Journal of Paleontology, 92(2), 2018, p. 207–220

0022-3360/18/0088-0906
doi: 10.1017/jpa.2017.123

JOURNAL OF PALEONTOLOGY
A PUBLICATION OF THE Paleontological SOCIETY

Magnigondolella, a new conodont genus from the Triassic of North America

Martyn L. Golding and Michael J. Orchard

Geological Survey of Canada, 1500-605 Robson Street, Vancouver, British Columbia, Canada, V6B 5J3 ⟨martyn.golding@canada.ca⟩, ⟨mike.orchard@canada.ca⟩

Abstract.—The new conodont genus *Magnigondolella* is recognized based on specimens recovered from the Anisian (Middle Triassic) of British Columbia in Canada, and Nevada in the USA. This new genus encompasses problematic specimens with high carinas, which have recently been collectively referred to as *Neogondolella* ex gr. *regalis* Mosher. Ten species from North America are herein assigned to *Magnigondolella* n. gen., including the eight new species *M. alexanderi*, *M. cyri*, *M. julii*, *M. nebuchadnezzari*, *M. salomae*, *M.* n. sp. A, *M.* n. sp. B, and *M.* n. sp. C, as well as the two existing species *M. regalis* (Mosher) and *M. dilacerata* (Golding and Orchard). Other species from the Tethys region are also tentatively assigned to *Magnigondolella* n. gen. Based on published records, the genus appears to range from the Spathian to the upper Anisian in North America. The recognition of eight new species from the Anisian significantly increases the conodont biodiversity of this period, which has previously been regarded as a time of low diversity. Although some of the species included within *Magnigondolella* n. sp. have relatively long stratigraphic ranges, many have been identified in both British Columbia and Nevada, and therefore show potential for biostratigraphic correlation on a regional scale.

Introduction

The taxonomy of Triassic conodonts from North America is currently undergoing extensive revision, with many new species recognized in both the Middle and Upper Triassic (Orchard, 2014; Golding and Orchard, 2016). This revision arises from both the great diversity of conodonts in North America during the Triassic, and the relatively conservative taxonomic approach that has been taken by workers previously. For the Anisian (lower Middle Triassic), the majority of conodont specimens recovered in North American strata have previously been referred to one of only seven species, including broad taxonomic interpretations of *Neogondolella mombergensis* (Tatge), *N. regalis* Mosher, *N. bulgarica* (Budurov and Stefanov), *N. constricta* (Mosher and Clark), *N. transita* Kozur and Mostler, *N. shoshonensis* Nicora, and *Paragondolella excelsa* Mosher (Mosher and Clark, 1965; Mosher, 1973; Nicora, 1976, 1977; Nicora and Kovács, 1984; Ritter, 1989; Orchard, 1994). These names have been applied to a wide range of morphologies, which has obscured morphological variation, extended the stratigraphic ranges of species, and in consequence led to a very coarse resolution for conodont biostratigraphic schemes covering this interval (Orchard and Tozer, 1997). Ritter (1989) went so far as to consider all of the upper Anisian conodonts from the Fossil Hill section in Nevada as belonging to a single species, *N. mombergensis*; this species was defined in the German Basin, and to date has not been found in North America.

Other taxa from the Anisian of North America have been identified by Nicora et al. (1980), Kozur et al. (1994), Orchard and Tozer (1997), Orchard (2010), and Golding and Orchard (2016), and some of these species have shown promise for biostratigraphic correlation (Orchard and Tozer, 1997; Golding and Orchard, 2016). A full appreciation of the conodont diversity of the Anisian of North America is necessary in order to understand the biodiversity, systematic relationships, and evolution of conodonts during this time period. Recent studies of these topics have underrepresented the global diversity of conodonts during the Anisian (Chen et al., 2016; Kiliç et al., 2016). Taxonomic revision of these conodonts will also improve the resolution of the conodont biostratigraphic zonation during this time interval, which is currently far less refined than that of the ammonoids (compare Orchard and Tozer, 1997, fig. 4 with Monnet and Bucher, 2005a, fig. 6). This in turn will improve local and regional correlations.

The present paper is concerned with the problematic group of conodonts with high, fused carinas previously referred to *Neogondolella* ex gr. *regalis*, and introduces the new genus *Magnigondolella*, as well as eight new species that encompass these forms. Numerous Anisian conodont samples from British Columbia (B.C.) and Nevada were examined for this study, many of them co-occurring with ammonoids and therefore directly correlated with the regional ammonoid timescales of Tozer (1994) and Monnet and Bucher (2005a).

Geologic setting

The Anisian rocks that crop out in northeastern B.C. belong to the Toad Formation, which consists primarily of siltstone, shale, fine-grained sandstone and carbonate (Zonneveld, 2010). These rocks are interpreted to have formed in relatively deep water, and some of the clastic sediments show evidence for deposition from turbidity currents (Ferri et al., 2010). The Toad Formation is not recognized in the subsurface of B.C. and Alberta, where Anisian rocks are referred to the upper part of the Montney Formation and the lower part of the Doig Formation, both of which are considered lateral equivalents of the Toad Formation. The Montney Formation consists of shale, siltstone, and very fine-grained sandstone, whereas the Doig Formation is primarily siltstone and sandstone (Zonneveld, 2010). The Montney and Doig formations represent deposition in a wide range of environments, from offshore turbidites (e.g., Moslow, 2000) to the shoreface (e.g., Evoy and Moslow, 1995). Deposition of all of the Anisian rocks of B.C. took place on the margin of the ancestral North American continent, in the Peace River sub-basin of the Western Canada Sedimentary Basin (Davies, 1997).

In Nevada, the Anisian rocks belong to the Fossil Hill Member, shared by both the Prida and Favret formations. This member consists primarily of an alternation of silty shale and micritic limestone, deposited below storm wave base in an oxygen-poor environment (Monnet and Bucher, 2005b). These rocks were formed in the Star Peak Basin, an intra-plate extensional basin related to the Early–Middle Triassic Sonoma Orogeny (Nichols and Silberling, 1977; Wyld, 2000).

The Anisian of North America is divided into the lower, middle and upper Anisian sub-stages, whereas the Aegean, Bithynian, Pelsonian, and Illyrian sub-stages are recognized in the Tethys region (Ogg et al., 2014). Tozer recognized five ammonoid zones in the lower and middle Anisian of B.C. (Tozer, 1967, 1994; Silberling and Tozer, 1968), and Bucher (2002) added an additional zone first recognized in Nevada (Fig. 1). In Nevada, a much larger number of ammonoid zones have been recognized through the work of Silberling (Silberling and Tozer, 1968; Silberling and Wallace, 1969; Silberling and Nichols, 1982) and Bucher (1988, 1989, 1992a, 1992b, 1994; Monnet and Bucher, 2005b), who identified a total of eight zones and 14 subzones throughout the lower and middle Anisian (Fig. 1). The correlation between the ammonoid zones in Nevada and B.C. (Fig. 1) follows the work of Monnet and Bucher (2005a). The samples utilized for the present paper are primarily lower and middle Anisian in age, coming from the *Lenotropites caurus*, *Paracrochordiceras americanum*, *Tetsaoceras hayesi*, and *Hollandites minor* ammonoid zones in B.C., and from the *Japonites welteri*, *Pseudokeyserlingites guexi*, *Lenotropites caurus*, and *Acrochordiceras hyatti* ammonoid zones in Nevada. Specimens belonging to the upper Anisian have been recovered from the subsurface of B.C., but cannot be related to the ammonoid zonation.

Materials and methods

Material for this study comes from 38 samples that were collected from 21 sections by various workers in northeastern B.C. and Nevada over the course of the past 30 years (Fig. 2; Table 1). Together, these collections yield more than 600 specimens of *Magnigondolella* n. gen. Samples from northeastern B.C. come from exposures of the Toad Formation at sections on the Liard and Toad rivers (Toad River map area 094 N) and the Alaska Highway (Tuchodi Lakes map area 094 K), and from the Doig Formation recovered in core taken from subsurface hydrocarbon wells drilled in the vicinity of Fort St. John. Samples from Nevada come from outcrop of the Prida and Favret formations exposed at sections in the Humboldt, New Pass, and Augusta mountain ranges of Pershing and Churchill counties.

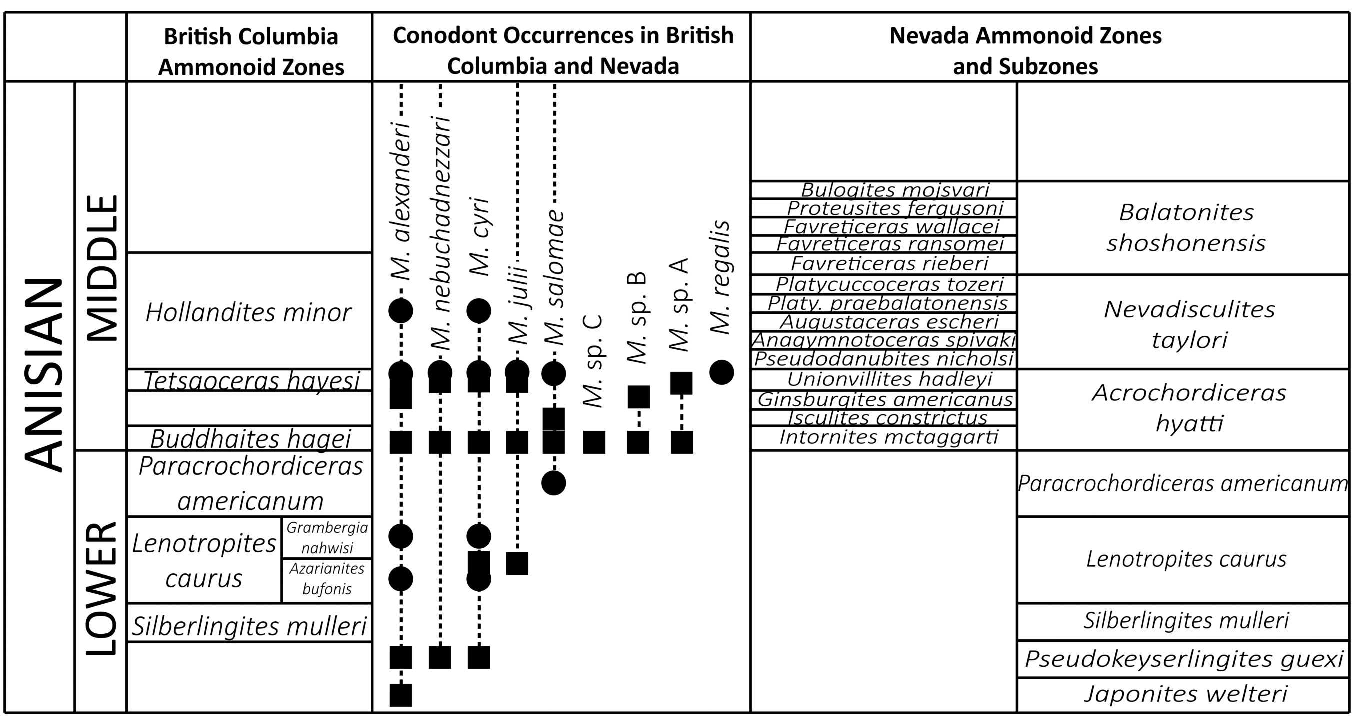

Figure 1. Chart showing the occurrences of the conodont species reported in this paper within lower and middle Anisian ammonoid zones. Squares indicate occurrences within the ammonoid zones of Nevada, and circles indicate occurrences within the ammonoid zones of B.C. Dashed lines between symbols indicate the inferred stratigraphic range of these species. Note that the ranges of *M. alexanderi* n. sp., *M. nebuchadnezzari* n. sp., *M. julii* n. sp., and *M. salomae* n. sp. continue into the upper Anisian. B.C. ammonoid zones after Tozer (1994) and Bucher (2002); Nevada ammonoid zones and correlation after Monnet and Bucher (2005a).

