*Mccloudius*) is reported outside the type locality for the first time. This correlation is strengthened by the occurrence of other corals of the McCloud Limestone in the eastern Nevada and Antler Highland faunas.

Stevens and Rycerski (1989) described the Early Permian coral fauna of the Stikine River area, British Columbia, Canada. Two genera from their fauna also occur in the Lee Canyon fauna, suggesting a correlation as well as being the southernmost reported occurrence of these genera.

In summary, the Lee Canyon fauna is part of the shelf fauna that includes eastern Nevada, but it has significant elements in common with faunas of the Antler Highland embayments, the northern California formations, and northern British Columbia.

Magginetti et al. (1988) reported a mixture of fusulinid faunas of the Texas-Cordilleran region and the eastern Klamath Mountains in the Lower Permian Owens Valley Group of east-central California. Nassichuk and Wilde (1977) had already extended the range of significant fusulinid species and zones from the fusulinid fauna of the eastern Klamath Mountains originally described by Skinner and Wilde (1965) to southwestern Ellesmere Island in the Canadian Arctic Archipelago. The mixture of these two very widespread fusulinid faunas in the Owens Valley Group is of a magnitude of significance equal to that of the mixing of the coral faunas reported in the present study.

Perhaps a somewhat comparable uniformitarian example ex-

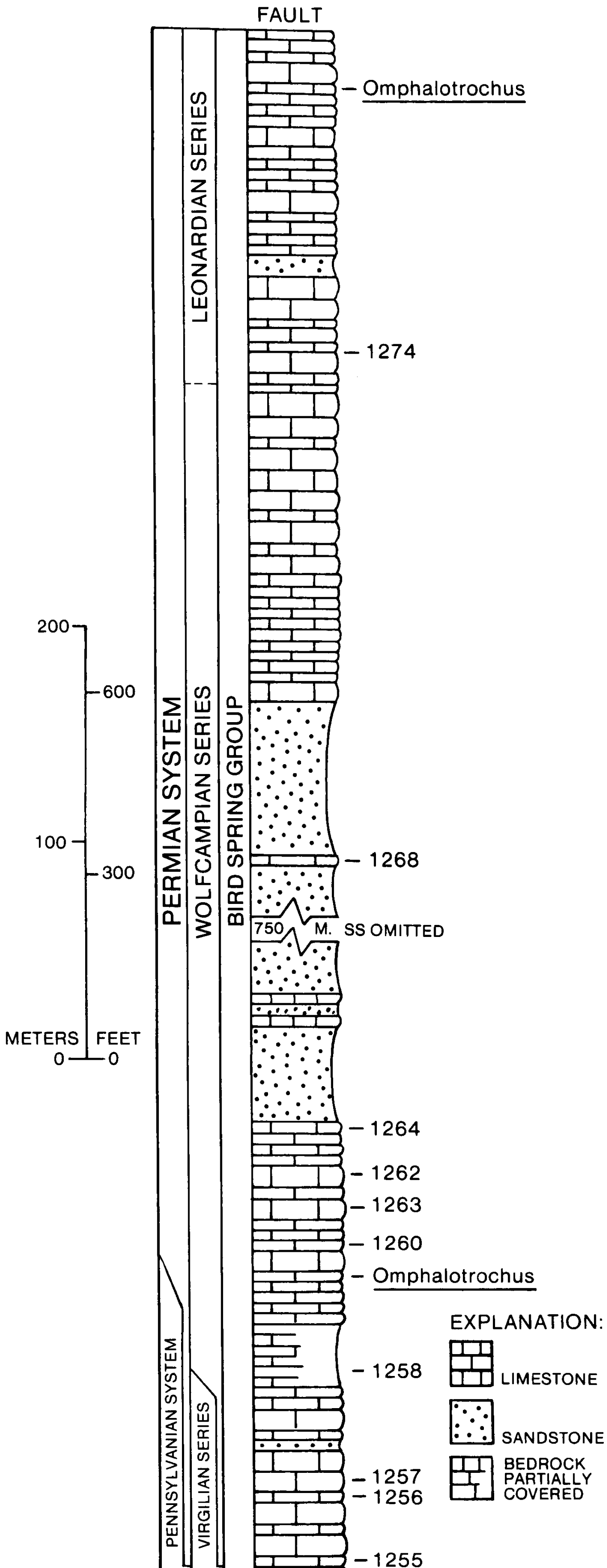

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FIGURE 1—Columnar section of Permian part of Bird Spring Group in Lee Canyon section of this paper, showing localitions of coral collections (numbers) and occurrences of the gastropod *Omphalotrochus*.

