

Radiolarian biostratigraphy of the Quinn River Formation, Black Rock terrane, north-central Nevada: Correlations with eastern Klamath terrane geology

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ABSTRACT: The Quinn River Formation, Black Rock terrane, Quinn River Crossing, is one of the few Nevadan sections of Permian and Triassic strata that are unaffected by Sonoman deformation. The formation consists of: (1) a basal tuff overlain by limestone and ferruginous dolomite, (2) interbedded radiolarian-bearing chert and argillite, (3) siltstone and carbonaceous shale, and (4) partly volcanoclastic rocks that include siltstone, shale, and minor sandstone and radiolarian-bearing argillite. Disconformities separate the dolomite from the radiolarian chert and the chert from the siltstone and shale. Abrupt lithologic and faunal changes indicate that the partly volcanoclastic unit is faulted.

All but the uppermost (barren) chert samples contain Late Permian (Abadehian and Djulfian) radiolarian taxa belonging to *Albaillella*, *Deflandrella*, *Ishigaum*, *Nealbaillella*, and *Triplanospongos*. These radiolarians suggest that early Wordian conodonts reported from near the top of the chert and argillite unit are reworked.

Poorly preserved Early(?) or Middle Triassic radiolarians and Middle Triassic ammonites and pectenacid bivalves from the middle part of the volcanoclastic unit indicate that Early Triassic deposition cannot be documented at the Quinn River locality. Late Triassic (early to middle Carnian) radiolarians assignable to the *Triassocampe nova* Assemblage Zone of Yao occur about 21 meters below the top of the Quinn River section; diagnostic genera include *Castrum*, *Corum*, *Poulpus*, *Pseudostylosphaera*, *Triassocampe*, and *Xipha*.

The ages of the Quinn River brachiopod, conodont, and radiolarian faunas resemble those of the Dekkas and Pit Formations, eastern Klamath terrane, northern California. The Early Triassic age for the lower part of the Pit Formation is questioned because the unit contains only unidentifiable "primitive" radiolarians and long-ranging (Late Permian and Early Triassic) neogondolellid conodonts. The analogous Quinn River and eastern Klamath rock types and faunal ages, as well as similar hiatuses in their stratigraphic records, suggest that they may be lateral equivalents that formed in the same island-arc sedimentary basin.

INTRODUCTION

The Quinn River Formation (Willden 1961), exposed in the Black Rock terrane southeast of Quinn River Crossing, Humboldt County, Nevada (text-fig. 1), contains one of the few radiolarian-bearing Permian and Triassic chert-rich sections in the western United States that is more than a few meters thick. The formation consists of a basal tuff and limestone unit overlain by approximately 15m of dolomite, 25m of radiolarian-bearing chert and argillite, 22m of siltstone and carbonaceous shale, and 110m of clastic and volcanoclastic strata with minor sandstone and radiolarian-bearing argillite. The Quinn River Formation is the youngest unit in the Black Rock terrane (Jones 1990) and unconformably overlies a sequence of undivided Lower Permian volcanoclastic rocks and mudstone. The Lower Permian volcanoclastic rocks, in turn, unconformably overlie the Lower Permian Bilk Creek limestone unit (text-fig. 2).

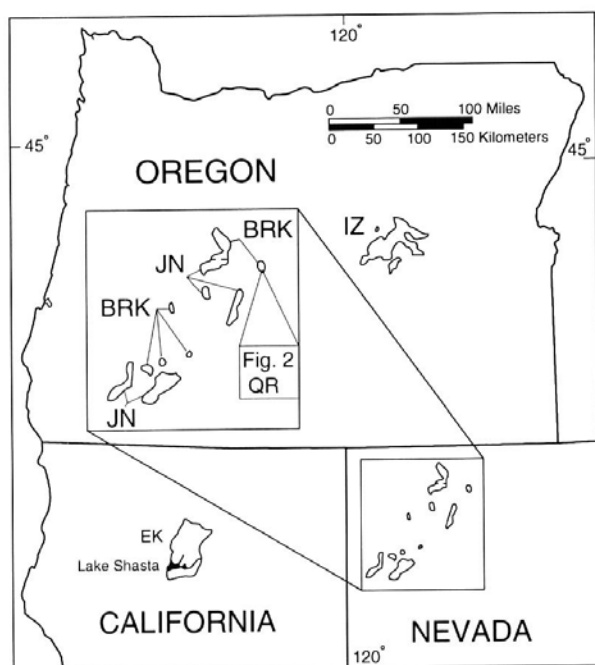
The Quinn River thrust fault of Willden (1961; text-fig. 2) forms the boundary between the Black Rock terrane and the Jackson terrane to the northwest (Silberling et al. 1987; JN in text-fig. 1). The Jackson terrane to the north contains a package of post-Middle Devonian cherty quartz arenite and conglomerate overlain by Jurassic(?) ash-flow tuff with large blocks of volcanic and intrusive(?) rocks and limestone (Jones 1990; text-fig. 2).

Silberling et al. (1987) included all pre-Tertiary rocks exposed near Quinn River in the Black Rock terrane (text-figs. 1 and 2). Wyld (1989) and Silberling (1990) later argued against the use of the Jackson terrane by showing that the Mesozoic strata in the Jackson

terrane west of Quinn River Crossing are in depositional contact with Paleozoic rocks of the Black Rock terrane.

Regional correlations of the Quinn River sequence and similar rock packages were addressed by Skinner and Wilde (1965), Ketner and Wardlaw (1981), Silberling and Jones (1982), Silberling et al. (1987), and Jones (1990). The rocks near Quinn River Crossing have been included as part of the far-traveled terrane called Sonoma by Speed (1979), which supposedly accreted to North America during closure of the Golconda basin during the Late Permian to Early Triassic Sonoma orogeny. However, Silberling and Jones (1982) recognized that the Quinn River Formation held stratigraphic ties to the eastern Klamath terrane to the west and noted the absence of Late Permian to Early Triassic Sonoman deformation that strongly affected rocks of the Golconda allochthon to the east in north-central Nevada. These similarities to the eastern Klamath terrane (text-fig. 1; Miller 1989; Miller and Harwood 1990) also suggest that both are parts of the west-facing Klamath-Sierran arc of Burchfiel and Davis (1981). According to Jones (1990), the Black Rock terrane provides no direct evidence that links the eastern Klamath terrane arc rocks to those of the Permian Golconda allochthon. She also suggested that dissimilarities between the rocks of the Black Rock terrane and Poverty Peak subterrane of the Golconda allochthon (Jones and Jones 1990) and the absence of linking facies between them tend to rule out their juxtaposition during Permian to Early Triassic time.

Our detailed measurements and sampling of the Permian chert unit and overlying clastic and volcanoclastic rocks of the Quinn River



TEXT-FIGURE 1
Regional location map showing exposures of the eastern Klamath (EK), Jackson Mountains (JN), Black Rock (BRK), and Izee (IZ) terranes; QR represents the Permian and Triassic Quinn River Formation (text-fig. 2) exposed at the south end of BRK (modified from Silberling et al. 1987). Dashed line indicates possible depositional contact between Paleozoic and Mesozoic rocks of the Black Rock and Jackson terranes.

Formation indicate that: (1) all radiolarian faunas in the chert unit are younger than previously reported and are of latest Permian (Abadehian and Djulfian) age, (2) a similar Permian radiolarian fauna from the Dekkas Formation (cf. Coogan 1960) in the eastern Klamath terrane is of the same age, and not Guadalupian as previously reported, (3) the association of previously reported Wordian mesogondolellid conodonts with Abadehian and Djulfian radiolarians indicates that the conodonts are reworked, (4) the previously reported Early Triassic age for the lower part of the volcanoclastic unit cannot be substantiated because of the absence of conodonts, megafossils, and age-diagnostic radiolarians, (5) Late Triassic (Carnian) radiolarians from siliceous argillite collected approximately 21m below the top of the volcanoclastic unit extend the age of the formation into the Late Triassic, and (6) the Carnian radiolarian fauna suggests either that previously reported Middle Triassic conodonts from the upper part of the volcanoclastic unit are reworked or that part of the section is structurally disrupted. We also believe that the abrupt changes in lithology document disconformable contacts between the ferruginous dolomite and Permian chert and argillite unit and between the chert unit and the Triassic siltstone and carbonaceous shale unit; in addition, a number of faults probably occur in the volcanoclastic unit.

Quinn River Formation

The lowermost parts of the Quinn River Formation comprise a thin green siliceous tuff overlain by 2m of brown bioclastic limestone and 15m of ferruginous dolomite. Approximately 25m of Upper Permian, dark, radiolarian-bearing chert and interbedded shale and

argillite overlie the dolomite (text-figs. 3A, 3B, and 4A); this sequence (text-fig. 3B) represents the basal part of the measured section shown in text-figure 3A. The dolomite-chert contact is interpreted as disconformable because of the abrupt transition in lithology (text-fig. 4B). The lower part of the chert and argillite unit is thick bedded (some beds to 20 cm thick), gray, and partly buried by colluvium (text-figs. 3B and 4B). The middle part of this unit is mostly thin bedded and medium gray, with abundant lighter colored siliceous shale interbeds. The upper part of the unit is characterized by dark-brown to black chert exhibiting abundant pinch-and-swell structures and minor shale interbeds. At the top of the chert and argillite unit is approximately 1m of cherty argillite (text-fig. 3B). We believe that the contact with the overlying light-brown siltstone unit is disconformable because of the abrupt change in lithology to brown platy siltstone (text-figs. 3B and 4C). A 5-cm interval of calcite crystals and chert debris separates the cherty argillite and the overlying siltstone.

Approximately 22m of Triassic(?), thin, light-brown, platy siltstone, siliceous siltstone, and dark carbonaceous shale with minor cherty argillite (text-fig. 3A) overlie the Permian chert unit. The lower part of the platy siltstone and carbonaceous shale unit is partially covered by colluvium, and all samples from DR-1119 to -1123 (text-fig. 3A) were collected by trenching a meter or more through the colluvium cover.

Approximately 110m of partly volcanoclastic rocks that consist of siltstone and cherty siltstone, laminated siliceous shale, minor sandstone, and thin bands of radiolarian-bearing siliceous argillite conformably overlie the platy siltstone and carbonaceous shale unit (text-fig. 3A). The lowermost part of the volcanoclastic unit is represented by 5m of cherty siltstone and argillite and 22m of siltstone and minor shale containing a 2-m lens of brown, resistant tuffaceous sandstone. The middle part of the volcanoclastic unit contains approximately 23m of multicolored siliceous shale that grades upward into a 15-m package of siltstone and minor shale that, in turn, grades into an additional 15m of shale and minor siltstone. The upper part of the unit is characterized by approximately 5m of cherty siltstone and 19m of siltstone and minor shale. Minor lenses of radiolarian-bearing siliceous argillite occur throughout the middle and upper parts of the volcanoclastic unit. Approximately 6m of unfossiliferous brown sandstone and minor siltstone mark the uppermost part of our measured section (text-fig. 3A). Intervals with abrupt lithologic changes, some with minor slickensides, are shown as questioned fault zones in text-figure 3A.

The Permian age of rocks in the lower part of the Quinn River Formation has been known for more than 10 years (Silberling and Jones 1982). Ketner and Wardlaw (1981) reported that the lower ferruginous dolomite contains the Late Permian (early Guadalupian; cf. their fig. 3) brachiopods *Ctenolosisia fixata* Cooper and Stehli and *Stenocisma* sp. Jones (1990) reported that the brachiopods in the dolomite are of middle Guadalupian (late Wordian) age (text-fig. 5).

In the early 1980's, D. L. Jones identified radiolarians from chert beds above the dolomite simply as Permian (cf. Ketner and Wardlaw 1981; Silberling and Jones 1982). Jones et al. (1988) noted that the radiolarians in the chert are Guadalupian in age, and in a later study Jones (1990) provided a list of the radiolarian and conodont taxa (cf. her fig. 7). Her Permian radiolarian sample is a composite of three samples collected from 35 to 38m above the base of her section or 19 to 22m above the dolomite-chert contact (text-fig. 5; A. E. Jones, Kennecott Exploration, written commun. 1993).