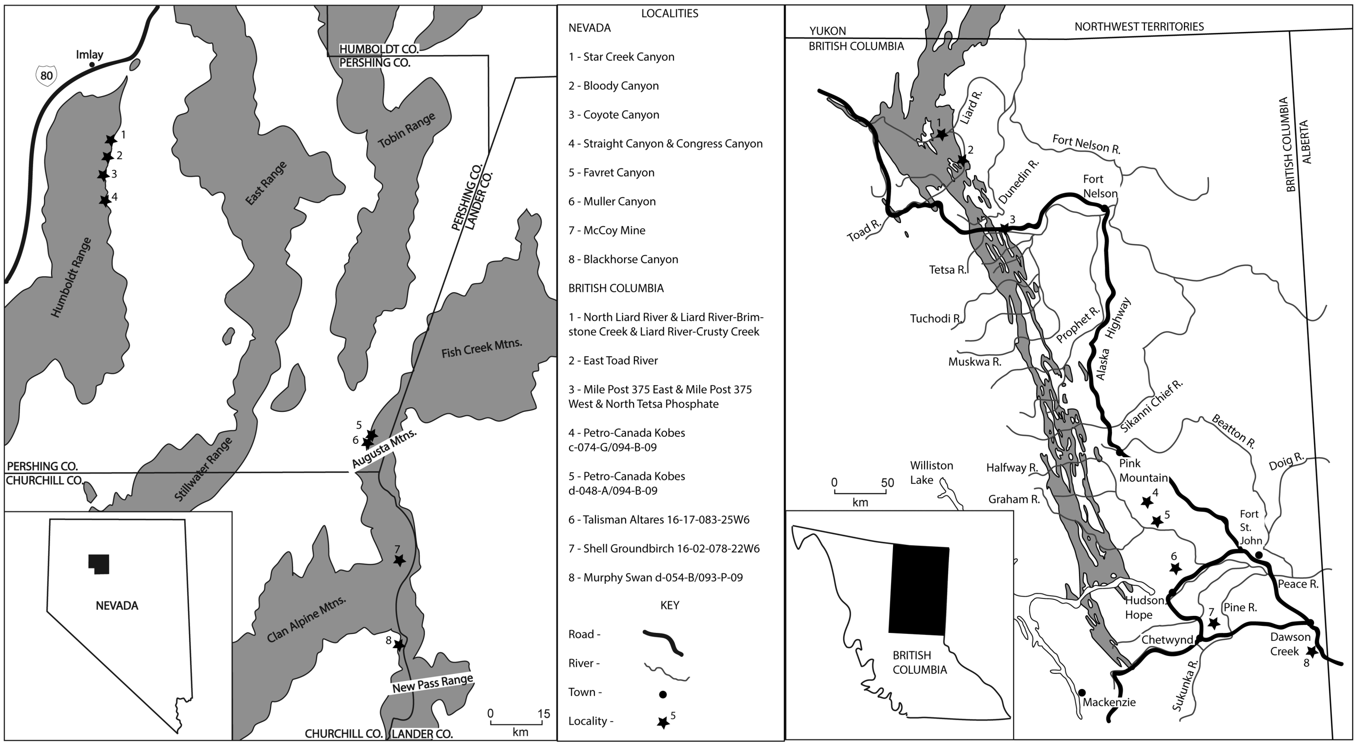

Figure 2. Maps showing the geographic locations of samples collected from Nevada and B.C.

Collections were primarily obtained from samples of limestone or calcareous siltstone, often taken from the same horizon as ammonoid samples. All of the conodont samples were previously processed at the Geological Survey of Canada in Vancouver, using standard techniques as outlined in Stone (1987) and Jeppsson et al. (1999).

Repository and institutional abbreviation.—Illustrated specimens are housed at the National Type Collection of Invertebrate and Plant Fossils at the Geological Survey of Canada (GSC) in Ottawa, Ontario, Canada.

Systematic paleontology

Class Conodonta Pander, 1856
Order Ozarkodinida Dzik, 1976
Family Gondolellidae Lindström, 1970
Subfamily Neogondolellinae Hirsch, 1994

Genus *Magnigondolella* new genus
Figure 3

Type Species.—*Magnigondolella salomae* n. gen. n. sp.

Other species.—*Neogondolella regalis* Mosher; *Neogondolella dilacerata* Golding and Orchard; *Neogondolella* sp. sensu Orchard et al. (2007a); *Neogondolella* sp. sensu Orchard et al. (2007b); *Magnigondolella alexanderi* n. gen. n. sp.; *Magnigondolella cyri* n. gen. n. sp.; *Magnigondolella julii* n. gen. n. sp.; *Magnigondolella nebuchadnezzari* n. gen. n. sp.; *Magnigondolella salomae* n. gen. n. sp.; *Magnigondolella* n. gen. n. sp. A; *Magnigondolella* n. gen. n. sp. B; and *Magnigondolella* n. gen. n. sp. C.

Diagnosis.—Genus with a 15-element apparatus including a P_1 element that is segminiplanate, with a high, fused carina of uniform height; and an S_0 element that is alate, with lateral processes that diverge from the cusp.

Description.—The diagnostic P_1 element is segminiplanate, with a biconvex platform that is widest at, or posterior to the midpoint of the element. A posterior platform brim may be present. Micro-reticulation is present on the margins of the platform. In side view, the element is arched, and the platform margins are upturned. The carina is high and uniformly well fused along its length. The upper margin of the carina is straight for most of its length, but may be deflected downward at the posterior end due to the curvature of the element. The denticles of the carina are laterally compressed and vary from upright to slightly inclined. The sub-terminal cusp is similar in size to, or slightly larger than the adjacent denticles, and a posterior denticle is present at all growth stages. On the lower surface, a relatively low keel of variable width is present, which terminates in a round to sub-quadrate loop around the sub-terminal basal pit.

Comparisons.—The uniformly high, fused carina of the P_1 element distinguishes *Magnigondolella* n. gen. from *Neogondolella*, which has a P_1 element with a much lower carina that rises to the anterior and posterior of the element. P_1 elements of *Paragondolella* have a high and fused carina like that of *Magnigondolella* n. gen., but it forms a convex crest that is highest in the midpoint of the element, descending to both the anterior and posterior. The upper profile of the carina places

Table 1. Table of samples from the Anisian of British Columbia and Nevada that contain species of *Magnigondolella*. Other species recorded from these samples have previously been described in Golding and Orchard (2016). Samples from Nevada were collected by H. Bucher (field nos. HB), and those from B.C. were collected by M. Golding and J.-P Zonneveld (curation nos. V-) or by M.J. Orchard and E.T. Tozer (curation nos. C-, O-). Ages are given to the level of ammonoid zone or subzone (see Fig. 1) where possible, or inferred on the basis of the complete conodont fauna. Conodonts: *M.* = *Magnigondolella*, *N.* = *Neogondolella*. Ammonoids: *Ac.* = *Acrochordiceras*, *Az.* = *Azarianites*, *G.* = *Grambergia*, *I.* = *Intornites*, *J.* = *Japonites*, *L.* = *Lenotropites*, *Pa.* = *Paracrochordiceras*, *Ps.* = *Pseudokeyserlingites*, *T.* = *Tetsaoceras*, *U.* = *Unionvillites*.