corals \ areas	NW BRITISH COLUMBIA, STIKINE RIVER AREA	EASTERN KLAMATH MOUNTAINS	ANTLER HIGHLAND EMBAYMENTS	EASTERN NEVADA	THIS PAPER
FOMICHEVELLA spp.	X				X
KLEOPATRINA FTATATEETA				X	X
PARAHERITSCHIOIDES spp.	X	X	X?		X
DIPHYPHYLLUM CONNORSENSIS				X	X
THYSANOPHYLLUM PRINCEPS				X	X
MCCLOUDIUS spp.		X			X
SYRINGOPORA MCCUTCHEONAE		X		X	X
SYRINGOPORA MULTATTENUATA		X		X	X
CORNWALLATIA TABULARIA			X		X

FIGURE 2—Occurrences of Permian corals in the Lee Canyon section of this paper and in other areas of western North America.

ists in the modern eastern Pacific, where the tropical hermatypic coral fauna of the Gulf of California is separated by the Baja California peninsula from the temperate coral fauna of the Pacific Ocean on the peninsula's west coast, with mixing of the two faunas around the southern end of the peninsula. In this analogy, the Lee Canyon fauna would have existed near the south end of the eastern sea, east and perhaps south of the Antler Highland, and the northern California to British Columbia faunas to the west of the Antler Highland, at least in part. Full oceanic access, as with the modern Gulf of California, would have been possible around the southern end of the Antler Highland, permitting faunal mixing. The sea east of the Antler Highland extended a great distance north, at least into British Columbia and perhaps farther.

Many elements (genera and species) of the modern hermatypic fauna of the Gulf of California and the entire eastern Pacific migrated there from the western Pacific in the Pleistocene (most recently summarized by Glynn and Wellington, 1983). Living corals are known to be dispersed great distances in the modern Pacific Ocean, both by larval dispersal in the plankton and rafting on floating objects (e.g., pumice). Jokiel (1984, 1989) studied examples of the latter, some involving reproductively mature coralla, which he suggested may have traversed a total distance of 20,000 to 40,000 km and could have completed several circuits of the tropical and subtropical Pacific basin. As one reviewer commented (Jokiel, 1984, p. 116) about the apparent rarity of rafting, "Two events in 4–5 years equals 400,000 times per million years!"

Perhaps a similar Permian dispersal might account for a few western North American occurrences of the typically Tethyan Permian corals reported by Stevens et al. (1987), a distribution now generally attributed chiefly to long distance terrane movement. The possibility for some migration into the eastern Pacific Permian faunas was first suggested by Newton (1988) on the basis of analogy with the well-known dispersal of modern mollusks across the Pacific Ocean from the western to the eastern Pacific.

PALEOECOLOGY

The fauna of the Permian part of the Lee Canyon section consists of encrusting calcareous algae, fusulinids, sponges, corals, bryozoans, brachiopods, several kinds of mollusks (including pectinid bivalves), echinoids, and crinoids. Of these taxa, only the sponges, bryozoans, and mollusks are known to occur in both fresh and marine waters. Fusulinids have not been reported from rocks of freshwater or brackish-water origin. Living corals, brachiopods, pectinids, and echinoderms are known only from marine environments. I saw no fossils indicative of a brackish, freshwater, or hypersaline environment in the Lee Canyon section. The entire fauna suggests normal salinity sea water.

Fusulinids occur throughout the section. Tasch (1957) considered that they lived in 5- to 50-foot depths (1.5–15 m). Thompson (1964) cited an offshore, open-water environment for them. Langenheim et al. (1977) noted several later viewpoints on fusulinid paleoecology, most of which are in general agreement with Tasch (1957) and Thompson (1964). More recently, Connolly (1987, p. 139) stated that "fusulinids favored shallow depths and estimates less than 100 feet seem reasonable." Wells (1957) considered Paleozoic colonial rugose corals to be indicative of well-oxygenated, gently circulating marine water with annual temperature minima of 16°–21°C. Sando (1980) used associations of corals and algae to determine depths of shallow-water corals, concluding that a maximum depth of 100 m was possible but less than 50 m more probable. Most paleogeographic maps show the Early Permian paleoequator