Murchey and Jones (1992), in their study of mid-Permian chert, consider the fauna of the Quinn River chert and argillite unit reported by Jones (1990) to be of Guadalupian age. They conclude (p. 168) that the radiolarian fauna from a Quinn River sample collected by A. E. Jones was assignable to the middle or upper(?) part of the *Follicucullus scholasticus* Zone of Ishiga (1986, 1990; middle Guadalupian). They also "arbitrarily" placed the base of this zone at the base of the Wordian, and their text-figure 2 shows the Quinn River radiolarian fauna as encompassing a large part of the Guadalupian (upper half of the Wordian and all the Capitanian).

Willden (1964) was the first to assign a late Middle Triassic (Ladinian) age to the overlying clastic and volcanoclastic rocks on the basis of the pectenacids *Daonella* Mojsisovics and *Posidonia* Bronn and the ammonite *Protrachyceras* Mojsisovics found in the middle part of the volcanoclastic unit (N. J. Silberling, USGS, written commun., 1956, to Willden; also written commun., 1993). Ketner and Wardlaw (1981) also reported Ladinian pelecypods and ammonites as occurring several meters above the contact with the Permian chert-argillite unit. Silberling and Jones (1982) noted "primitive Triassic radiolarians" from these rocks, and Jones et al. (1988) reported an Early Triassic (Spathian) ammonite from stratigraphically high in the section.

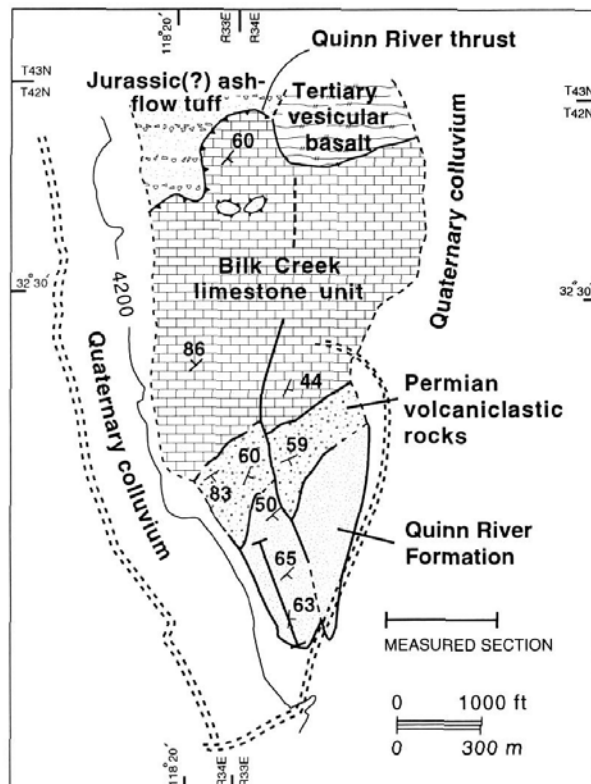
Jones (1990, her fig. 7) showed earliest Triassic radiolarians occurring at about 82m above the base of the formation (60m above the dolomite-chert contact in text-fig. 5), primitive spumellarians at about 110m (88m above the contact), and unidentified "primitive nassellarians" and a late Spathian to early Anisian ammonite ("acrochordiceratid" in Jones 1990, p. 251, = *Paracrochordiceratid* Spath, late early Anisian, Hugo Bucher, Université de Lausanne, written commun., 1992) from her locality 7 (her table 1, p. 243, and appendix 1) at about 145m (123m above the contact; text-fig. 5). Jones (1990) also reported unidentified Middle Triassic radiolarians and the Ladinian(?) conodont *Neogondolella* sp. cf. *N. constricta* Mosher and Clark (her appendix 1, p. 251; B. Wardlaw and A. G. Harris, USGS, written commun., 1988) from her locality 8 near the top of the formation (text-fig. 5).

New Permian Radiolarian Data

Only a few specimens of any taxon were recovered from each of our chert sample residues. Radiolarian preservation in samples from near the top of the Permian chert unit is poorer than for those lower in the section, and all samples in the argillite near the chert-siltstone boundary (text-fig. 3B) were barren. Examination of etched chert surfaces after hydrofluoric acid processing, a technique that typically results in greater abundance and diversity values in comparison to those for the dry residues (Blome and Reed 1993), did not reveal any additional taxa.

The same taxa generally appear throughout the Permian chert unit (text-figs. 3B and 6). Among the distinctive radiolarians found in all parts of this unit (from DR-1278 to -1104) are poorly preserved robust forms assignable to *Triplanospongos* sp. cf. *T. dekkasensis* (Noble and Renne) (Pl. 1, figs. 22, 23). In addition, *Hegleria mammilla* (Sheng and Wang) first appears near the base of the chert unit (DR-1094; Pl. 1, figs. 27, 28) and is common throughout.

Also present in various parts of the unit are poorly preserved forms assignable to *?Ormistonella* sp., *Ishigaum* sp. cf. *I. obesum*, *Ishigaum* sp., and *Deflandrella* sp. (text-fig. 6, Pl. 1). Caridroit and De Wever (1986, p. 57, 81) indicate that these latentifistulids occur with and above *Albaillella triangularis* Ishiga and Imoto and in the *Neobalbaillella ornithoformis* Zone.



TEXT-FIGURE 2

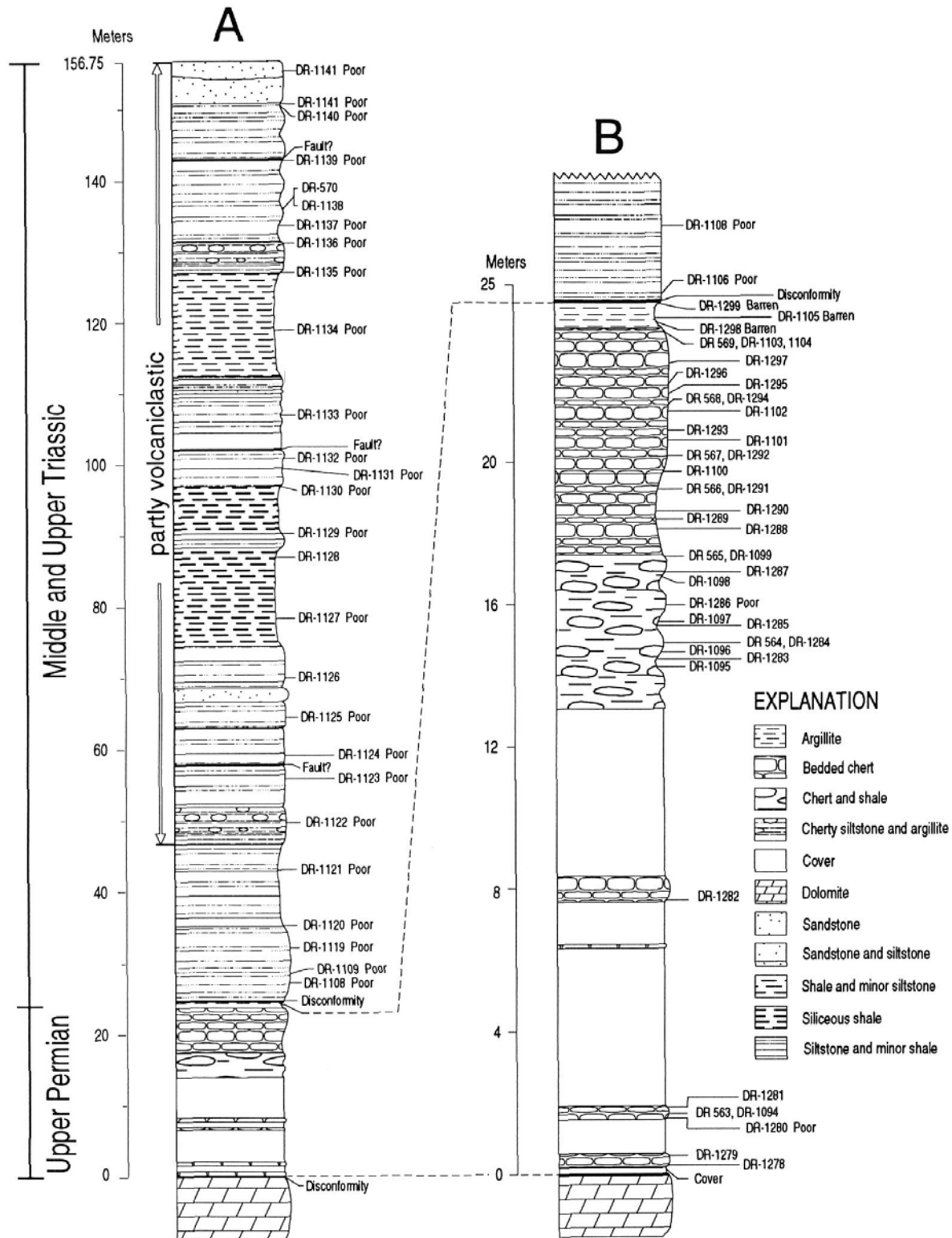
Geologic map of the southern end of the Bilk Creek Mountains near Quinn River Crossing, north-central Nevada (modified from Jones 1990; base map, Mustang Spring 7.5 min. quad., 1990).

Radiolarians we refer to as *Albaillella levis* Ishiga and Imoto, A. sp. cf. *A. levis*, and A. sp. cf. *A. triangularis* Ishiga and Imoto (Pl. 1) apparently are confined to the lower half of the section (DR-1278 to -565), from just above the dolomite-chert contact to the top of the chert-shale interval (text-fig. 3B). The spumellarians *Entactinia itsukaichiensis* Sashida and Tonishi (Pl. 1, figs. 25, 26) and *?Octatormentum* sp. cf. *O. floriferum* Sashida and Tonishi (Pl. 1, fig. 18) were also recovered from low in the Quinn River chert unit (DR-1282 and -564, text-fig. 6).

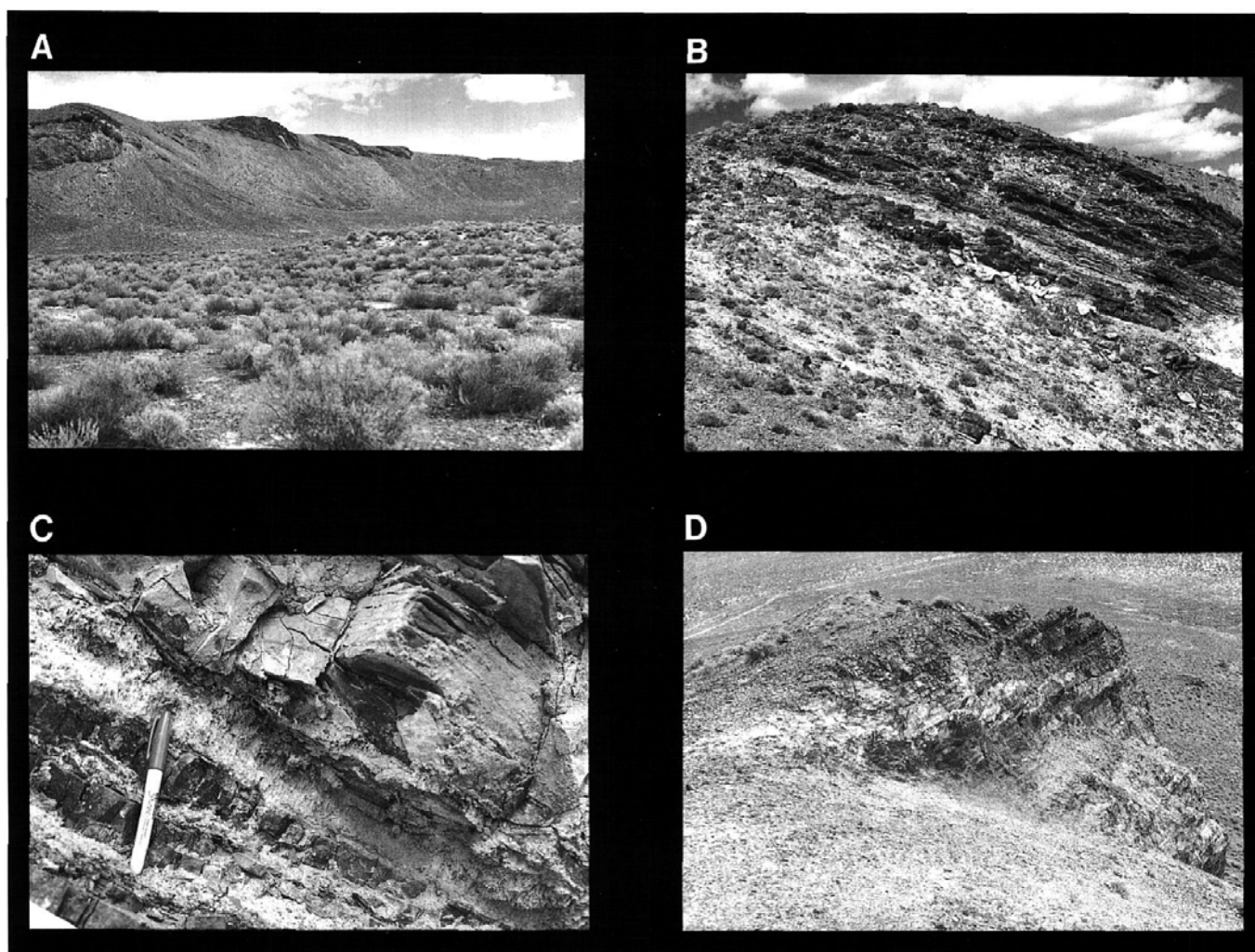
One incomplete specimen of *Neobalbaillella* sp. aff. *N. ornithoformis* Takemura and Nakaseko (1981) was found in sample DR-1294 (text-fig. 6; Pl. 1, fig. 5) about 3m below the contact with the overlying siltstone and carbonaceous shale (text-fig. 3B). We cannot conclude that this one specimen represents the first occurrence in the section because HF processing affects the recovery of many delicate forms (Blome and Reed 1993).