Section	Lat./Long. of Section	GSC Cur. No.	Field No.	Formation	Age (Zone; Subzone)	Conodont Fauna
					British Columbia	
North Liard River	59°18'42"N, 125°07'57"W	O-99574	83/211A	Toad	lower Anisian (*L. caurus*; *G. nahwisi*)	*M. alexanderi*, *M. cyri*, *M. dilacerata*
		O-99575	83/211B	Toad	middle Anisian (*T. hayesi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*
Liard River-Brimstone Creek	59°13'35"N, 125°08'03"W	O-42349	42349	Toad	lower Anisian (*L. caurus*; *G. nahwisi*)	*M. cyri*
Liard River-Crusty Creek	59°18'33"N, 125°08'24"W	C-090852	82/B9F	Toad	middle Anisian (*T. hayesi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*
East Toad River	59°11'23"N, 124°41'52"W	O-99588	83/215B	Toad	middle Anisian (*T. hayesi*)	*M. alexanderi*
Mile Post 375 East	58°39'07"N, 124°14'26"W	C-201922	92/AH-22	Toad	lower Anisian (*L. caurus*; *Az. bufonis*)	*M. alexanderi*, *M. cyri*, *N. vellicata*
		C-209952	HB-655	Toad	lower Anisian (*Pa. americanum*)	*M. alexanderi*, *M. cyri*, *M. dilacerata*, *N. curva*
		C-302187	HB-656	Toad	lower Anisian (*Pa. americanum*)	*M. cyri*, *M. julii*, *M. salomae*, *N. hastata*, *N. bifurcata*, *N.* ex gr. *constricta*
		C-101077	82/AH6	Toad	middle Anisian (*T. hayesi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*
Mile Post 375 West	58°39'16"N, 124°14'48"W	O-68294	68294	Toad	middle Anisian (*T. hayesi*)	*M. alexanderi*, *M. cyri*, *M. julii*, *M. regalis*, *M. salomae*, *N. hastata*
North Tetsa Phosphate	58°40'04"N, 124°25'55"W	V-002606	NTP-CO	Toad	middle Anisian	*M. alexanderi*, *M. nebuchadnezzari*
Petro-Canada Kobes d-048-A/094-B-09	56°32'21"N, 122°05'35"W	V-002992	MG-11-C30	Doig	lower Anisian	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*, *N. panlaurentia*
		V-002995	MG-11-C33	Doig	lower Anisian	*M. alexanderi*
Talisman Altares 16-17-083-25W6	56°12'05"N, 121°54'24"W	V-002978	MG-11-C8	Doig	upper Anisian	*M. alexanderi*, *M. nebuchadnezzari*, *M. salomae*
		V-002979	MG-11-C9	Doig	upper Anisian	*M. alexanderi*
		V-002980	MG-11-C10	Doig	upper Anisian	*M. alexanderi*, *M. julii*
Murphy Swan d-054-B/093-P-09	55°32'53"N, 120°09'58"W	V-002955	MG-10-JP5	Doig	middle Anisian	*M. julii*, *M. nebuchadnezzari*, *N. hastata*
		V-002957	MG-10-JP7	Doig	middle Anisian	*M. nebuchadnezzari*
Petro-Canada Kobes c-074-G/094-B-09	56°38'44"N, 122°10'19"W	V-002999	MG-11-JP20	Doig	middle Anisian	*M. alexanderi*, *M. cyri*, *N. curva*, *N.* ex gr. *shoshonensis*
Shell Groundbirch 16-02-078-22W6	55°44'05"N, 121°17'25"W	V-002506	SG-10-3073	Doig	middle Anisian	*M. nebuchadnezzari*
					Nevada	
Bloody Canyon	40°31'26"N, 118°08'06"W	C-159809	HB-180	Prida	lower Anisian (*L. caurus*)	*M. alexanderi*, *M. cyri*, *M. julii*
Star Creek Canyon	40°32'41"N, 118°07'52"W	C-176347	HB-184	Prida	lower Anisian (*J. welteri*)	*M. alexanderi*
Favret Canyon	40°03'46"N, 117°33'56"W	C-201551	HB-97	Favret	middle Anisian (*Ac. hyatti*; *I. mctaggarti*)	*M. alexanderi*, *M.* sp. C
		C-176314	HB-3D	Favret	middle Anisian (*Ac. hyatti*; *I. mctaggarti*)	*M. alexanderi*, *M. cyri*, *M. julii*, *M. nebuchadnezzari*, *M. salomae*, *M.* sp. A, *M.* sp. B
Congress Canyon	40°26'53"N, 118°09'00"W	C-176324	HB-82	Prida	middle Anisian (*Ac. hyatti*; *I. mctaggarti*)	*M. alexanderi*, *M. cyri*, *M. julii*, *M. nebuchadnezzari*, *M. salomae*, *M.* sp. A, *M.* sp. C
Coyote Canyon	40°29'24"N, 118°08'34"W	C-176327	HB-92	Prida	lower Anisian (*J. welteri*)	*M. alexanderi*
		C-176338	HB-147	Prida	lower Anisian (*Ps. guexi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*
		C-176321	HB-57	Prida	middle Anisian (*Ac. hyatti*; *I. constrictus*)	*M. alexanderi*, *M. cyri*, *M. salomae*
		C-176337	HB-145	Prida	middle Anisian (*Ac. hyatti*; *G. americanus*)	*M. alexanderi*, *M. cyri*, *M. julii*, *M.* n. sp. B
Straight Canyon	40°26'53"N, 118°09'00"W	C-176317	HB-25	Prida	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*, *M. julii*
Blackhorse Canyon	39°42'56"N, 117°30'25"W	C-176325	HB-87	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*, *M. julii*
McCoy Mine	39°52'05"N, 117°29'39"W	C-176339	HB-159	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. nebuchadnezzari*
		C-175807	HB-157 A	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. nebuchadnezzari*
		C-175803	HB-157 B2	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*
		C-175805	HB-157 D	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*, *M. nebuchadnezzari*, *M.* sp. A
		C-175806	HB-157 F	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*
		C-175804	HB-157 G	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*
Muller Canyon	40°02'33"N, 117°34'03"W	C-176526	HB-196	Favret	middle Anisian (*Ac. hyatti*; *U. hadleyi*)	*M. alexanderi*, *M. cyri*, *M. julii*, *M. nebuchadnezzari*

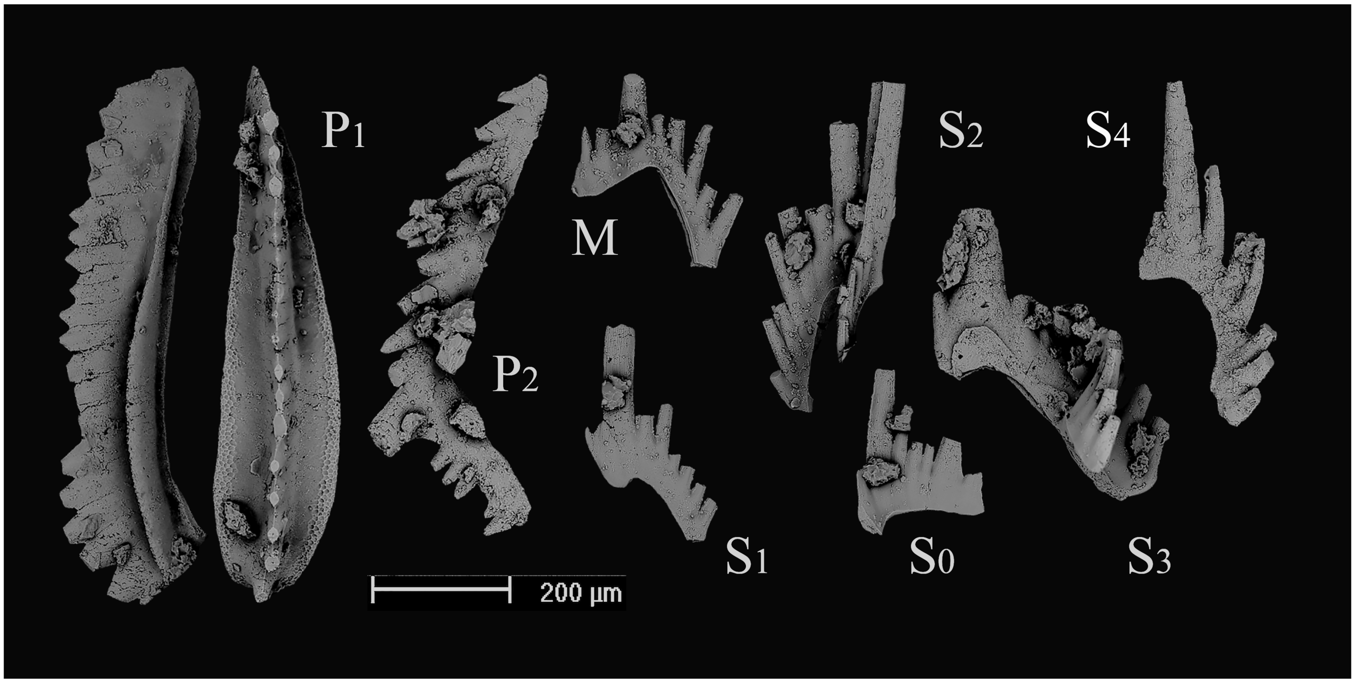

Figure 3. Apparatus of *Magnigondolella* n. gen. (**P_1**) GSC Type No. 131574; (**P_2**) GSC Type No. 131575; (**M**) GSC Type No. 131576; (**S_1**) GSC Type No. 131577; (**S_2**) GSC Type No. 131578; (**S_3**) GSC Type No. 131579; (**S_4**) GSC Type No. 131580; (**S_0**) GSC Type No. 131581; all from the Prida Formation (*Lenotropites caurus* Zone, lower Anisian), GSC Cur. No. C-159809, Bloody Canyon, northern Humboldt Range, Nevada.

Anisian species such as *Paragondolella bulgarica* Budurov and Stefanov and *Gondolella szaboi* Kovács within *Paragondolella* rather than *Magnigondolella* n. gen.

Etymology.—From the Latin *magnus*, meaning "great", in reference to the high carina that is typical of the genus.

Occurrence.—Spathian (*Keyserlingites subrobustus* Zone) to upper Anisian of B.C. (Mosher, 1970; Orchard, 1987; Orchard and Bucher, 1992; Golding 2014; Golding et al., 2014a, b, 2015; Golding and Orchard, 2016; this study); Spathian (*Keyserlingites subrobustus* Zone) of the Canadian Arctic (Orchard, 2008); middle Anisian of the Yukon (Orchard, 2006); Spathian (*Neopopanoceras haugi* Zone) to middle Anisian (*Balatonites shoshonensis* Zone) of Nevada (Mosher, 1968; Nicora, 1977; Clark et al., 1979; Goudemand et al., 2012; this study); Anisian of Alaska (Wardlaw and Jones, 1980); lower Anisian of China (Orchard et al., 2007b); lower Anisian of Tibet (Wang and Wang, 1976; Tian, 1982); lower Anisian of the Indian Himalayas (Chhabra and Kumar, 1992); Spathian (*Keyserlingites subrobustus* Zone) to middle Anisian (*Anagymnotoceras varium* Zone) of Svalbard (Nakrem et al., 2008); lower Anisian of Turkey (Nicora, 1977); lower Anisian of Poland (Narkiewicz, 1999); and lower Anisian of Romania (Orchard et al., 2007a).

Remarks.—The multielement apparatus of *Magnigondolella* n. gen. (figured by Golding, in press) is based on specimens from the upper Anisian of B.C.; this reconstruction is confirmed by specimens from the lower Anisian of Nevada, illustrated in Figure 3. It has previously been postulated that *Magnigondolella* n. gen. (*Neogondolella regalis* or *N.* ex gr. *regalis* of earlier authors) originated from *Chiosella* in the early Anisian (Bender, 1970; Kozur, 1989). The occurrence of specimens of *Magnigondolella* n. gen. in the Spathian (Mosher, 1970; Nakrem et al., 2008; Orchard, 2008; Goudemand et al., 2012), before the first known occurrence of *Chiosella*, instead suggests that *Magnigondolella* n. gen. originated from a Spathian, or older, gondolellid (Orchard, 1994, 2007). Unpublished collections from near the Smithian-Spathian boundary in B.C. support a possible origin from *Neogondolella* n. sp. D sensu Orchard (2007).

Magnigondolella alexanderi new genus new species
Figure 4

1987 *Neogondolella* ex gr. *regale* Mosher; Orchard, p. 105.
1992 *Neogondolella* ex gr. *regale*; Orchard and Bucher, p. 138.
2006 *Neogondolella* ex gr. *regalis*; Orchard, pl. 5, figs. 33, 34.
2014 *Neogondolella* ex gr. *regalis* morphotype alpha; Golding, p. 121, fig. 2.30, parts 1–11.
2014a *Neogondolella* ex gr. *regalis*; Golding et al., p. 171, pl. 1, figs. 16–18.
2015 *Neogondolella* ex gr. *regalis* morphotype alpha; Golding et al., p. 166, fig. 11.15–11.17.