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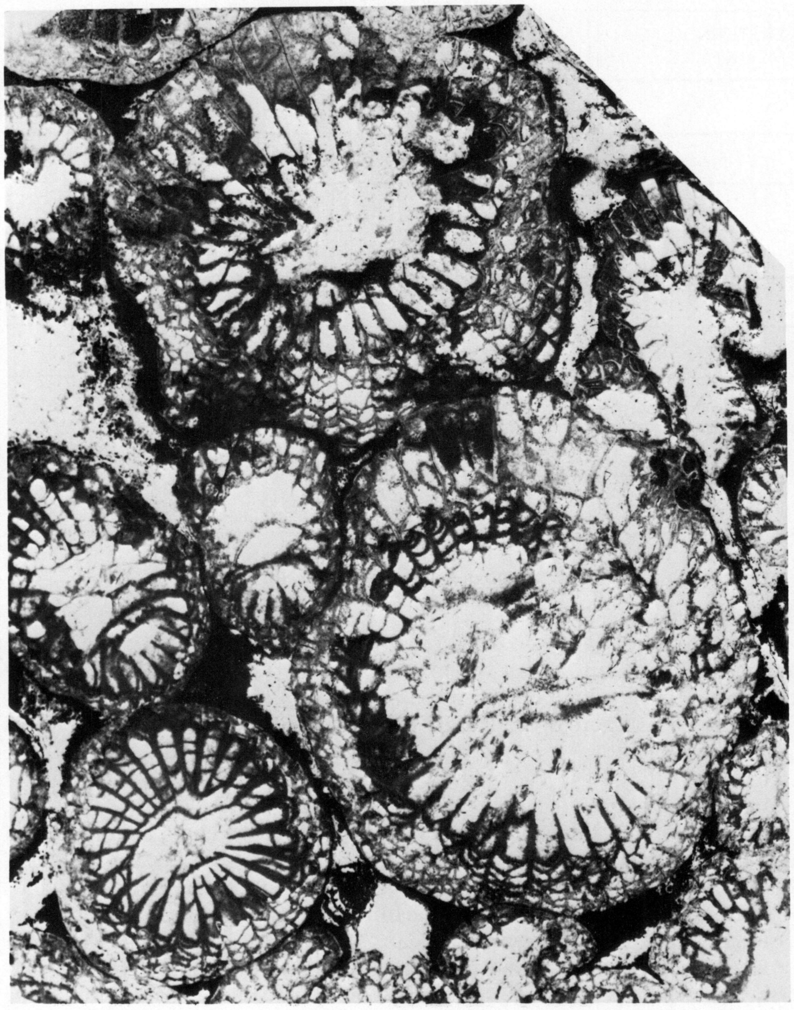
FIGURE 3—*1–3*, *Fomichevella nevadensis* n. sp., holotype LACMIP 8367. *1*, *2*, transverse sections; *3*, longitudinal sections. *4*, *5*, *Fomichevella waltersi* n. sp. *4*, transverse section, holotype LACMIP 8368; *5*, transverse sections, paratype LACMIP 8369. All figures ×3.

FIGURE 4—*Fomichevella waltersi* n. sp. *1*, transverse sections, holotype, LACMIP 8368; *2*, transverse sections, paratype LACMIP 8370; *3*, longitudinal sections paratype LACMIP 8370; *4*, transverse sections, paratype LACMIP 8369. All figures ×3.



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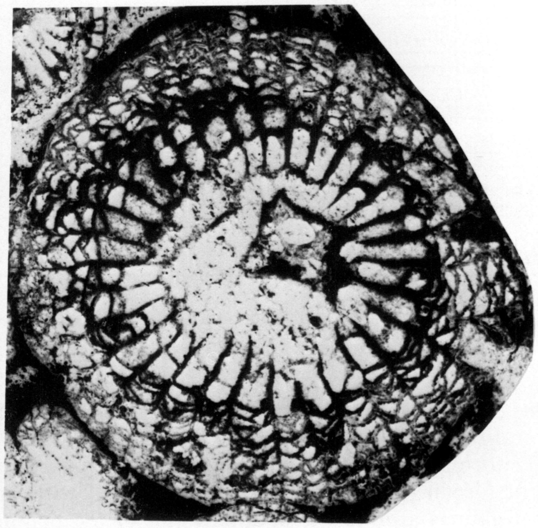

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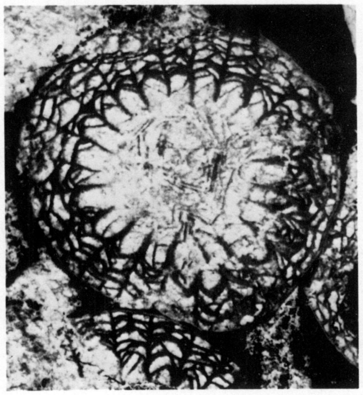

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