In addition to the taxa shown in text-figure 6, A. E. Jones (written commun., 1993) reported *Ruzhencevispongos girtyi*? Nazarov and Ormiston (1985), *Neobalbaillella*? sp., *Polyfistula* sp., and *Latentifistula* sp. from at interval approximately 18.5m above the dolomite-chert contact (text-fig. 5).

The radiolarian species we found in the Quinn River chert unit are characteristic of Late Permian faunas elsewhere. For example, *Albaillella levis* was reported by Ishiga et al. (1982b) as abundant in middle and upper Guadalupian and post-Guadalupian faunas in Japan, but, according to Ishiga et al. (1982a), the range of the



TEXT-FIGURE 3
(A) Measured lithostratigraphic section of lower chert, overlying siltstone and shale, and upper, partly volcaniclastic units of the Quinn River Formation, Black Rock terrane, north-central Nevada. Measurements begin at dolomite-chert contact. (B) Expanded view of the Upper Permian chert unit. All U.S. Geological Survey samples containing badly preserved and unidentifiable radiolarians denoted as "Poor".



TEXT-FIGURE 4

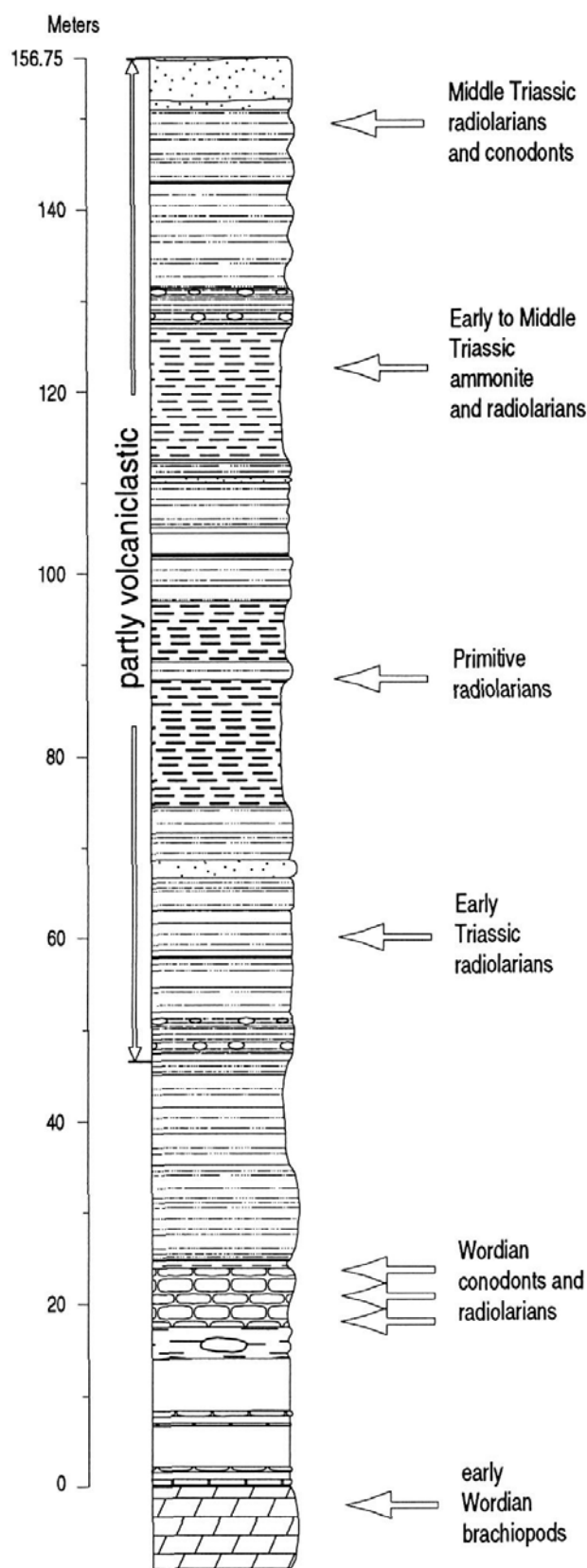
(A) Upper Permian ferruginous dolomite, Upper Permian chert unit, and overlying Triassic siltstone and shale and partly volcaniclastic units of the Quinn River Formation near Quinn River Crossing, Black Rock terrane, north-central Nevada. View to the southeast. Ferruginous dolomite is shown at left of the photo; chert forms the northwest flank of the first prominent hill at left of photo, whereas Triassic siltstone, shale, and partly volcaniclastic rocks form the other prominent ridges and saddles to the south. (B) Uppermost part of the ferruginous dolomite at bottom left corner of the photo and overlying, darker colored Permian chert unit. Note the large amount of cover in the lower part of the chert section. (C) Disconformable contact between the Upper Permian siliceous argillite and overlying lighter colored Triassic siltstone. The boundary is marked by a 5-cm interval of fine calcite crystals and chert debris. (D) Resistant beds of partly volcaniclastic siltstone and interbedded siliceous radiolarian-bearing argillite. U.S. Geological Survey samples DR-570 and -1138 (text-fig. 3A) were collected from near the top of this resistant ledge.

species was limited to the basal part of their Upper Permian *Neoalbaillella ornithoformis* Zone. Kozur and Mostler (1989) renamed this form *Imotella levis* (Ishida and Imoto) and list it in their *Neoalbaillella ornithoformis* Assemblage Zone, which they place in the upper part of the Djulfian (text-fig. 7). Ishida (1990) has integrated the fusulinacean work of Ishii (1990) and indicates that the lower part of his *N. ornithoformis* Zone is equivalent to the uppermost part of the *Nanlingella simplex* fusulinacean Zone (upper Kuman; text-fig. 7) and that the upper part of the *N. ornithoformis* Zone is equivalent to the whole of the *Palaeofusulina sinensis* - *Colaniella parva* fusulinacean Zone (latest Permian, Mitaian or Chiangxinian).

Sashida and Tonishi (1988) illustrated a fauna that contains some of the genera in the Quinn River Formation, including *Neoal-*

baillella and *Triplanospongos*; both faunas contain variations of *?O. floriferum*. They assigned their fauna to the upper Upper Permian *Neoalbaillella ornithoformis* Zone (Djulfian or Chiangxinian; text-fig. 7). Ishida et al. (1992, fig. 3) show the ranges of *Neoalbaillella ornithoformis*, *Albaillella levis*, *A. triangularis*, *Follicucullus scholasticus*, and others as overlapping but simply call the age Late Permian.

In our samples, we note two forms that are assigned to *Albaillella levis*. One has a smooth shell like that of the holotype, whereas the other possesses two or three large pores arranged vertically on the ventral side (Pl. 1, fig. 3 and fig. 8, respectively). Noble and Renne (1990) illustrated similar pored forms that they identified as *A. sp. aff. A. levis*. Other studies note similar pored forms (e.g., Kuwahara and Sakamoto 1992, pl. 3, fig. 8). We believe that some forms (Pl.



TEXT-FIGURE 5
Measured section showing the approximate stratigraphic positions of fossil-bearing horizons of Jones (1990) relative to the dolomite-chert contact in our measured section, Quinn River Crossing, Nevada (text-fig. 3B). See text-fig. 3 for explanation of lithologic patterns.

1, fig. 9) may represent a morphologic transition from *A. triangularis* to *A. levis* (see discussion and references in systematic section).

An approximately 10-m section in the Nabigawa Formation of the Mino belt yielded an abundant fauna that includes *Follicucullus scholasticus* Ormiston and Babcock, *F. ventricosus* Ormiston and Babcock, *Neobaillella optima* Takemura and Nakaseko, rare *Albaillella asymmetrica* Ishiga and Imoto, *A. sinuata* Ishiga and Imoto, *A. triangularis* Ishiga and Imoto, *A. levis*, *A. excelsa* Ishiga, Kito, and Imoto, and two new *Albaillella* species, *A. lauta* and *A. flexa*, in addition to *A. sp. aff. A. levis* (Wakita 1983; Kuwahara and Sakamoto 1992). Kuwahara and Sakamoto describe *A. sp. aff. A. levis* as having the shape of *triangularis* but a smooth outer surface. Their occurrence chart listing 36 samples shows the distribution of *Albaillella* species only, and it reconfirms the co-occurrence of *A. triangularis* and *A. levis*. *Albaillella sp. aff. A. levis* is present or queried throughout their section and is the only albaillellid in the upper part of the section. They demonstrate that their samples straddle the boundary of the *Neobaillella optima* and *N. ornithoformis* Zones (Ishiga 1986) and that *A. triangularis* and *A. levis* have short ranges that are restricted to the Late Permian.

Although Jones (1990) listed *Follicucullus scholasticus* and *F. ventricosus* as part of her fauna from the Quinn River Formation, she re-evaluated the fauna (A. E. Jones, written commun., 1993) and determined that the genus is not present. Not one fragment of *Follicucullus* was recovered in any of our samples. Follicucullids are an important element in Japanese Guadalupian (and younger) radiolarian faunas (cf. Sashida and Tonishi 1985; Takemura and Nakaseko 1981; Kuwahara and Sakamoto 1992). One Quinn River sample (82MR5) collected by B. L. Murchey (USGS, written commun., 1990) contained the long-ranging species *F. scholasticus* associated with *Albaillella sp. aff. A. levis*. Ishiga (1985) subdivided the species *F. scholasticus* Ormiston and Babcock into *F. scholasticus* morphotype I and *F. scholasticus* m. II. According to Ishiga (1990), the range of *F. scholasticus* m. I is from the *F. scholasticus* to *Neobaillella optima* Zones of Guadalupian to Djulfian age, whereas *F. scholasticus* m. II (= *F. japonicus* of Ishiga 1991a) ranges from the *F. monacanthus* through the *Neobaillella ornithoformis* Zones of early Guadalupian to late Djulfian age. Kozur and Mostler (1989) restrict the ranges of both morphotypes to the late Guadalupian (Capitanian; *F. ventricosus* to *Ishigaconus scholasticus* Zones), but the Japanese data suggest longer ranges.