Holotype.—GSC Type No. 131586 (Fig. 4.12–4.14), from the *Paracrochordiceras americanum* Zone (lower Anisian) of the Toad Formation, GSC Cur. No. C-302187, Mile Post 375 East, northeastern B.C.

Diagnosis.—A species of *Magnigondolella* n. gen. in which the P_1 element has a biconvex platform that is widest at the mid-point of the element and tapers evenly to both the anterior and posterior, leaving a relatively narrow and pointed posterior

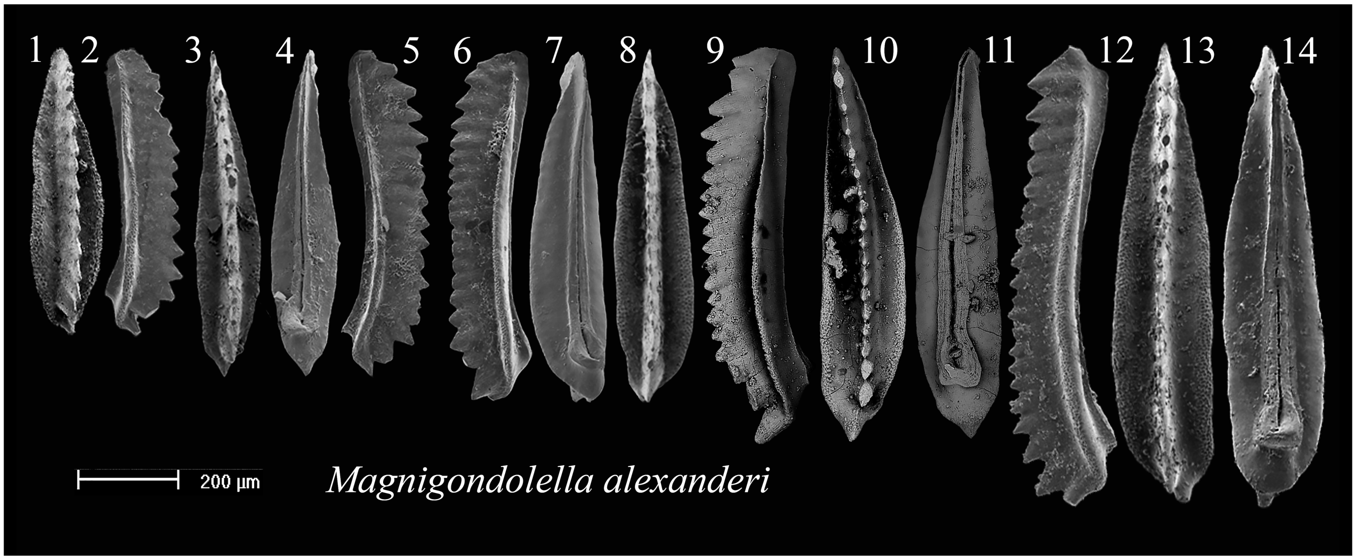

Figure 4. *Magnigondolella alexanderi* n. gen. n. sp. (**1, 2**) GSC Type No. 131582, from the Toad Formation (*Lenotropites caurus* Zone, lower Anisian), GSC Cur. No. C-201922, Mile Post 375 East, B.C.; (**3–5**) GSC Type No. 131583, from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. C-90852, Liard River, B.C.; (**6–8**) GSC Type No. 131584, from the Toad Formation (*T. hayesi* Zone, middle Anisian), GSC Cur. No. O-99588, East Toad River, B.C.; (**9–11**) GSC Type No. 131585, from the Favret Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176314, Favret Canyon, Augusta Mountains, Nevada; (**12–14**) GSC Type No. 131586 (holotype), from the Toad Formation (*Paracrochordiceras americanum* Zone, lower Anisian), GSC Cur. No. C-302187, Mile Post 375 East, B.C.

platform at all growth stages. The carina is deflected downwards at the posterior end of the element.

Occurrence.—Lower Anisian (*Lenotropites caurus* Zone) to upper Anisian of B.C. (Orchard, 1987; Orchard and Bucher, 1992; Golding, 2014; Golding et al., 2014a, 2015; this study); lower Anisian (*Japonites welteri* Zone) to middle Anisian (*Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study); and middle Anisian of the Yukon (Orchard, 2006).

Etymology.—Named for Alexander the Great, King of Macedon.

Materials.—83 specimens from B.C.; 265 specimens from Nevada.

Comparisons.—The biconvex, symmetrically tapering platform and pointed posterior margin of *Magnigondolella alexanderi* n. gen. n. sp. serves to differentiate it from most other species of the genus. P_1 elements of *M. regalis* and *M. salomae* n. sp. have a similar platform shape to that of *M. alexanderi* n. sp., but they can be differentiated from the latter by the straight upper margin of their carinas.

Magnigondolella cyri new genus new species
Figure 5

2014 *Neogondolella* ex gr. *regalis* morphotype beta; Golding, p. 122, fig. 2.31, parts 1–6.
2014 *Neogondolella* ex gr. *regalis* morphotype delta; Golding, p. 126, fig. 2.33, parts 1–6.
2015 *Neogondolella* ex gr. *regalis* morphotype beta; Golding et al., p. 166, fig. 11.18–11.20.
2015 *Neogondolella* ex gr. *regalis* morphotype delta; Golding et al., p. 166, fig. 12.1–12.3.

Holotype.—GSC Type No. 131588 (Fig. 5.7–5.9), from the *Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone (middle Anisian) of the Favret Formation, GSC Cur. No. C-176314, Favret Canyon, Nevada.

Diagnosis.—A species of *Magnigondolella* n. gen. in which the P_1 element has a platform that is widest in the posterior half of the element. Specimens tend to have a sub-quadrate to quadrate posterior margin, and generally lack a posterior platform brim. The carina is deflected downwards at the posterior end of the element.

Occurrence.—Lower Anisian (*Lenotropites caurus* Zone) to middle Anisian (*Hollandites minor* Zone) of B.C. (Golding 2014; Golding et al., 2015; this study); and lower Anisian (*Pseudokeyserlingites guexi* Zone) to middle Anisian (*Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Etymology.—Named for Cyrus the Great, King of the Persians.

Materials.—44 specimens from B.C.; 134 specimens from Nevada.

Comparisons.—The position of the widest part of the platform in *Magnigondolella cyri* n. gen. n. sp., behind the midpoint of the element, together with the sub-quadrate to quadrate posterior margin, serve to distinguish it from most other species of the genus. The platform of *M. nebuchadnezzari* n. sp. is also wide in

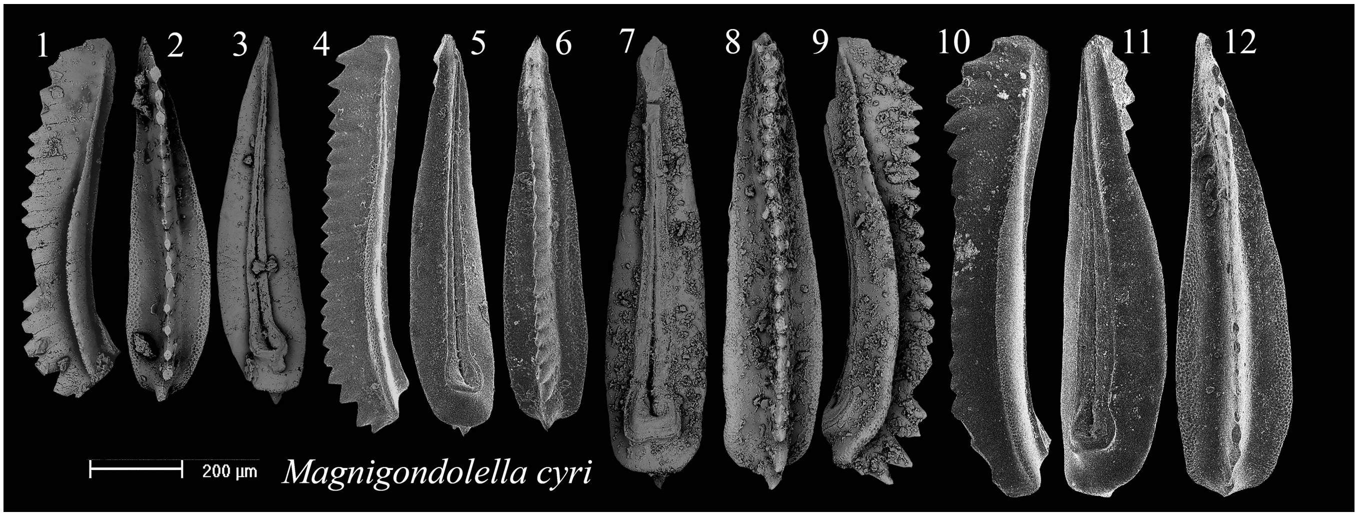

Figure 5. *Magnigondolella cyri* n. gen. n. sp. (**1–3**) GSC Type No. 131587, from the Prida Formation (*Lenotropites caurus* Zone, lower Anisian), GSC Cur. No. C-159809, northern Humboldt Range, Nevada; (**4–6**) GSC Type No. 131492, from the Doig Formation (middle Anisian), GSC Cur. No. V-002999, Petro-Canada Kobes c-074-G/094-b-09 well, B.C.; (**7–9**) GSC Type No. 131588 (holotype), from the Favret Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176314, Favret Canyon, Augusta Mountains, Nevada; (**10–12**) GSC Type No. 131589, from the Doig Formation (lower Anisian), GSC Cur.No. V-002992, Petro-Canada Kobes d-048-A/094-b-09 well, B.C.