We believe that the recovery of the radiolarians *Albaillella levis*, *A. sp. cf. A. levis*, and *A. sp. cf. A. triangularis* from the lower half of the chert unit, *Triplanospongos sp. cf. T. dekkasensis* from throughout the unit, and *Neobaillella sp. aff. N. ornithoformis* from near the top of the unit all substantiate an Abadehian and Djulfian age for the chert unit as a whole on the basis of the zonations (text-fig. 7) of Kozur and Mostler (1989), Ishiga (1990), and Ishii (1990).

NEW TRIASSIC RADIOLARIAN DATA

Radiolarian recovery in the upper volcaniclastic unit was poor (text-fig. 3A) with only four of the 27 samples yielding identifiable forms. Samples USGS DR-1108 to -1125 contained casts of spumellarians lacking spines or identifiable cortical shell meshwork and internal structures. Samples DR-1126 and -1128 contained poorly preserved, recrystallized forms that strongly resemble Early Triassic and early Middle Triassic (Anisian) nodose forms assign-

Late Permian Radiolarian Taxa from the Quinn River Formation	Sample No.																																			
	DR	1278	1279	563	1094	1281	1282	1095	1283	1096	564	1284	1285	1097	1098	1287	565	1099	1288	1289	1290	566	1291	1100	567	1292	1101	1293	1102	1294	1295	1296	1297	569	1103,4	
<i>Albaillella levis</i>																																				
<i>Albaillella</i> sp. cf. <i>A. levis</i>																																				
<i>Albaillella</i> sp. cf. <i>A. triangularis</i>						?																?														
<i>Deflandrella</i> sp.																																				
<i>Entactinia itsukaichiensis</i>																																				
<i>Hegleria mammilla</i>																														?			?			
<i>Ishigaum</i> sp. cf. <i>I. obesum</i>																																				
latentifistulids (fragments)											?											?				?										
<i>Nazarovella</i> sp. cf. <i>N. gracilis</i>																						?														
<i>Neoalbaillella</i> aff. <i>ornithoformis</i>																																				
? <i>Octotortum</i> cf. <i>floriferum</i>			?																																	
? <i>Ormistonella</i> sp.																																				
<i>Pseudotortum</i> sp.												?																								
<i>Triplanospongus</i> cf. <i>dekkasensis</i>																																				

TEXT-FIGURE 6

Occurrence chart of Upper Permian radiolarian taxa in the Quinn River chert samples. Field sample numbers and corresponding U.S. Geological Survey Denver Radiolarian Laboratory (DR) sample numbers are given.

able to the entactiniid genus *Cryptostephanidium* Dumitrica (1978). Several of these Quinn River forms resemble the taxa *Cryptostephanidium longispinosum* (Sashida) (cf. Sashida 1991) and *Cryptostephanidium* sp. cf. *C. verrucosum* Dumitrica (1978), both of which range through the Lower Triassic *Parentactinia nakatsugawaensis* (Pn) and lower Anisian *Hozmadia gifuensis* (Hg) Zones of Sugiyama (1992). Blome and Reed (1992, fig. 14, nos. 7-9) illustrated Early(?) Triassic unidentified entactiniid forms from the Grindstone terrane of east-central Oregon that resemble *Cryptostephanidium longispinosum* (Sashida).

Siltstone and shale samples from the upper part of the volcanoclastic unit contained mostly poorly preserved radiolarians; exceptions are samples DR-570 and -1138 (text-fig. 3A). Both samples, collected from approximately 21m below the top of the Triassic volcanoclastic section from an argillaceous siltstone interval, contained a moderately preserved Late Triassic (Carnian) radiolarian fauna (Pl. 2). This fauna is similar to faunas assigned by Yeh (1989) to her Carnian *Poulpus karnicus* and Norian *Corum parvum* Assemblages recovered from the Fields Creek Formation, Izee terrane of east-central Oregon (text-fig. 1). The taxa *Corum* sp. aff. *C. candidum* Yeh, *Gorgansium* sp. aff. *G. thayeri* Yeh, and *Xipha* sp. cf. *X. pessagno* (Nakaseko and Nishimura) (see Pl. 1) are common to the Quinn River and Fields Creek faunas. A form similar to *Corum* sp. aff. *C. candidum* Yeh was figured as *Corum speciosum* (Blome et al. 1989, pl. 33.1, fig. 19) from the Punupkahkroak Mountain section of the Otuk Formation, northern Alaska.

The Triassic fauna from the Quinn River Formation also contains marker taxa used to construct the Carnian to middle Norian *Triassocampe nova* Assemblage Zone of Yao (1982, 1990), including *Corum* sp. cf. *C. perfectum* Blome [= *Triassocampe*(?) sp. E

in Yao 1982, pl. 2, figs. 11-12], *Triassocampe* sp. C (Yao 1982, pl. 2, figs. 5-7; Yao 1990, pl. 1, fig. 12), *Triassocampe nova* Yao, and *Xipha* sp. cf. *X. pessagno* [= *Eucyrtidium*? *pessagno* (Nakaseko and Nishimura), Yao 1982, pl. 2, fig. 8]. The fauna also contains poorly preserved forms assignable to *Pseudostylosphaera* sp. (Pl. 2, fig. 19). Although the genus *Pseudostylosphaera* Kozur and Mostler (1981) has a published age range of Ladinian to Norian, the majority of its species are most abundant in Ladinian and Carnian strata. This fact prompted Blome et al. (1989) to erect a *Pseudostylosphaera* Zone for late Ladinian to middle Carnian taxa from the lower parts (shale and chert members) of the Otuk Formation of northern Alaska.

In addition, the Quinn River fauna lacks tests or robust spines belonging to the morphologically distinct radiolarian subfamily Capnodocinae Pessagno (in Pessagno et al. 1979; emend. Blome 1983) and family Capnuhosphaeridae De Wever (in De Wever et al. 1979; emend. Pessagno in Pessagno et al. 1979; emend. Blome 1984); both groups possess taxa with restricted age ranges of basal late Carnian to latest middle Norian in North America. Therefore, we believe the youngest strata in the upper part of the Triassic volcanoclastic unit are of early to middle Carnian age on the basis of the co-occurrence of taxa belonging to the nodose genus *Corum* Blome, along with *Pseudostylosphaera* sp., *Triassocampe nova* Yao, *Triassocampe* sp. C, and *Xipha* sp. cf. *X. pessagno* (Nakaseko and Nishimura), and the apparent absence of any taxa belonging to the Capnodocinae and Capnuhosphaeridae.

DISCUSSION

The results of detailed collection of radiolarian-bearing strata from the chert unit of the Quinn River Formation and comparisons of the faunas with other Late Permian faunas from Japan, Europe, and

elsewhere indicate that the chert unit is younger than Guadalupian, an age previously reported by Silberling and Jones (1982), Jones et al. (1988), Jones (1990), and Murchey and Jones (1992). There is no independent age control because of the absence of megafossils and rarity of conodonts, as is commonly the case with Paleozoic chert-rich units.

The Permian conodont fauna at Quinn River consists of a "corroded Pa element of *Neogondolella* sp. indet. of Wordian morphotype" (B. R. Wardlaw, USGS, written commun., 1988 to A. E. Jones) from a chert sample collected approximately 37.5m above the base of Jones' (1990) section (approx. 21m above the dolomite-chert contact, text-fig. 5) along with "well-preserved Permian (Guadalupian?) radiolarians". A. E. Jones (written commun., 1993) reported that these Wordian conodonts occur 3.3m above a chert sample containing the Late Permian radiolarian genera *Neobaillella* and *Trifidospongos* (= *Triplanospongos* Sashida and Tonishi). Additional conodonts (only Pa elements are listed), identified in another chert sample approximately 40m above the base (Jones 1990; approx. 23.5m above the dolomite-chert contact, text-fig. 5), included *Neogondolella phosphoriensis* (Youngquist, Hawley and Miller), *N.* sp. aff. *N. prolongata* Wardlaw and Collinson, and fragments of an unidentified *Neogondolella*. The named species are no younger than middle Wordian according to Wardlaw and Collinson (1986, text-fig. 5), but B. R. Wardlaw (USGS, written commun., 1988, to A. E. Jones) gave the age as early Wordian. If the upper conodont collection actually contained only Pa elements, then winnowing may have occurred during transport from an unknown Wordian (or younger) provenance. This, and the occurrence of Abadehian to Djulfian radiolarians stratigraphically below Wordian conodonts, indicate that the Permian Quinn River conodonts are reworked.

Although Jones (1990) reported the occurrence of *Follicucullus scholasticus* and *F. ventricosus* as part of her fauna, none was found in any of the samples. A. E. Jones (written commun., 1993) independently has concluded that follicucullids are not present at this locality. However, a Quinn River sample (82MR5) collected from the Quinn River Formation by B. L. Murchey (USGS, written commun., 1990) contained *F. scholasticus* as well as *Albaillella* sp. aff. *A. levis*.

Follicucullids also are an important element in other Guadalupian and younger faunas, such as those of the Baker and Grindstone terranes of east-central Oregon (Blome et al. 1986; Blome and Reed 1992) and coeval terranes of Japan (cf. Takemura and Nakaseko 1981; Sashida and Tonishi 1985; Kuwahara and Sakamoto 1992). Two coeval but taxonomically different Japanese faunas have been described; one is follicucullid-rich and the other follicucullid-poor but characterized by abundant albaillellids. Caridroit and De Wever (1986, p. 58) note that the richest fauna in samples from their locality Mt. 1 resembles that from the Japanese Ultra-Tamba Zone (clastic rocks) and Maizuru Group; all possess follicucullids but lack albaillellids. In contrast, Permian faunas reported from the Tamba Belt have few follicucullids in common with the Ultra-Tamba Belt, but contain the albaillellids *Albaillella levis* Ishiga and Imoto, *Neobaillella ornithoformis* Takemura and Nakaseko, *N. gracilis* Takemura and Nakaseko, and *N. optima* Ishiga and Imoto. According to Kozur and Mostler (1989), *A. levis* is restricted to rocks of deep-water facies. Caridroit and De Wever (1986) attribute these differences among coeval faunas to paleogeographic factors (see also discussion in Sashida and Tonishi 1988, p. 526; Ishiga and Miyamoto 1986, p. 332). The scarcity or absence of follicucullids at Quinn River Crossing suggests that the fauna may be of Tamba Belt aspect.

Although the thick pile of Permian volcanoclastic rocks and lava flows of the Dekkas Formation (eastern Klamath terrane, text-fig. 1) is not present at Quinn River Crossing, the gray to black chert and argillite of the Quinn River Formation have been correlated with the red and maroon Dekkas cherty rocks (Miller 1989; Jones 1990; Noble and Renne 1990). The Dekkas Formation is a sequence greater than 5 km thick of volcanoclastic rocks and lava flows that overlies the Leonardian and early Guadalupian Nosoni Formation (Jones 1990, p. 248). Miller (1989) and Miller and Harwood (1990) suggested that the Nosoni and Dekkas must have been deposited in a short period (approximately 4m.y.) because the upper part of the Nosoni contains latest Leonardian fusulinids and the upper part of the Dekkas contains early Guadalupian brachiopods and radiolarians. However, J. T. Dutro (USGS, oral commun., 1993) states that the brachiopods are from the top of the lower one-third of the Dekkas Formation. Miller and Harwood (1990) also suggest that the Quinn River bedded chert may be a lateral equivalent of the Dekkas Formation.

Noble and Renne's (1990, pl. 1) radiolarian fauna from chert near the middle and top parts of the Minnesota Member (lower part of the Dekkas Formation; Renne 1987) contains many of the genera found in the Quinn River Formation, including their new genus *Trifidospongos* (= *Triplanospongos* Sashida and Tonishi), *Hegleria* Nazarov and Ormiston, *Polyfistula* Nazarov and Ormiston, *Ishigaum* De Wever and Caridroit, *Albaillella levis*, and *Albaillella* sp. A. We believe that their *Albaillella* sp. A is a junior synonym of *A. sp. cf. A. triangularis* Ishiga and Imoto (Ishiga et al. 1982b, pl. 1, text-fig. 6). The samples shown in their figure 4 come from at least four different localities, and the placement in their "generalized stratigraphic column" is not precise (P. Noble, Sacramento State Univ., written commun., 1993). Noble and Renne (1990, p. 379; cf. Coogan 1960) stated that their radiolarians are no older than early Guadalupian on the basis of fusulinaceans (*Parafusulina* spp.) collected from an interval in the upper part of the Nosoni Formation about 100m below their radiolarians. The *Parafusulina* species closely resemble the fusulinaceans described from the early Guadalupian Word Formation in west Texas. The highly advanced fusulinacean *Parafusulina juncea* Skinner and Wilde (1965, p. 93) was described from the upper beds of the Nosoni Formation and also reported by Coogan (1960, p. 278) from the Dekkas Formation. Skinner and Wilde consider its age to be early Guadalupian. The range of the genus *Parafusulina* is early Leonardian to late Wordian-early Capitanian (M. K. Nestell, Univ. of Texas at Arlington, oral commun., 1993). The Abadehian and Djulfian Quinn River radiolarian faunas and their similarity to the Dekkas faunas indicate that a part of the Dekkas Formation may well be significantly younger than previously reported and is distinctly younger than the underlying Nosoni Formation.

Cheng (1989) described similar Permian radiolarian assemblages from the Philippine Islands and assigned them to the Djulfian *Neobaillella optima* or *N. ornithoformis* Zones of Ishiga (1986; Fig. 7) but inferred that the age of the fauna is Guadalupian/Kazanian. Wang (1991, p. 248) illustrated a chert fauna containing many of the Quinn River faunal elements, such as *Albaillella excelsa*, *A. levis*, *A. triangularis*, and *Neobaillella* sp. from Upper Permian strata in southwest China that he assigned to the "*Neobaillella* Zone".

The presence of the variant form of *Albaillella levis* (with pores) in the Quinn River material strengthens the correlation of Quinn River and Dekkas Formation faunas with those of the Philippine Islands and the Sasayama section in southwest Japan. Given the plasticity of some Permian radiolarians (Ishiga 1991b), however,

SERIES	UPPER PERMIAN												
North American Stages/Series	GUADALUPIAN*			DZHULFIAN*									
	Wordian	Capitanian	Amarassian	Araksian	Chhidruan	Changhsingian							
<i>Albaillella levis</i> and <i>A. sp. cf. A. levis</i> ? -----													
<i>Albaillella triangularis</i> and <i>A. cf. triangularis</i> ? -----													
<i>Deflandrella</i> -----													
<i>Hegleria</i> ? -----													
<i>Ishigaum</i> -----													
<i>Nazarovella</i> ? ---													
<i>Neobaillella sp. aff. N. ornithoformis</i> ? -----													
<i>Ormistonella</i> ? -----													
<i>Pseudotormetus</i> ---													
<i>Triplanospongos</i> ? -----													
European Rad. Zones (Kozur and Mostler, 1989)	Wordian		Capitanian		Abadehian		Djulfian		Chiangxinian				
	<i>Parafollicucullus fusiformis</i> - <i>P. globosa</i> A. Zone		<i>Follicucullus monacanthus</i> Zone		<i>F. ventricosus</i> - <i>Ishigaconus scholasticus</i> Assemb. Zone		<i>F. charveti</i> - <i>Imotoella triangularis</i> Assemblage Zone		<i>N. optima</i> - <i>Imotoella triangularis</i> Assem. Zone		<i>Neobaillella ornithoformis</i> Assemb. Zone		<i>N. grypa</i> Zone
Japanese Rad. Zones (Ishiga, 1990)	Artinskian		Kazanian/Akaskan			Kuman/Wuchiapingian					Mitaian		
	<i>Pseudoalbaillella longtanensis</i> Zone		<i>Pseudoalbaillella globosa</i> Zone		<i>F. monacan.</i> Zone	<i>F. schol. m. l</i> Zone	<i>Follicucullus japonicus</i> Zone		<i>Neobaillella optima</i> Zone			<i>Neobaillella ornithoformis</i> Zone	
Fusulinacean Zones (Ishii, 1990)	← (OTHER ZONES)		<i>Neo. crat.**</i> Zone	<i>Colania douvillei</i> Zone	<i>Lepidolina multisepta shiraiwaensis</i> Zone		<i>Lepidolina kumaensis</i> Zone		<i>Nanlingella simplex</i> Zone			<i>Palaeofusulina sinensis</i> - <i>Colaniella parva</i> Zone	

TEXT-FIGURE 7

Established ranges (solid lines) for Late Permian taxa recovered from the Quinn River Formation and a comparison of coeval European and Japanese radiolarian and fusulinacean zonations. Potential range extensions shown as dashed lines. Note the contrasting ages of the supposedly correlative *N. ornithoformis* (Kozur and Mostler 1989) and *N. optima* Zones (Ishiga 1990). Kozur and Mostler (1989, p. 231) indicate that the base of their *N. ornithoformis* Assemblage Zone is defined by the occurrence of the conodont *Gondolella orientalis* Barskov and Koroleva. *Guadalupian and Dzhulfian Series and Stages of Wardlaw et al. 1979. ***Neoschwagerina craticulifera* Zone of Ishii 1990.

the taxonomic or biostratigraphic significance of this morphotype of *A. levis* is not clear. Caridroit and De Wever (1986, p. 58) note that *A. triangularis* of Ishiga et al. (1982b) is intermediate between *A. sp. C* of Ishiga and Imoto (1980) and *A. levis* of Ishiga et al. (1982b).

Yoshida and Murata (1985), Murchey (1989), and Blome and Reed (1992) all report co-occurrences that could extend the ranges of some Permian taxa. If the fauna from the Quinn River Formation is of Abadehian and Djulfian age (Araksian and Chhidruan of Wardlaw et al. 1979), some adjustments of published ranges may be required. For example, in their discussion of Tethyan Permian faunas, Kozur and Mostler (1989, p. 230) noted *Hegleria* (= *Phaenicosphaera* Sheng and Wang) as occurring in upper Capitanian strata, but they put *Deflandrella* and *Ishigaum* in the Abadehian (post-Capitanian but pre-Djulfian; *Lepidolina kumaensis* fusulinid Zone; text-fig. 7). Forms belonging to all these genera occur at the same interval in the Quinn River section. Kozur (1993) indicates that the range of *Hegleria* extends into the Chiangxinian (text-fig. 7). Nevertheless, it is possible that the ranges of some taxa in North American Permian strata differ from those in Japan (Blome and Reed 1992).

Jones (1990) indicated that a large part of the Triassic volcanoclastic rocks at Quinn River Crossing is of Early Triassic age on the basis of primitive radiolarians found 70m below strata containing an Early to early Middle Triassic (late Spathian to early Anisian) ammonite (text-fig. 5). The poorly preserved forms from the middle part of the volcanoclastic unit (DR-1126 and -1128, text-fig. 3) resemble the late Early and early Middle Triassic radiolarians *Cryptostephanidium longispinosum* (Sashida; cf. Sashida 1991) and *Cryptostephanidium sp. cf. C. verrucosum* Dumitrica (1978) and suggest an Early Triassic to early Middle Triassic (Anisian) age for the lower part of the unit. Sugiyama (1992) showed that these forms range through the Lower Triassic *Parentactinia nakat-sugawaensis* (Pn) and lower Anisian *Hozmadia gifuensis* (Hg) Zones in Japanese strata.

Ketner and Wardlaw (1981) reported Ladinian pelecypods and ammonites several meters above the contact with the Permian chert unit, but N. J. Silberling (USGS, written commun., 1956, to Willden; also written commun., 1993) indicated that late Middle Triassic (Ladinian) pectenacids (*Daonella*, *Posidonia*) and the ammonite *Protrachyceras* were collected from the middle part of the sequence. The sharp disconformable contact between the chert

and volcanoclastic units, absence of definite Early Triassic fossils in the lower part of the volcanoclastic unit, and recovery of Early Triassic to early Middle Triassic (Anisian) radiolarians and late Middle (Ladinian) pectenacid bivalves and ammonite in the middle part of the sequence all suggest that the Early Triassic may not be represented in the Quinn River Crossing section.

At least some of the volcanoclastic unit is of early Late Triassic age, as shown by moderately preserved early to middle Carnian radiolarians recovered from argillaceous siltstone 135m above the dolomite/chert contact and 21m below the top of the section (DR-570 and -1138, text-fig. 3A). These data conflict with the report of Middle Triassic radiolarians and a Ladinian(?) conodont from near the top of the formation (Jones 1990; text-fig. 5). These biostratigraphic anomalies suggest either that the conodont and radiolarian faunas from the upper part of the section are misdated or, more likely, that this part of the volcanoclastic unit is faulted and structurally repeated. Other questioned faults occur in the lower and middle parts of the volcanoclastic unit as well (text-fig. 3A).

The Pit Formation overlies the Dekkas Formation and contains sparsely fossiliferous, siliceous argillite, siliceous tuffs, turbidites, and radiolarian-bearing hemipelagic sedimentary rocks in its lower part. Noble and Renne (1990, p. 382-383) suggested that the Pit could be divided into three informal members: (1) a lower member characterized by tuffaceous cherts and localized flows; "locally a gray-green mud-rich radiolarian chert marks the basal contact", (2) a middle member containing organic and pyritic shales and minor tuff, and (3) an upper member that consists of volcanoclastic sedimentary rocks with rare conglomerates containing chert and mudstone clasts derived from the underlying Dekkas Formation.

Silberling and Jones (1982) were the first to note the age similarities between the lower strata of the Pit Formation near Lake Shasta and the Quinn River radiolarian-bearing siliceous tuffs that overlie the Permian bedded chert. The Pit Formation is generally considered to be Middle and Late Triassic in age on the basis of ammonites and brachiopods in the shale and limestone (Diller 1906; Albers and Robertson 1961). Silberling and Jones (1982) had reported Permian radiolarians in tuffaceous chert from the basal part of the Pit. However, Noble and Renne (1990) have noted that radiolarians from the basal part of the Pit are too poorly preserved to be age-diagnostic and that the fauna contains only spumellarians with simple, rod-like spines of possible Early Triassic age and conodonts assigned to *Neogondolella* of either Late Permian or Early Triassic age. Miller and Harwood (1990) also tentatively identified Early Triassic radiolarians from the lower part of the Pit Formation in addition to Middle Triassic radiolarians from the overlying Brock Shale in the northern part of the eastern Klamath terrane.

CONCLUSIONS

The ages of the brachiopod, conodont, and radiolarian faunas from the Quinn River Formation discussed in this report are similar to those of the Dekkas and Pit Formations in the eastern Klamath terrane of northern California. Jones (1990) suggested that these strong similarities indicate that these units were deposited in the same Permian and Triassic sedimentary basin under similar paleo-environmental conditions. For example, a similar hiatus may be recorded between Wordian and latest Permian deposition, as shown by Wordian brachiopods and Abadehian and Djulfian radiolarians, in the Quinn River and possibly in the Dekkas sections. At the Quinn River locality, the absence of pre-Abadehian fossils between the first occurrence of *Triplanospongos* and the underlying Wordian dolomite indicates that the chert/dolomite contact represents a disconformity at which the Capitanian is missing. The same hiatus

could be present in the Dekkas on the basis of Wordian brachiopods from limestone lenses and our revised Abadehian and Djulfian ages of the radiolarian fauna reported by Noble and Renne (1990). Whereas Miller (1988) proposed that deformation of the Paleozoic sequence in the eastern Klamath terrane occurred prior to deposition of the Triassic Pit Formation and that a structural break occurs at the Permian-Triassic boundary, the occurrence of Abadehian and Djulfian radiolarians in the upper part of the Dekkas would invalidate Miller and Harwood's (1990) statement that no post-middle Guadalupian rocks are present in the eastern Klamath terrane.

Although questionable Early Triassic radiolarians have been reported from parts of the Quinn River and Pit Formations, the faunal evidence to substantiate Early Triassic deposition in both units is problematic and is based only on the presence of low-diversity faunas containing spumellarians with simple, rod-like spines. Whereas an Early Triassic age cannot be ruled out, the occurrence of an Anisian ammonite with these "primitive" spumellarians in the middle part of the Quinn River section and the apparent disconformity between the chert and overlying siltstone and carbonaceous shale units suggest that Early Triassic deposition is probably not represented in the Quinn River Formation at Quinn River Crossing. Like Noble and Renne (1990), we question the Early Triassic age of the lower part of the Pit Formation on the basis of the same poorly preserved "primitive" radiolarian faunas and long-ranging (Late Permian and Early Triassic) neogondolellid conodont faunas (Jones 1990; Miller and Harwood 1990).