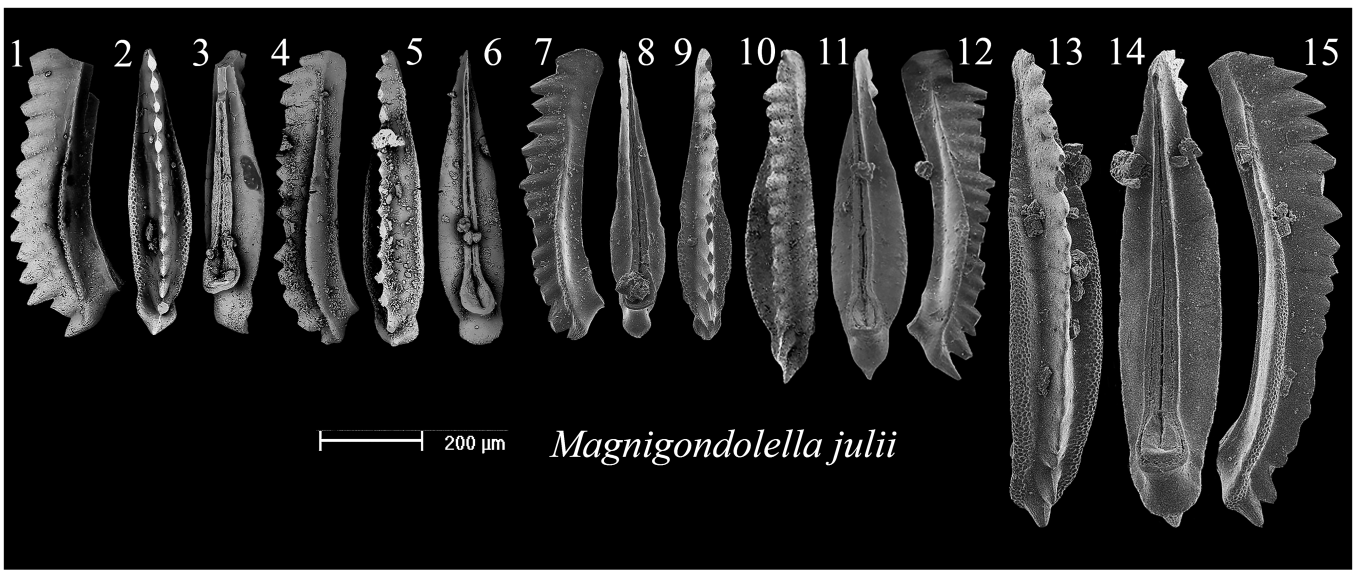

Figure 6. *Magnigondolella julii* n. gen. n. sp. (**1–3**) GSC Type No. 131590, from the Favret Formation (*Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176526, Muller Canyon, Augusta Mountains, Nevada; (**4–6**) GSC Type No. 131591, from the Prida Formation (*Lenotropites caurus* Zone, lower Anisian), GSC Cur. No. C-159809, northern Humboldt Range, Nevada; (**7–9**) GSC Type No. 131592; (**10–12**) GSC Type No. 131593 (holotype), from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. O-68294, Mile Post 375 West, B.C.; (**13–15**) GSC Type No. 131493, from the Doig Formation (middle Anisian), GSC Cur. No. V-002955, Murphy Swan d-054-B/094-P-09 well, B.C.

the posterior half of the element, however the widest part of its platform is at the midpoint, and it possesses a narrow posterior brim.

Magnigondolella julii new genus new species
Figure 6

1970 *Neogondolella regalis* Mosher, p. 110, fig. 5 (only).

1992 *Neogondolella* ex gr. *regale*; Orchard and Bucher, pl. 1, fig. 18 (only).

2014 *Neogondolella* ex gr. *regalis* morphotype gamma; Golding, p. 124, fig. 2.32, parts 1–9.

2015 *Neogondolella* ex gr. *regalis* morphotype gamma; Golding et al., p. 166, fig. 11.21–11.23.

Holotype.—GSC Type No. 131593 (Fig. 6.10–6.12), from the *Tetsaoceras hayesi* Zone (middle Anisian) of the Toad Formation, GSC Cur. No. O-68294, Mile Post 375 West, northeastern B.C.

Diagnosis.—A species of *Magnigondolella* n. gen. in which the P_1 element has a narrow, biconvex platform with a posterior constriction, which causes an expansion of the posterior end of the platform around the cusp. The carina is deflected downwards at the posterior end of the element.

Occurrence.—Middle Anisian (*Tetsaoceras hayesi* Zone) to upper Anisian of B.C. (Mosher, 1970; Orchard and Bucher, 1992; Golding, 2014; Golding et al., 2015; this study); and lower Anisian (*Lenotropites caurus* Zone) to middle Anisian (*Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Etymology.—Named for Gaius Julius Caesar, Dictator of the Roman Republic.

Materials.—15 specimens from B.C.; 41 specimens from Nevada.

Comparisons.—The constricted posterior platform of *Magnigondolella julii* n. gen. n. sp. serves to distinguish it from most other species of the genus. The posterior platform of *M*. n. sp. A narrows markedly, but it is not constricted. Some specimens of *M. salomae* n. sp. possess a small posterior platform constricton, but the carina has a straight upper margin. *Paragondolella szaboi* also possesses a posterior platform constriction, but its convex carina that is highest near the midpoint of the element differs from that of *M. julii* n. sp. The high, fused carina of *M. julii* n. sp. differentiates it from species of *Neogondolella* that have posterior platform constrictions, including the *N. constricta* group and the *N. transita* group.

Magnigondolella nebuchadnezzari new genus new species
Figure 7

2014 *Neogondolella* ex gr. *regalis* morphotype theta; Golding, p. 131, fig. 2.37, parts 1–6 (only).
2014b *Neogondolella* ex gr. *regalis* morphotype C; Golding et al., fig. 3.13–3.15.

Holotype.—GSC Type No. 131506 (Fig. 7.10–7.12), from the *Tetsaoceras hayesi* Zone (middle Anisian) of the Toad Formation, GSC Cur. No. C-101077, Mile Post 375 East, northeastern B.C.

Diagnosis.—Species of *Magnigondolella* n. gen. in which the P_1 element has a biconvex platform that is widest at the midpoint of the element and remains broad to the posterior end. The posterior platform margin is rounded and a narrow posterior platform brim is present. The anterior platform margins may develop a weak crenulation. The carina is deflected downwards at the posterior end of the element.

Occurrence.—Middle Anisian (*Tetsaoceras hayesi* Zone) to upper Anisian of B.C. (Golding, 2014; Golding et al., 2014b; this study); and lower Anisian (*Pseudokeyserlingites guexi* Zone) to middle Anisian (*Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Etymology.—Named for Nebuchadnezzar II, King of Babylon.

Materials.—14 specimens from B.C.; 23 specimens from Nevada.

Comparisons.—The wide posterior platform and presence of a posterior platform brim serve to distinguish *Magnigondolella nebuchadnezzari* n. gen. n. sp. from most other species of the genus. Specimens of *M. cyri* n. sp. have wide posterior platforms, and some may possess a posterior platform brim; however, the platform of *M. cyri* n. sp. is longer and narrower than that of *M. nebuchadnezzari* n. sp., and the carina of *M. cyri* n. sp. has more numerous denticles.

Remarks.—The holotype of this species was figured previously in Golding et al. (2014b), where it was erroneously labeled as coming from the Mile Post 375 West section.

Magnigondolella regalis (Mosher, 1970)
Figure 8

1968 *Gondolella mombergensis* Tatge; Mosher, pl. 116, fig. 15 (only).

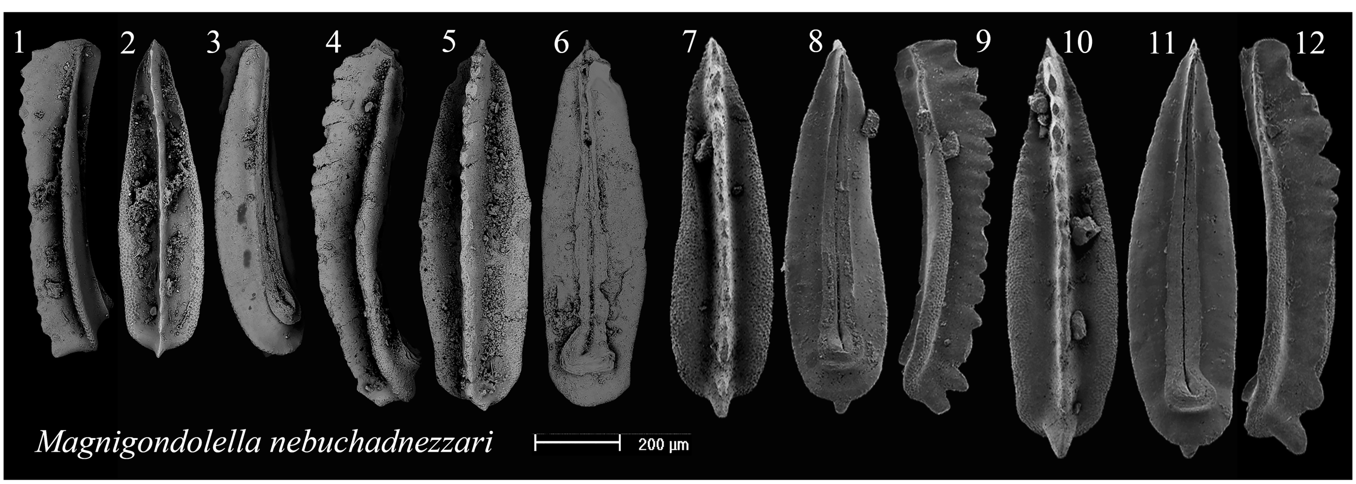

Figure 7. *Magnigondolella nebuchadnezzari* n. gen. n. sp. (**1–3**) GSC Type No. 131594, from the Doig Formation (lower Anisian), GSC Cur. No. V-002992, Petro-Canada Kobes d-048-A/094-b-09 well, B.C.; (**4–6**) GSC Type No. 131595, from the Prida Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176324, Congress Canyon, northern Humboldt Range, Nevada; (**7–9**) GSC Type No. 131596, from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. O-68294, Mile Post 375 West, B.C.; (**10–12**) GSC Type No. 131506 (holotype), from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. C-101077, Mile Post 375 East, B.C.

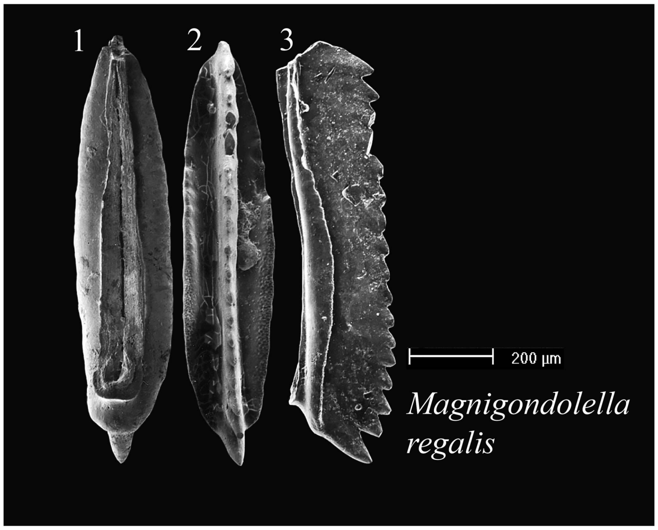

Figure 8. *Magnigondolella regalis* (Mosher). (**1–3**) GSC Type No. 25048 (holotype), from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. O-68294, Mile Post 375 West, B.C.

1970 *Neogondolella regale* Mosher, p. 741, pl. 110, figs. 1, 4 (only).
1976 *Neogondolella regale*; Wang and Wang, pl. 4, fig. 7 (only).
1977 *Neogondolella regale*; Nicora, pl. 5, fig. 3b (only).