Finally, faunal evidence to support Middle and Late Triassic ages for the Quinn River volcanoclastic unit is extensive, ranging from the Ladinian ammonite *Protrachyceras* and pectenacid bivalves *Daonella* and *Posidonia* in the middle part of the section to Ladinian(?) radiolarians and conodonts and Carnian radiolarians in the upper 21m of the section. The occurrence of Carnian radiolarians in the Quinn River Formation and Late Triassic fossils in the Pit Formation strengthens the correlation between these two units and suggests that deposition of both units may have terminated in early Late Triassic time as the Pit Formation is overlain by the Upper Triassic (Carnian) Hosselkus Limestone and Upper Triassic Brock Shale (see Miller and Harwood 1990, for references).

SYSTEMATIC PALEONTOLOGY

The following is an abbreviated systematic discussion of the Late Permian and Late Triassic radiolarian taxa found in the chert and volcanoclastic units of the Quinn River Formation. Refer to Blome and Reed (1992) for complete synonymies for most of the Permian taxa discussed below.

European stage names are used throughout unless otherwise noted.

Permian Radiolarians

Genus *Albaillella* Deflandre 1952

Type species: *Albaillella paradoxa* Deflandre 1952

Albaillella levis Ishiga and Imoto

Plate 1, figure 3

Albaillella levis Ishiga and Imoto 1982 (in Ishiga et al. 1982b), p. 17, plate 3, figs. 1-4.

Remarks: This specimen exhibits a smooth conical test and strong ventral spine, but lacks evidence of the H-frame structure.

Range: Upper Permian (Djulfian through lower Changxianian).

Occurrence: Japan, Philippine Islands, and western North America.

Albaillella sp. cf. *A. levis* Ishiga and Imoto
Plate 1, figures 1, 2, 4, 7-11

Albaillella levis Ishiga and Imoto 1982 (in Ishiga et al. 1982b), p. 17, pl. 3, figs. 1-4.
Albaillella sp. A in Ishida et al. 1992, pl. 1, fig. 5.

Remarks: Two morphotypes are assignable to *Albaillella levis*. One has a smooth shell like that of the holotype whereas the other possesses two or three large pores arranged vertically on the ventral side (cf. Pl. 1, fig. 3 versus fig. 8). Noble and Renne (1990) illustrated similar pored forms they identified as *A. sp. aff. A. levis*. The *A. sp. A* in Ishida et al. (1992, pl. 1, fig. 5) exhibits only one pore (possibly two) ventrally and several pores in the central part of the test, similar to our specimen in Pl. 1, fig. 1. Pores in ventral positions are also found on *A. triangularis* Ishiga and Imoto (Pl. 1, fig. 4 versus fig. 6).

Kozur and Mostler (1989) place *A. levis*, *A. excelsa* Ishiga and Imoto, and ?*A. triangularis* Ishiga and Imoto in their new genus *Imotoella* on the basis of their manner of growth toward the aperture and the strong ventral spine.

Range: Upper Permian (Guadalupian and younger).

Occurrence: Japan and western North America.

Albaillella sp. cf. *A. triangularis* Ishiga and Imoto 1982 (in Ishiga et al. 1982b)
Plate 1, figure 6

Albaillella triangularis Ishiga and Imoto 1982, p. 17, pl. 2, figs. 8-11.

Remarks: This form has the pronounced transverse bands and strong ventral spine of the species, but has a more massive "vane" along dorsal and ventral margins. It also resembles the *Albaillella* sp. A of Noble and Renne (1990, pl. 1, figs. 18 and 19). None of the Quinn River specimens preserves the dorsal, blade-like part of the H-frame. Our specimens are similar to *Albaillella* sp. C in Ishiga and Imoto (1980, pl. V, figs. 11-16) but lack the pores near the aperture.

Albaillella triangularis differs from *A. levis* by having distinct transverse bands. Ishiga et al. (1982b, pl. III, figs. 5-8) illustrate specimens of *A. triangularis* that have pores along the dorsal side and along one band. We believe that some forms (cf. Pl. 1, fig. 9) may represent a morphologic transition from *A. triangularis* to *A. levis*.

Range: Upper Permian (Guadalupian?; Abadehian to mid-Djulfian); also *Follicucullus charveti-Imotoella triangularis* Assemblage Zone of Kozur and Mostler (1989; text-fig. 7); lower Abadehian.

Occurrence: Europe, Japan, Philippine Islands, and western North America.

Genus *Deflandrella* De Wever and Caridroit 1984
Type species: *Deflandrella manica* De Wever and Caridroit 1984

Deflandrella sp.
Plate 1, figures 15, 19

Remarks: The characteristic trumpet shape of the rays and at least two of the four central pores are illustrated in fig. 19. Other perforations and the ray chambers are not visible.

Range: Upper Permian; *Follicucullus charveti-Imotoella triangularis* Assemblage Zone of Kozur and Mostler (1989; text-fig. 7), Abadehian; *Neoalbaillella ornithoformis* Zone of Ishiga (1990; text-fig. 7); Djulfian. *Deflandrella* may extend into the Guadalupian because it commonly occurs with *Pseudoalbaillella fusiformis* (Holdsworth and Jones) in Oregon. Blome and Reed (1992) suggested that either *P. fusiformis* extends into the Djulfian or that *Deflandrella* and other latentifistulids are older in Oregon than in Japan (cf. Ishida et al. 1992.)

Occurrence: Europe, Japan, Philippine Islands, and western North America.

Genus *Entactinia* Foreman 1963
Type species: *Entactinia herculea* Foreman 1963

Entactinia itsukaichiensis Sashida and Tonishi 1985
Plate 1, figures 25, 26

Entactinia itsukaichiensis Sashida and Tonishi 1985, p. 9-10, pl. 1, figs. 1-10.

Remarks: Our poorly preserved and broken specimens still retain the small spherical shell possessing the thorny by-spines and robust, three-bladed main spines.

Range: Upper Permian, *Neoalbaillella grypa* Zone of Kozur and Mostler (1989; text-fig. 7), Chiangxinian; may range into older zones because it occurs with *Deflandrella* as well as with pseudoalbaillellids.

Occurrence: Japan and western North America.

Genus *Hegleria* Nazarov and Ormiston 1985
Type species: *Hegleria mammilla* (Sheng and Wang) 1985

Hegleria mammilla (Sheng and Wang)
Plate 1, figures 27, 28

Phaenicosphaera mammilla Sheng and Wang 1985, p. 179, pl. 3, figs. 7-8.
Hegleria mammifera Nazarov and Ormiston 1985, p. 22, pl. 6, figs. 3-5.

Remarks: The Quinn River morphotypes possess less inflated mammae than the morphotypes figured by Sheng and Wang, Nazarov and Ormiston (1985), and Blome and Reed (1992, fig. 11, nos. 10, 12) but otherwise conform to the specific diagnosis.

Range: Upper Permian (middle and upper Guadalupian through Djulfian; text-fig. 7).

Occurrence: China and western North America.

Genus *Ishigaum* De Wever and Caridroit 1984
Type species: *Ishigaum trifustis* De Wever and Caridroit 1984

Ishigaum sp. cf. *I. obesum* De Wever and Caridroit
Plate 1, figure 21

Ishigaum obesum De Wever and Caridroit 1984, p. 81, pl. III, (figs.) 6, 7.

Remarks: The length and width of the preserved ray resemble the morphotypes figured in Caridroit and De Wever (1984, plate III, fig. 7) but differ by having a less massive distal part of the arm and narrower spongy structure.

Range: Upper Permian (Capitanian through Djulfian).

Occurrence: Japan, China, Philippine Islands, and western North America.

Ishigaum sp.

Plate 1, figure 20

Remarks: The specimen is too poorly preserved to be identified to the species level.

Range: Upper Permian.

Occurrence: Northern Nevada.

Unidentifiable Latentifistulids

Fragments of tubular arms are common in many of the radiolarian dry residues from the Quinn River Formation. Similar forms have been reported by Ishiga and Miyamoto (1986; unnamed spumellarian, pl. 64, fig. 18) and Cheng (1989; *Pseudotormentus*?, pl. 2, fig. 13). Some of the fragments consist of a hollow tube with a regular mesh exterior and terminate in a slightly inflated, bilaterally symmetrical tip; the mesh pores are larger at the tip. Another type of fragment could be assigned to *Pseudotormentus kamigoriensis* De Wever and Caridroit or perhaps *Nazarovella scalae* De Wever and Caridroit, but all rays are extremely fragile and all are broken.

Genus *Nazarovella* De Wever and Caridroit 1984

Type species: *Nazarovella gracilis* De Wever and Caridroit 1984

Nazarovella sp. cf. *N. gracilis* De Wever and Caridroit

Plate 1, figure 12

Nazarovella gracilis De Wever and Caridroit 1984, p. 82-83, pl. IV, 9-15.

Remarks: The imperforate rays and gutter on our Quinn River specimens closely resemble those described as *N. gracilis*. The distal parts of rays do not suggest the development of beams as with *N. scalae* De Wever and Caridroit (1984).

Range: Lower to Upper Permian (through Djulfian).

Occurrence: Worldwide.

Genus *Neobaillella* Takemura and Nakaseko 1981

Type species: *Neobaillella ornithoformis* Takemura and Nakaseko 1981

Neobaillella sp. aff. *N. ornithoformis* Takemura and Nakaseko

Plate 1, figure 5

Neobaillella ornithoformis Takemura and Nakaseko 1981, p. 211-213, pl. 33, figs. 1-6 and text-fig. 2; Ishiga, Kito, and Imoto 1982b, p. 15-16, pl. 1, figs. 6-8; pl. 2, fig. 1.

Remarks: This Quinn River specimen differs from *N. ornithoformis* by lacking the wide, triangular dorsal and ventral wings. Although our lone specimen is badly preserved, the amount of curvature of the apical cone distinguishes it from *N. grypus* Ishiga and Imoto (in Ishiga et al. 1982b). There is no evidence of connections between the side spines and the stout spines at the base of the apical cone as in *N. optima* Ishiga and Imoto (in Ishiga et al. 1982b); the apical cone is less perforated than is typical for *N. optima*. The short projection low on the ventral side of the figured specimen may be a remnant of the lower part of the beak of *N. ornithoformis*.

Range: Upper Permian; *Neobaillella ornithoformis* Zone of Ishiga (1986); *Neobaillella ornithoformis* Zone of Kozur and Mostler (1989), mid-Djulfian and Chiangxinian/Mitaian (text-fig. 7).

Occurrence: Japan, China, and western North America.

Genus *Octatormentum* Nazarov and Ormiston 1985

Type species: *Octatormentum cornelli* Nazarov and Ormiston 1985

?*Octatormentum* sp. cf. *O. floriferum* Sashida and Tonishi 1988

Plate 1, figure 18

Octatormentum floriferum Sashida and Tonishi 1988, p. 533-536, pl. 10, figs. 1-4.

Remarks: The protuberances surrounding the primary spines are more cylindrical than those of *O. floriferum* Sashida and Tonishi. Internal structures are not visible in our single specimen. The assignment of this form to *Octatormentum* is questioned because the test is spherical, similar to *Tetratormentum globiforme* Sashida and Tonishi (1988, fig. 10, nos. 11, 12), and is not bipyramidal.

Range: The genus is listed in Kozur and Mostler (1989) as a component of the *Follicucullus ventricosus* - *Ishigaconus scholasticus* Assemblage Zone (Capitanian; text-fig. 7). However, Sashida and Tonishi (1988) report *Octatormentum* and *Tetratormentum* from a radiolarian assemblage containing *Albaillella levis*, *Neobaillella ornithoformis*, and others characteristic of the *Neobaillella ornithoformis* Assemblage Zone (Ishiga 1990) of Djulfian or younger age.

Occurrence: Japan and western North America.

Genus *Ormistonella* De Wever and Caridroit 1984

Type species: *Ormistonella robusta* De Wever and Caridroit 1984

Remarks: We question Schwartzapfel's (1990, p. 268) expansion of the range of *Pseudotormentus* into the lower part of the Carboniferous (Chesterian).

?*Ormistonella* sp.

Plate 1, figure 24

Remarks: This taxon is rare in our material, but the large size and tetrahedral arrangement of the four rays are similar to that of *Ormistonella*. Our figured specimen has perforations on two rays similar to the latentifistulid illustrated in fig. 13, no. 21 in Blome and Reed (1992).

Range: Same as for the genus *Deflandrella*.

Occurrence: Worldwide.

Genus *Pseudotormentus* De Wever and Caridroit 1984

Type species: *Pseudotormentus kamigoriensis* De Wever and Caridroit 1984

Remarks: We question Schwartzapfel's (1990, p. 271) expansion of the range of *Ormistonella* into the lower part of the Carboniferous (Chesterian).

Pseudotormentus sp. cf. *P. kamigoriensis*

Plate 1, figures 13, 14, 16, 17

Pseudotormentus kamigoriensis De Wever and Caridroit 1984, p. 85-86, pl. V, 7-11.

Remarks: Only fragments of the central part of the skeleton are preserved in the Quinn River faunas; the swollen central knob, Y-arrangement of the three arms, and vestiges of the three beams on distal parts of the rays are generally visible. The simplicity of the perforations between beams, even though near the central part of the individuals, superficially resembles the arrangement of beams and mesh in *Nazarovella scalae*, but this genus possesses one arm perpendicular to the three co-planar arms.

Range: Lower to Upper Permian.

Occurrence: Japan, China, and western North America

Genus *Triplanospongos* Sashida and Tonishi 1988

Type species: *Triplanospongos musashiensis* Sashida and Tonishi 1988

Triplanospongos sp. cf. *T. dekkasensis* (Noble and Renne)

Plate 1, figures 22, 23

Trifidospongos dekkasensis Noble and Renne 1990, p. 338-389, pl. I, figs. 1-6.

Remarks: The Quinn River forms do not possess the bars connecting the paired central beams on each ray that are characteristic of *T. dekkasensis*.

Range: Upper Permian (Guadalupian?, Noble and Renne 1990; Abadehian to lower Chiangxinian).

Occurrence: Japan, the Philippine Islands, and western North America.

Triassic Radiolarians

Genus *Canesium* Blome 1984

Type species: *Canesium lentum* Blome 1984

Canesium sp.

Plate 2, figures 7, 8, 29

Remarks: These forms differ from *C. lentum* Blome (1984, p. 53, pl. 14, figs. 3, 8, 11) by possessing a post-abdominal chamber that is less inflated and more irregular (polygonal) in outline. The cephalis, thorax, and abdomen of these forms, like those of *C. lentum*, are covered by an outer layer of microgranular silica.

Range: Upper Triassic (middle Carnian to middle Norian or Alalaunian; *Triassocampe nova* Assemblage Zone of Yao 1982, 1990) as far as known.

Occurrence: Northern Nevada.

Genus *Canoptum* Pessagno (in Pessagno et al. 1979)

Type species: *Canoptum poissoni* Pessagno (in Pessagno et al. 1979)

Canoptum sp. aff. *C. laxum* Blome 1984

Plate 2, figures 27, 28

Canoptum laxum Blome 1984, p. 47-48, pl. 11, figs. 9, 14.

Remarks: This form differs from *C. laxum* by possessing chambers with less inflated circumferential ridges.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Genus *Corum* Blome 1984

Type species: *Corum speciosum* Blome 1984

Corum sp. aff. *C. candidum* Yeh 1989

Plate 2, figures 13, 14

Corum candidum Yeh 1989, p. 69, pl. 9, figs. 7, 8, 20, 21.

Remarks: These forms are similar to those figured by Yeh (1989) in exhibiting a large number of post-abdominal chambers but differ by having more irregularly inflated costae. Our specimens (Pl. 2, figs. 13, 14) show the characteristic narrow final post-abdominal chamber similar to those figured by Yeh (1989, pl. 9, figs. 7, 8).

Range: Yeh (1989, p. 69) shows *C. candidum* as having a range of Upper Triassic (upper Carnian? to upper middle Norian). We believe that the occurrence of *Corum* sp. aff. *C. candidum* in the Quinn River Formation may extend the range of synonymous forms down into the middle Carnian.

Occurrence: Western North America (Oregon, Nevada).

Corum sp. cf. *C. perfectum* Blome

Plate 2, figures 2, 4, 15, 16

Corum perfectum Blome 1984, p. 51, pl. 13, figs. 2, 7, 16; pl. 17, fig. 11. *Triassocampe*(?) sp. E, Yao 1982, pl. 2, figs. 11, 12.

Remarks: These forms differ from *C. perfectum* by possessing a smaller number of costae visible laterally. Total number of post-abdominal chambers could not be determined because of the poor preservation.

Range: Upper Triassic (Carnian to middle Norian or Alalaunian; *Triassocampe nova* Assemblage Zone of Yao 1982, 1990) as far as known.

Occurrence: Western North America, Japan.

Corum speciosum Blome

Plate 2, figure 10

Corum speciosum Blome 1984, p. 51-52, pl. 13, figs. 4, 13, 14, 17.

Remarks: Although the form figured is poorly preserved, the general shape of the test and geometry and number of costae visible laterally are nearly identical to those in the holotype described in Blome (1984).

Range: Upper Triassic (mid-Carnian to upper middle Norian; *Capnodoce* Zone of Blome 1984; upper *Pseudostylosphaera* Zone through *Capnodoce* Zone of Blome et al. 1989).

Occurrence: Western North America (Oregon and Nevada).

?*Corum* sp.

Plate 2, figures 3, 21, 22

Remarks: Poor preservation makes it impossible to describe these specimens beyond the generic level.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Nevada.

Genus *Gorgansium* Pessagno and Blome 1980

Type species: *Gorgansium silviesense* Pessagno and Blome 1980

Gorgansium sp. aff. *G. thayeri* Yeh

Plate 2, figure 25

Gorgansium thayeri Yeh 1989, p. 60-61, pl. 7, fig. 12.

Remarks: This form is similar to *Gorgansium thayeri* Yeh in possessing straight (untwisted) bladed primary spines but differs by possessing a more inflated test and shorter and thinner third primary spine. It also differs from *Gorgansium* sp. cf. *G. thayeri* Yeh (1989, p. 61, pl. 7, fig. 11) by having more massive primary spines.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Western North America (Oregon, Nevada).

Genus *Plafkerium* Pessagno (in Pessagno et al. 1979)

Type species: *Plafkerium abbotti* Pessagno (in Pessagno et al. 1979)

Plafkerium sp.

Plate 2, figure 26

Remarks: This form was assigned to the genus *Plafkerium* because it exhibits four radially arranged primary spines with alternating ridges and grooves and a two-layered cortical shell with an outer layer consisting of irregular nodes.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Genus *Poulpus* De Wever (in De Wever et al. 1979)

Type species: *Poulpus piabyx* De Wever (in De Wever et al. 1979)

Poulpus sp.

Plate 2, figure 24

Remarks: This form differs from *P. piabyx* De Wever (in De Wever et al. 1979), *P. curvispinus* Dumitrica, Kozur, and Mostler (1980), and other *Poulpus* species because it has straight feet; the horn is not preserved.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Genus *Pseudostylosphaera* Kozur, and Mostler 1981

Type species: *Pseudostylosphaera gracilis* Kozur, and Mostler 1981

Pseudostylosphaera sp.

Plate 2, figure 19

Remarks: This poorly preserved form can be assigned to the genus *Pseudostylosphaera* on the basis of its bipolar primary spine arrangement and its multilayered cortical shell consisting of polygonal pore frames.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

?*Pseudostylosphaera* sp.

Plate 2, figure 23

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Genus *Tiborella* Dumitrica, Kozur, and Mostler 1980

Type species: *Tiborella magnidentata* Dumitrica, Kozur, and Mostler 1980

Tiborella sp.

Plate 2, figure 20

Remarks: This form differs from *T. magnidentata* (Dumitrica, Kozur, and Mostler 1980, p. 18, pl. 1, figs. 2, 6; pl. 11, figs. 2-4; pl. 12, fig. 4) and *T. sp. A* (Yeh 1990, p. 20-21, pl. 4, fig. 15) by possessing straight, untwisted spines and large nodes at the pore frame vertices.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Genus *Triassocampe* Dumitrica, Kozur, and Mostler 1980 (emend. Blome 1984)

Type species: *Triassocampe scalaris* Dumitrica, Kozur, and Mostler 1980

Triassocampe nova Yao

Plate 2, figure 17

Dictyomitrella sp. B in Yao, Matsuda, and Isozaki 1980, pl. 3, figs. 1-3. *Triassocampe nova* Yao 1982, p. 59-60, pl. 2, figs. 1-4; Yao 1990, pl. 1, figs. 11.

Remarks: This form is similar to those illustrated by Yao (1982, 1990) in possessing very inflated circumferential ridges.

Range: Upper Triassic (Carnian to middle Norian or Albian; *Triassocampe nova* Assemblage Zone of Yao 1982, 1990).

Occurrence: Japan, western North America.

Triassocampe sp. C Yao

Plate 2, figure 18

Triassocampe sp. C in Yao 1982, p. 66, pl. 2, figs. 5-7; Yao 1990, pl. 1, fig. 12.

Remarks: This Nevada form is similar to that illustrated by Yao (1982, pl. 2, fig. 6) in possessing a rounded cephalis and pronounced circumferential ridges separating chambers.

Range: Upper Triassic (Carnian to middle Norian or Albian; *Triassocampe nova* Assemblage Zone of Yao 1982, 1990).

Occurrence: Japan, western North America.

Triassocampe sp. A

Plate 2, figure 1

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Northern Nevada.

Triassocampe sp.

Plate 2, figure 1

Remarks: The poor preservation makes it impossible to describe the specimen beyond the generic level.

Range: Upper Triassic (Carnian) as far as known.

Occurrence: Nevada

Genus *Xipha* Blome 1984

Type species: *Xipha pessagnoii* (Nakaseko and Nishimura) 1979

Xipha sp. cf. *X. pessagnoii* (Nakaseko and Nishimura)

Plate 2, figures 5, 6, 11, 12

Dictyomitra pessagnoii Nakaseko and Nishimura 1979, p. 77, p. 9, figs. 2-4.
Eucyrtidium (?) *pessagnoii* (Nakaseko and Nishimura) in Yao 1982, pl. 2, fig. 8.

Nakasekoellus polita (Hinde) in Kozur 1984, p. 60, pl. 3, fig. 4.

Xipha pessagnoii (Nakaseko and Nishimura) in Blome 1984, p. 59-60, pl. 16, figs. 6, 9, 17; Yao 1990, pl. 1, fig. 13.

Remarks: These forms differ from *X. pessagnoii* by possessing a wider cephalis and thorax, more pronounced costae, and very little stricture between abdomen and post-abdominal chambers.

Range: Upper Triassic (Carnian to middle Norian or Albian; *Triassicampe nova* Assemblage Zone of Yao 1982, 1990; *Capnodocoe* Zone of Blome 1984, and Blome et al. 1989).

Occurrence: Japan, western North America (Alaska, Oregon and Nevada).