Holotype.—GSC Type No. 25048 (Fig. 8.1–8.3), from the *Tetsaoceras hayesi* Zone (middle Anisian) of the Toad Formation, GSC Cur. No. O-68294, Mile Post 375 West, northeastern B.C.

Emended diagnosis.—Species of *Magnigondolella* n. gen. in which the P_1 element has a platform that is widest at the midpoint of the element, and maintains its width nearly to the anterior end. The platform margins are strongly upturned, producing deep adcarinal grooves. The upper profile of the carina is uniformly straight along its length, with no curvature. The keel is very wide and deeply excavated.

Occurrence.—Middle Anisian (*Testsaoceras hayesi* Zone) of B.C. (Mosher, 1970; this study); middle Anisian of Nevada (Mosher, 1968; Nicora, 1977); and middle Ansian of Tibet (Wang and Wang, 1976).

Materials.—One specimen from B.C.

Comparisons.—The upper margin of the carina of *Magnigondolella regalis* is similar to that of *M. salomae* n. sp., which differs from *M. regalis* by possessing a flatter, more anteriorly tapered platform, and a shallower keel.

Remarks.—The revised, more restricted diagnosis of this species includes only forms similar to the holotype, which was described from the *Tetsaoceras hayesi* Zone in B.C. (Mosher, 1970), and is re-illustrated in Figure 8. This is the only specimen of this species to be recovered in B.C. thus far. After examination of the original specimen, Mosher's (1970) figured paratype from B.C. is excluded from the present definition of the species, and is instead considered to belong to *Magnigondolella julii* n. gen. n. sp.

Magnigondolella salomae n. gen. new species
Figure 9

2014 *Neogondolella* ex gr. *regalis* morphotype eta; Golding, p. 130, fig. 2.36, parts 1–6.
2014a *Neogondolella* ex gr. *regalis* morphotype A; Golding et al., p. 171, Pl. 2, figs. 4–6.
2014b *Neogondolella* ex gr. *regalis* morphotype D; Golding et al., fig. 3.22–3.24.

Holotype.—GSC Type No. 131598 (Fig. 9.7–9.9), from the *Paracrochordiceras americanum* Zone (lower Anisian) of the Toad Formation, GSC Cur. No. C-302187, Mile Post 375 East, northeastern B.C.

Diagnosis.—A species of *Magnigondolella* n. gen. in which the relatively narrow platform of the P_1 element is widest at, or just posterior to the midpoint of the element, and tapers evenly to both the anterior and posterior ends. The upper profile of the carina is uniformly straight along its length, with little to no curvature.

Occurrence.—Lower Anisian (*Paracrochordiceras americanum* Zone) to upper Anisian of B.C. (Golding, 2014; Golding et al., 2014a, b; this study); and middle Anisian (*Intornites mctaggarti* Subzone to *Isculites constrictus* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Etymology.—Named for Salome Alexandra, Queen of Judea.

Materials.—Five specimens from B.C.; five specimens from Nevada.

Comparisons.—See above for comparisons with *Magnigondolella regalis* and *M. julii* n. sp.

Magnigondolella new species A
Figure 10

Occurrence.—Middle Anisian (*Intornites mctaggarti* Subzone to *Unionvillites hadleyi* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Description.—A species of *Magnigondolella* n. gen. in which the platform of the P_1 element is widest at the midpoint, and narrows rapidly in the posterior third to form a very narrow, flange-like platform that continues to the end of the element.

Comparisons.—See above for comparison with *Magnigondolella julii* n. gen. n. sp.

Remarks.—Thus far, only four specimens of *Magnigondolella* n. sp. A have been recovered from three samples in Nevada, so despite its distinctive morphology, this species is kept in open nomenclature until its geographic and stratigraphic range can be determined.

https://doi.org/10.1017/jpa.2017.123 Published online by Cambridge University Press

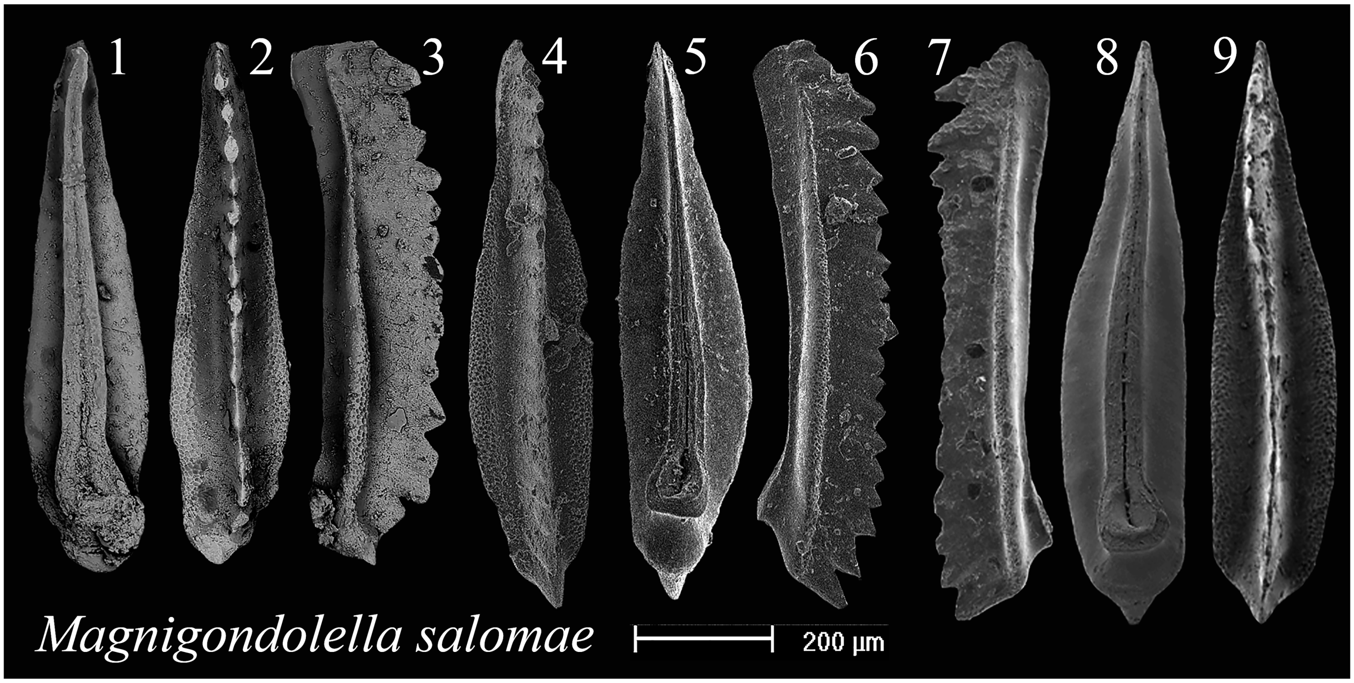

Figure 9. *Magnigondolella salomae* n. gen. n. sp. (**1–3**) GSC Type No. 131597, from the Toad Formation (*Tetsaoceras hayesi* Zone, middle Anisian), GSC Cur. No. O-68294, Mile Post 375 West, B.C.; (**4–6**) GSC Type No. 131476, from the Doig Formation (middle Anisian), GSC Cur.No. V-002978, Talisman Altares 16-17-083-25W6 well, B.C.; (**7–9**) GSC Type No. 131598, (holotype) from the Toad Formation (*Paracrochordiceras americanum* Zone, lower Anisian), GSC Cur. No. C-302187, Mile Post 375 East, B.C.

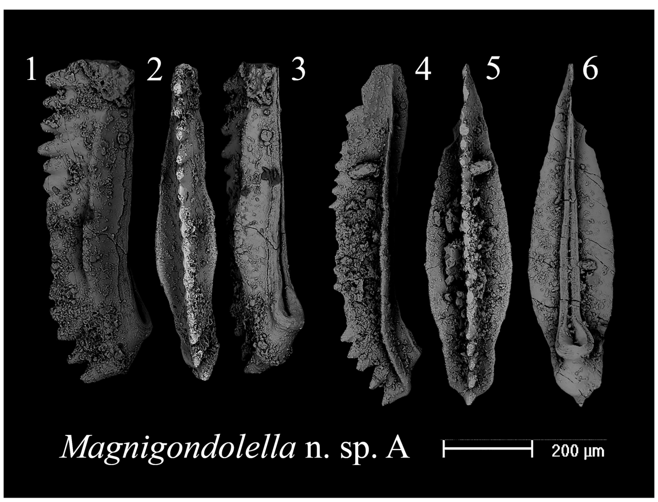

Figure 10. *Magnigondolella* n. gen. n. sp. A. (**1–3**) GSC Type No. 131599; (**4–6**) GSC Type No. 131600; both from the Favret Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176314, Favret Canyon, Augusta Mountains, Nevada.

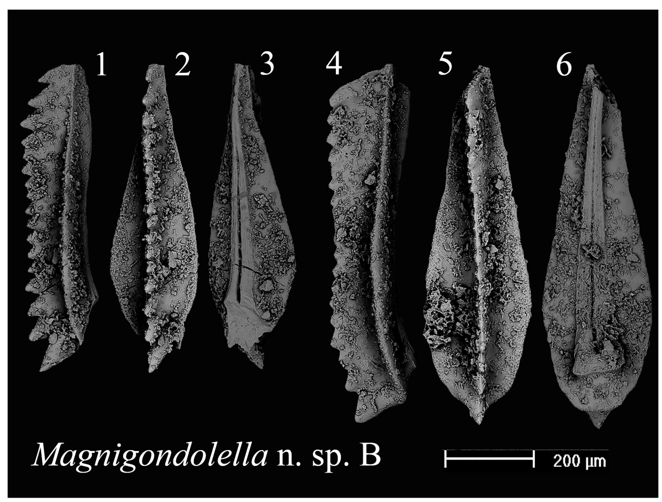

Figure 11. *Magnigondolella* n. gen. n. sp. B. (**1–3**) GSC Type No. 131601; (**4–6**) GSC Type No. 131602; both from the Favret Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176314, Favret Canyon, Augusta Mountains, Nevada.

Magnigondolella new species B
Figure 11

Occurrence.—Middle Anisian (*Intornites mctaggarti* Subzone to *Ginsbergites americanus* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Description.—A species of *Magnigondolella* n. gen. in which the platform of the P_1 element is strongly biconvex and lachrymiform, being widest in the posterior half of the element and possessing rounded postero-lateral margins. A large posterior denticle projects beyond the end of the platform in upper view.

Comparisons.—The teardrop shaped platform, large posterior denticle, and lack of posterior platform brim serve to distinguish *Magnigondolella* n. sp. B from other species of this genus.