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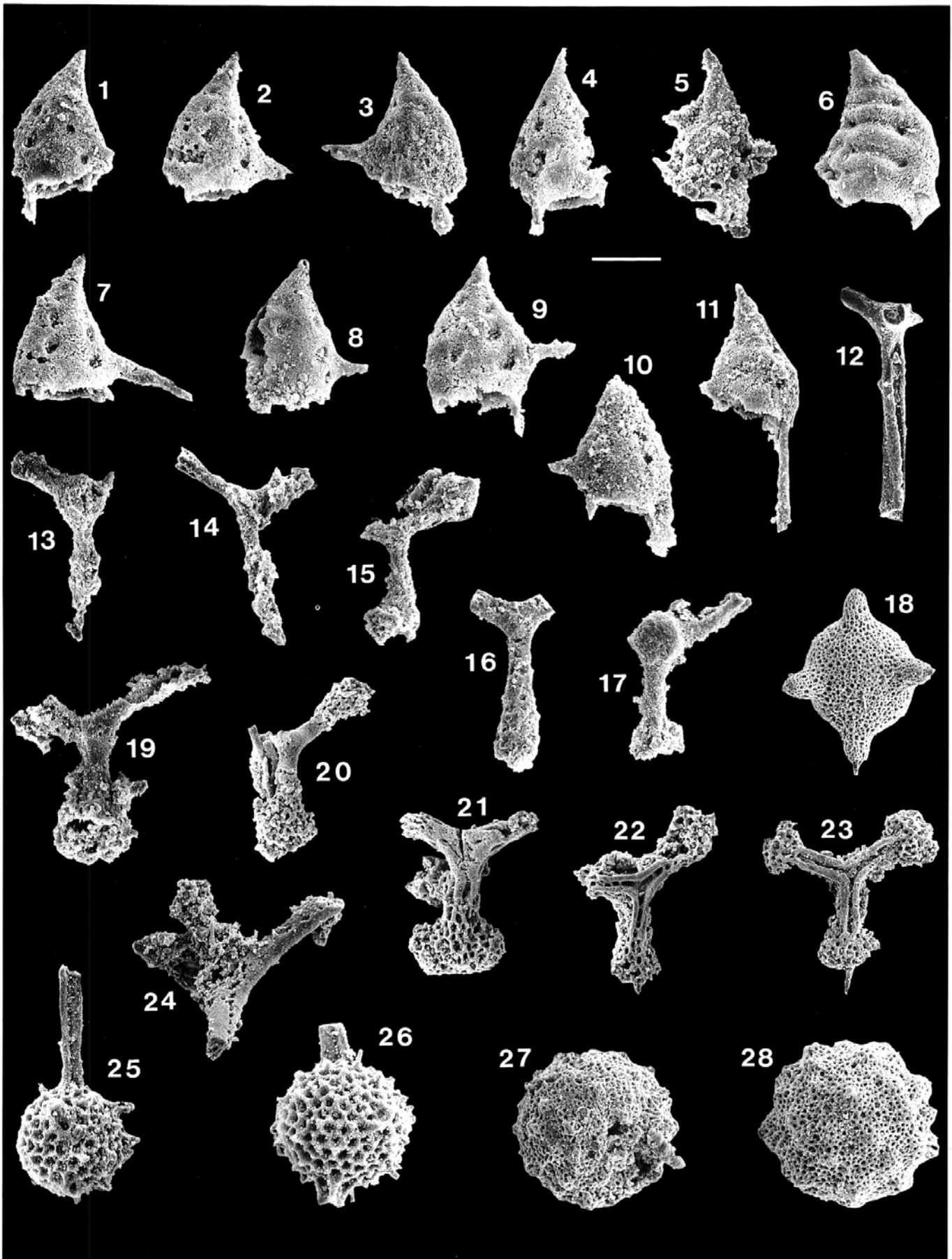
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PLATE 1

All illustrations are scanning electron micrographs of Upper Permian radiolarians from the chert unit of the Quinn River Formation, north-central Nevada. Bar scale in upper right = number of μm cited for each illustration.

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|--------------|--|-------|---|
| 1,2,4, 7-11 | <i>Albaillella</i> sp. cf. <i>A. levis</i> Ishiga and Imoto. DR-565. 1, 2, 4, 7-10, Scale = 62.5 μm ; 11, Scale = 68.2 μm . | 15,19 | <i>Deflandrella</i> sp.; 15, DR-1100, Scale = 83.3 μm ; 19, DR-1095, Scale = 75 μm . |
| 3 | <i>Albaillella levis</i> Ishiga and Imoto. DR-565, Scale = 68.2 μm . | 18 | ? <i>Octatormentum</i> sp. cf. <i>O. floriferum</i> Sashida and Tonishi, DR-1282, Scale = 150 μm . |
| 5 | <i>Neobaillella</i> sp. aff. <i>N. ornithiformis</i> Takemura and Nakaseko. DR-1294, Scale = 83.3 μm . | 20 | <i>Ishigaum</i> sp., DR-567, Scale = 100 μm . |
| 6 | <i>Albaillella</i> sp. cf. <i>A. triangularis</i> Ishiga and Imoto, DR-1282, Scale = 55.5 μm . | 21 | <i>Ishigaum</i> sp. cf. <i>I. obesum</i> De Wever and Caridroit, DR-1095, Scale = 115.4 μm . |
| 12 | <i>Nazarovella</i> sp. cf. <i>N. gracilis</i> De Wever and Caridroit, DR-1289, Scale = 115.4 μm . | 22,23 | <i>Triplanospongus</i> sp. cf. <i>T. dekkasensis</i> (Noble and Renne); 22, DR-567, Scale = 125 μm ; 23, DR-567, Scale = 136.4 μm . |
| 13,14, 16,17 | <i>Pseudotormentus</i> sp. cf. <i>P. kamigoriensis</i> Caridroit and De Wever; 13, DR-1095, Scale = 83.3 μm ; 14, DR-567, Scale = 83.3 μm ; 16, DR-567, Scale = 75 μm ; 17, DR-1282, Scale = 68.2 μm . | 24 | ? <i>Ormistoneella</i> sp., DR-1278, Scale = 100 μm . |
| | | 25,26 | <i>Entactinia itsukaichiensis</i> Sashida and Tonishi; 25, DR-1282, Scale = 93.8 μm ; 26, DR-1282, Scale = 100 μm . |
| | | 27,28 | <i>Hegleria mammilla</i> (Sheng and Wang); 27, DR-1100, Scale = 115.4 μm ; 28, DR-1282, Scale = 115.4 μm . |

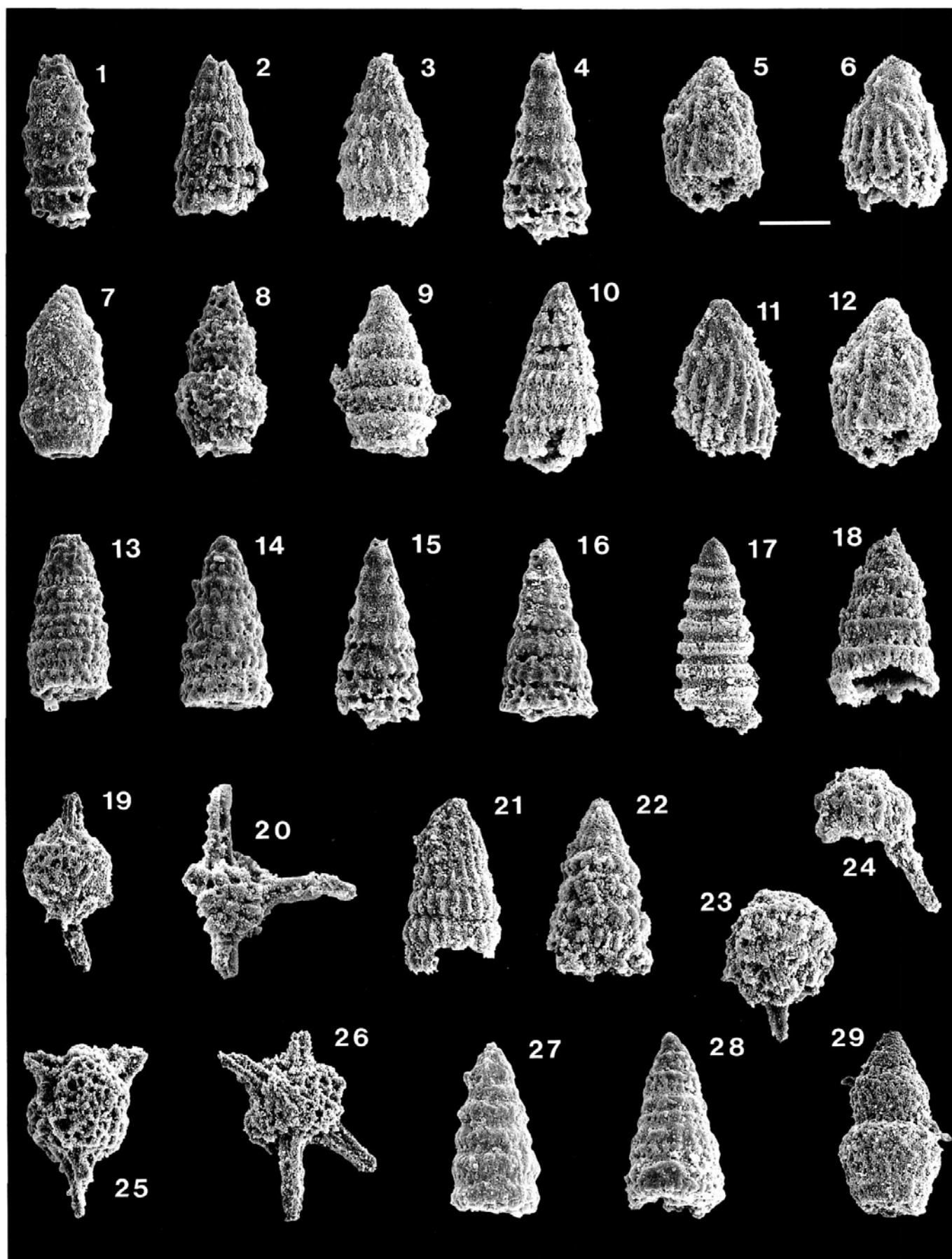


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Plate 2

All figures scanning electron photomicrographs of Late Triassic (Carnian) radiolarians from the volcanoclastic unit of the Quinn River Formation, north-central Nevada.

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|-----------|---|--------|---|
| 1 | <i>Triassocampe</i> sp., DR-570, Scale = 68.2µm. | 13, 14 | <i>Corum</i> sp. aff. <i>C. candidum</i> Yeh; 13, DR-1138, Scale = 83.3µm; 14, DR-1138, Scale = 62.5µm. |
| 2, 4, 15, | <i>Corum</i> sp. cf. <i>C. perfectum</i> Blome; 2, DR-570, Scale = 68.2µm; 4, DR-570, Scale = 75µm; 15, DR-570, Scale = 75µm; 16, DR-570, Scale = 68.2µm. | 17 | <i>Triassocampe nova</i> Yao, DR-570, Scale = 75µm. |
| 3, 21, 22 | ? <i>Corum</i> sp.; 3, DR-570, Scale = 68.2µm; 21, DR-570, Scale = 68.2µm; 22, DR-570, Scale = 62.5µm. | 18 | <i>Triassocampe</i> sp. C of Yao, DR-570, Scale = 75µm. |
| 5, 6, 11, | <i>Xipha</i> sp. cf. <i>X. pessagno</i> (Nakaseko and Nishimura); 5, DR-570, Scale = 68.2µm; 6, DR-570, Scale = 62.5µm; 11, DR-570, Scale = 62.5µm; 12, DR-570, Scale = 62.5µm. | 19 | <i>Pseudostylosphaera</i> sp., DR-570, Scale = 68.2µm. |
| 7, 8, 29 | <i>Canesium</i> sp.; 7, DR-570, Scale = 68.2µm; 8, DR-570, Scale = 68.2µm; 29, DR-570, Scale = 75µm. | 20 | <i>Tiborella</i> sp., DR-570, Scale = 68.2µm. |
| 9 | <i>Triassocampe</i> sp. A, DR-570, Scale = 68.2µm. | 23 | ? <i>Pseudostylosphaera</i> sp., DR-570, Scale = 68.2µm. |
| 10 | <i>Corum speciosum</i> Blome, DR-570, Scale = 75µm. | 24 | <i>Poulpus</i> sp., DR-570, Scale = 68.2µm. |
| | | 25 | <i>Gorgansium</i> sp. aff. <i>G. thayeri</i> Yeh, DR-570, Scale = 68.2µm. |
| | | 26 | <i>Plafkerium</i> sp., DR-570, Scale = 83.3µm. |
| | | 27, 28 | <i>Canoptum</i> sp. aff. <i>C. laxum</i> Blome; 27, DR-1138, Scale = 62.5µm; 28, DR-1138, Scale = 68.2µm. |



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