Remarks.—Thus far, only six specimens of *Magnigondolella* n. sp. B have been recovered from two samples in Nevada, so

https://doi.org/10.1017/jpa.2017.123 Published online by Cambridge University Press

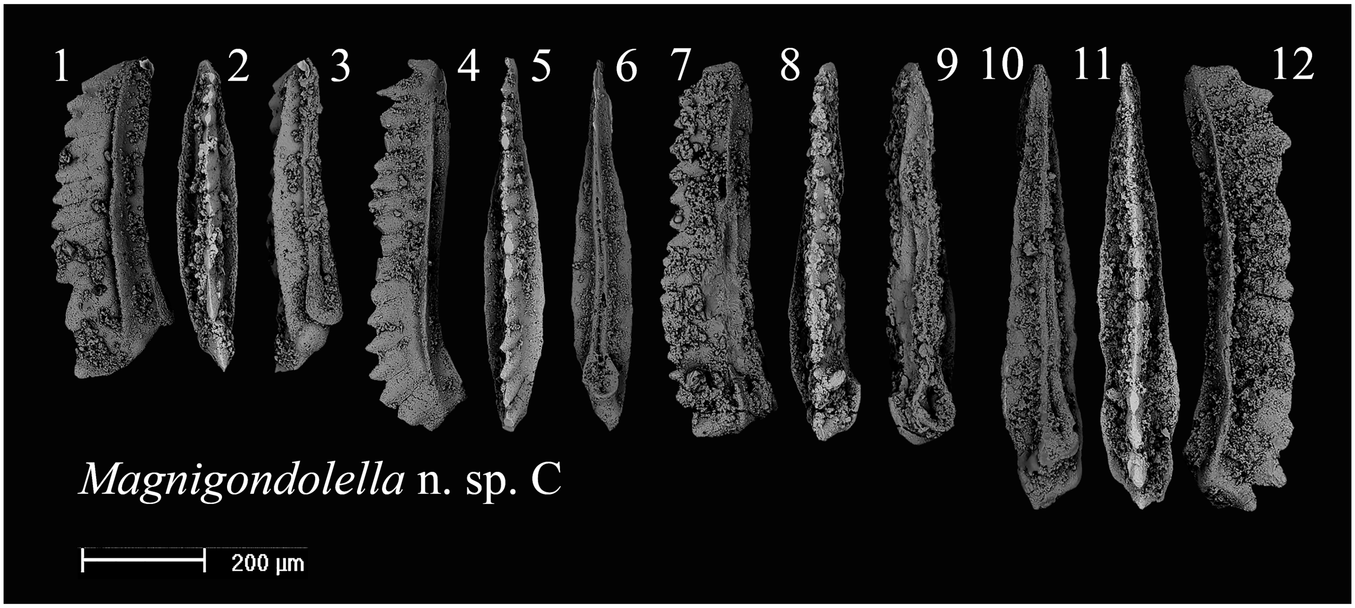

Figure 12. *Magnigondolella* n. gen. n. sp. C. (**1–3**) GSC Type No. 131603; (**4–6**) GSC Type No. 131604; (**7–9**) GSC Type No. 131605; (**10–12**) GSC Type No. 131606; all from the Prida Formation (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone, middle Anisian), GSC Cur. No. C-176324, Congress Canyon, northern Humboldt Range, Nevada.

despite its distinctive morphology, this species is kept in open nomenclature until its geographic and stratigraphic range can be determined.

Magnigondolella new species C
Figure 12

Occurrence.—Middle Anisian (*Intornites mctaggarti* Subzone, *Acrochordiceras hyatti* Zone) of Nevada (this study).

Description.—A species of *Magnigondolella* n. gen. in which the platform of the P_1 element is reduced to form a very narrow flange that runs along the length of the element at all growth stages.

Comparisons.—The very narrow platform serves to differentiate *Magnigondolella* sp. C from other species of the genus.

Remarks.—Thus far, only 22 specimens of *Magnigondolella* sp. C have been recovered from two samples in Nevada, so despite its distinctive morphology, this species is kept in open nomenclature until its geographic and stratigraphic range can be determined.

Discussion

The genus *Magnigondolella* n. gen. appears to range from the Spathian to the upper Anisian, and the stratigraphic ranges of the nine Anisian species discussed in this paper are shown in Figure 1. These ranges can be combined with those of other new species recognized in B.C. and Nevada (Golding and Orchard, 2016) to generate a more refined conodont biostratigraphic scheme for the Anisian of North America. Preliminary versions of this scheme have previously been published by Golding (2014) and Golding et al. (2014b), and a final version incorporating newly described species will be presented after taxonomic work on the conodont fauna from B.C. and Nevada is completed.

Magnigondolella alexanderi n. gen. n. sp. is a relatively long ranging taxon, occurring first in the *Azarianites bufonis* Subzone of the *Lenotropites caurus* Zone and continuing into the upper Anisian in B.C., and ranging from the *Japonites welteri* Zone to the *Unionvillites hadleyi* Subzone of the *Acrochordiceras hyatti* Zone in Nevada. The range of *M. nebuchadnezzari* n. sp. is markedly different in B.C. than it is in Nevada; in B.C., this species appears first in the *Tetsaoceras hayesi* Zone, whereas in Nevada representatives are found as low as the *Pseudokeyserlingites guexi* Zone. Similarly, *M. julii* n. sp. appears in the *T. hayesi* Zone of B.C., but ranges down into the *L. caurus* Zone in Nevada. Specimens of *M. cyri* n. sp. are present in the *P. guexi* Zone in Nevada, where they range up to the *U. hadleyi* Subzone of the *A. hyatti* Zone; in B.C., this species continues to a slightly higher level, the *H. minor* Zone. Of all the newly recognized species, *M. salomae* n. sp. has the most restricted range in Nevada, being confined to the *A. hyatti* Zone. There it spans from the *Isculites constrictus* Subzone to the *Ginsburgites americanus* Subzone, whereas in B.C. it ranges from the *P. americanum* Zone to the upper Anisian. *Magnigondolella regalis* and the three species left in open nomenclature are very stratigraphically restricted, although this likely reflects the limited number of specimens identified, rather than short stratigraphic ranges for these species.

Specimens of *Magnigondolella* n. gen. have been recorded from across North America, including examples of *M. julii* n. sp. from the Quesnel terrane of B.C. (Orchard and Bucher, 1992); *M. alexanderi* n. sp. from the Yukon and the Stikine terrane of B.C. (Orchard, 1987, 2006; Orchard and Bucher, 1992); and *Magnigondolella* sp. from Alaska and the Canadian Arctic (Wardlaw and Jones, 1980; Orchard and Bucher, 1992; Orchard, 2008). The widespread occurrence of this genus demonstrates the potential for its use in correlation at a continental scale.

https://doi.org/10.1017/jpa.2017.123 Published online by Cambridge University Press

Table 2. Table showing the number of P1 elements of *Magnigondolella* n. gen. species identified from localities in B.C. and Nevada.

British Columbia	lower Anisian							middle Anisian										upper Anisian			
	C-201922	O-99574	O-42349	C-209952	V-002992	V-002995	C-302187	V-002955	V-002957	V-002999	V-002506	C-101077	O-68294	O-99575	O-99588	C-090852	V-002606	V-002978	V-002979	V-002980	Total
M. alexanderi	22	4	—	2	7	7	—	—	—	1	—	11	5	5	3	2	1	7	4	2	83
M. cyri	1	6	3	2	4	—	4	—	—	7	—	3	2	11	—	1	—	—	—	—	44
M. julii	—	—	—	—	—	—	3	2	—	—	—	—	8	—	—	—	—	—	—	2	15
M. nebuchadnezzari	—	—	—	—	1	—	—	1	1	—	2	1	—	5	—	1	1	1	—	—	14
M. regalis	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
M. salomae	—	—	—	—	—	—	2	—	—	—	—	—	2	—	—	—	—	1	—	—	5
Total	23	10	3	4	12	7	9	3	1	8	2	15	17	21	3	4	2	9	4	4	162

Nevada	lower Anisian				middle Anisian														
	C-176327	C-176347	C-176338	C-159809	C-176314	C-176324	C-201551	C-176339	C-176321	C-176337	C-176317	C-176325	C-175807	C-175803	C-175805	C-175806	C-175804	C-176526	Total
M. alexanderi	10	1	6	2	65	78	6	1	11	43	8	13	—	7	8	2	1	3	265
M. cyri	—	—	5	10	34	21	—	—	13	3	8	7	—	5	8	6	1	13	134
M. julii	—	—	—	8	4	11	—	—	—	2	10	2	—	—	—	—	—	4	41
M. nebuchadnezzari	—	—	5	—	2	1	—	4	—	—	—	—	4	2	3	—	—	2	23
M. salomae	—	—	—	—	2	1	—	—	2	—	—	—	—	—	—	—	—	—	5
M. n. sp. A	—	—	—	—	2	1	—	—	—	—	—	—	—	—	1	—	—	—	4
M. n. sp. B	—	—	—	—	5	—	—	—	—	1	—	—	—	—	—	—	—	—	6
M. n. sp. C	—	—	—	—	—	18	4	—	—	—	—	—	—	—	—	—	—	—	22
Total	10	1	16	20	114	131	10	5	26	49	26	22	4	14	20	8	2	22	500

Additional specimens belonging to the genus can also be identified throughout the Tethys region, including Poland (Narkiewicz, 1999), Romania (Orchard et al., 2007a), Turkey (Nicora, 1977), China (Orchard et al., 2007b), India (Chhabra and Kumar, 1992), and Tibet (Wang and Wang, 1976; Tian, 1982). It is not clear from the published illustrations whether the Tethyan specimens represent species that can be identified in North America, so detailed correlation between these regions is not possible at this time. However, the occurrence of *Magnigondolella* n. gen. close to the proposed position of the Olenekian-Anisian boundary in the sections at Desli Caira in Romania (Orchard et al., 2007a) and Guandao in China (Orchard et al., 2007b) suggests that the genus is potentially important for the recognition of this boundary. Further study of specimens of *Magnigondolella* n. gen. from these sections will be necessary as work on defining and correlating the Olenekian-Anisian boundary continues.

The recognition of five new species of *Magnigondolella* n. gen., and three additional species in open nomenclature, increases the number of conodont species identified from the lower and middle Anisian of North America considerably. The early and middle parts of the Anisian were characterized as a low diversity period globally by Chen et al. (2016) and Kiliç et al. (2016), with both studies recognizing ~30 species for the Aegean, Bithynian, and Pelsonian (equivalent to the lower and middle Anisian). Such a low value may be due partially to the preliminary nature of the study of North American Anisian taxa, and partially to endemism of North American species. This highlights the need to carry out detailed taxonomic work before accurate judgments of biodiversity can be made.

Acknowledgments

The authors wish to thank Associate Editor H.-D. Sues and an anonymous reviewer for comments that helped to improve this manuscript. The samples from B.C. utilized in this study were collected by the authors as well as by E.T. Tozer and J.-P. Zonneveld. The samples from Nevada were largely derived from the matrix of ammonoid collections made by H. Bucher. Samples were processed and specimens photographed by P. Krauss and H. Taylor. Financial support for this study was provided by the Cordillera Project of the Geological Survey of Canada GEM-2 Program.

References

Bender, H., 1970, Zur Gliederung der Mediterranen Trias II. Die Conodontenchronologie der Mediterranen Trias: Annales Géologiques des Pays Helléniques, v. 19, p. 465–550.

Bucher, H., 1988, A new Middle Anisian (Middle Triassic) ammonoid zone from northwestern Nevada (USA): Eclogae Geologicae Helvetiae, v. 81, p. 723–762.

Bucher, H., 1989, Lower Anisian ammonoids from the northern Humboldt Range (northwestern Nevada, USA) and their bearing upon the Lower-Middle Triassic boundary: Eclogae Geologicae Helvetiae, v. 82, p. 945–1002.

Bucher, H., 1992a, Ammonoids of the Hyatti Zone and the Anisian transgression in the Star Peak Group, northwestern Nevada, USA: Palaeontographica Abteilung A, v. 223, p. 137–166.

Bucher, H., 1992b, Ammonoids of the Shoshonensis Zone (Middle Anisian, Middle Triassic) from northwestern Nevada (USA): Jahrbuch der Geologischen Bundesanstalt Wien, v. 135, p. 425–465.

Bucher, H., 1994, New ammonoids from the Taylori Zone (Middle Anisian, Middle Triassic) from northwestern Nevada (USA): Mémoires de Géologie (Lausanne), v. 22, p. 1–8.

Bucher, H., 2002, Early Anisian (Middle Triassic) ammonoid biostratigraphy of northeastern British Columbia: Eclogae Geologicae Helvetiae, v. 95, p. 277–287.
Chen, Y., Krystyn, L., Orchard, M.J., Lai, X., and Richoz, S., 2016, A review of the evolution, biostratigraphy, provincialism and diversity of Middle and early Late Triassic conodonts: Papers in Palaeontology, v. 2, p. 235–263.
Chhabra, N.L., and Kumar, S., 1992, Late Scythian through early Carnian conodont assemblages and their biostratigraphic importance from off shore carbonates of northern Kumaun, Tethys Himalaya, India: Revue de Micropaléontologie, v. 35, p. 3–21.
Clark, D.L., Paull, R.K., Solien, M.A., and Morgan, W.A., 1979, Triassic conodont biostratigraphy in the Great Basin, *in* Sandberg, C.A., and Clark, D.L., eds., Conodont biostratigraphy of the Great Basin and Rocky Mountains: Brigham Young University Geology Studies, v. 26, p. 179–186.
Davies, G.R., 1997, The Triassic of the Western Canada Sedimentary Basin: tectonic and stratigraphic framework, paleogeography, paleoclimate and biota, *in* Moslow, T.F., and Wittenberg, J., eds., Triassic of the Western Canada Sedimentary Basin: Bulletin of Canadian Petroleum Geology, v. 45, p. 434–460.
Dzik, J., 1976, Remarks on the evolution of Ordovician conodonts: Acta Palaeontologica Polonica, v. 21, p. 395–455.
Evoy, R.W., and Moslow, T.F., 1995, Lithofacies associations and depositional environments in the Middle Triassic Doig Formation, Buick Creek Field, northeastern British Columbia: Bulletin of Canadian Petroleum Geology, v. 43, p. 461–475.
Ferri, F., Golding, M.L., Mortensen, J.K., Zonneveld, J.P., and Orchard, M.J., 2010, Toad Formation (Montney and Doig equivalent) in northwestern Halfway River map area, British Columbia (NTS 094B/14): Geoscience Reports 2010, B.C. Ministry of Energy, p. 21–34.
Golding, M.L., 2014, Biostratigraphy and sedimentology of Triassic hydrocarbon-bearing rocks in northeastern British Columbia [Ph.D. Dissertation]: Vancouver, University of British Columbia, 402 p.
Golding, M.L., in press, Reconstruction of the multielement apparatus of *Neogondolella* ex gr. *regalis* Mosher (Conodonta) from the Anisian (Middle Triassic) of British Columbia, Canada: Journal of Micropalaeontology.
Golding, M.L., and Orchard, M.J., 2016, New species of the conodont *Neogondolella* from the Anisian (Middle Triassic) of northeastern British Columbia, Canada, and their importance for regional correlation: Journal of Paleontology, v. 90, p. 1197–1211.
Golding, M.L., Orchard, M.J., Zonneveld, J.-P., Henderson, C.M., and Dunn, L., 2014a, An exceptional record of the sedimentology and biostratigraphy of the Montney and Doig formations in British Columbia: Bulletin of Canadian Petroleum Geology, v. 62, p. 157–176.
Golding, M.L., Orchard, M.J., and Zonneveld, J.-P., 2014b, A summary of new conodont biostratigraphy and correlation of the Anisian (Middle Triassic) strata in British Columbia, Canada: Albertiana, v. 42, p. 33–42.
Golding, M.L., Orchard, M.J., Zonneveld, J.-P., and Wilson, N.S.F., 2015, Determining the age and depositional model of the Doig Phosphate Zone in northeastern British Columbia using conodont biostratigraphy: Bulletin of Canadian Petroleum Geology, v. 63, p. 143–170.
Goudemand, N., Orchard, M.J., Bucher, H., and Jenks, J., 2012, The elusive origin of *Chiosella timorensis* (Conodont Triassic): Geobios, v. 45, p. 199–207.
Hirsch, F., 1994, Triassic conodonts as ecological and eustatic sensors, *in* Embry, A.F., Beauchamp, B., and Glass, D.J., eds., Pangea: Global Environments and Resources: Memoir of the Canadian Society of Petroleum Geologists, v. 17, p. 949–959.
Jeppsson, L., Anehus, R., and Fredholm, D., 1999, The optimal acetate buffered acetic acid technique for extracting phosphatic fossils: Journal of Paleontology, v. 73, p. 964–972.
Kiliç, A.M., Plasencia, P., Ishida, K., Guex, J., and Hirsch, F., 2016, Proteromorphosis of *Neospathodus* (Conodonta) during the Permian–Triassic crisis and recovery: Revue de Micropaléontologie, v. 59, p. 33–39.
Kozur, H., 1989, The taxonomy of the Gondolellid conodonts in the Permian and Triassic: Courier Forschunginstitut Senkenberg, v. 117, p. 409–469.
Kozur, H., Krainer, K., and Mostler, H., 1994, Middle Triassic conodonts from the southern Karawanken Mountains (Southern Alps) and their stratigraphic importance: Geologische-Paläontologische Mitteilungen Innsbruck, v. 19, p. 165–200.
Lindström, M., 1970, A suprageneric taxonomy of the conodonts: Lethaia, v. 3, p. 427–445.
Monnet, C., and Bucher, H., 2005a, Anisian (Middle Triassic) ammonoids from North America: quantitative biochronology and biodiversity: Stratigraphy, v. 2, p. 281–296.
Monnet, C., and Bucher, H., 2005b, New Middle and Late Anisian (Middle Triassic) ammonoid faunas from northwestern Nevada (USA): taxonomy and biochronology: Fossils and Strata, v. 52, 121 p.
Mosher, L.C., 1968, Triassic conodonts from western North America and Europe and their correlation: Journal of Paleontology, v. 42, p. 895–946.
Mosher, L.C., 1970, New conodont species as Triassic guide fossils: Journal of Paleontology, v. 44, p. 737–742.
Mosher, L.C., 1973, Triassic conodonts from British Columbia and the northern Arctic Islands: Geological Survey of Canada Bulletin, v. 222, p. 141–193.
Mosher, C., and Clark, D.L., 1965, Middle Triassic conodonts from the Prida Formation of Northwestern Nevada: Journal of Paleontology, v. 39, p. 551–565.
Moslow, T.F., 2000, Reservoir architecture of a fine-grained turbidite system: Lower Triassic Montney Formation, Western Canada Sedimentary Basin: Deep Water Reservoirs of the World, Society of Economic Paleontologists and Mineralogists, Gulf Coast Section, 20th Annual Bob Perkins Research Conference, Houston. Program and Abstracts, p. 42.
Nakrem, H.A., Orchard, M.J., Weitschat, W., Hounslow, M.W., Beatty, T.W., and Mørk, A., 2008, Triassic conodonts from Svalbard and their Boreal correlations: Polar Research, v. 27, p. 523–539.
Narkiewicz, K., 1999, Conodont biostratigraphy of the Muschelkalk (Middle Triassic) in the central part of the Polish Lowlands: Geological Quarterly, v. 43, p. 313–328.
Nichols, K.M, and Silberling, N.J., 1977, Stratigraphy and depositional history of the Star Peak Group (Triassic), northwestern Nevada: Geological Society of America Special Paper, v. 178, 73 p.
Nicora, A., 1976, Conodont-fauna, stratigraphic position and relations to the Tethyan succession of the Shoshonensis Zone (Pelsonian) of Nevada: Rivista Italiana di Paleontologia e Stratigrafia, v. 82, p. 627–648.
Nicora, A., 1977, Lower Anisian platform-conodonts from the Tethys and Nevada: taxonomic and stratigraphic revision: Palaeontographica Abteilung A, v. 157, p. 88–107.
Nicora, A., and Kovács, S., 1984, Conodont fauna from the Rotelliformis, Meeki and Occidentalis zones (Middle Triassic) of Humboldt Range, Nevada, Western North America: Rivista Italiana di Paleontologia e Stratigrafia, v. 90, p. 135–164.
Nicora, A., Kozur, H., and Mietto, P., 1980, Gondolella pridaensis sp. n. A new conodont species from the Middle Triassic: Rivista Italiana di Paleontologia, v. 86, p. 761–768.
Ogg, J.G., Huang, C., and Hinnov, L., 2014, Triassic timescale status: a brief overview: Albertiana, v. 41, p. 3–30.
Orchard, M.J., 1987, Conodonts from western Canadian chert: their nature, distribution and stratigraphic application, *in* Austin, R.L., ed., Conodonts: Investigative Techniques and Applications: British Micropalaeontological Society Series: Chichester, Ellis Horwood Ltd., p. 94–119.
Orchard, M.J., 1994, Conodont biochronology around the Early-Middle Triassic boundary: new data from North America, Oman and Timor: Mémoires de Géologie (Lausanne), v. 22, p. 105–114.
Orchard, M.J., 2006, Late Paleozoic and Triassic conodont faunas of Yukon and northern British Columbia and implications for the evolution of the Yukon-Tanana terrane, *in* Colpron, M., and Nelson, J.L., eds., Paleozoic Evolution and Metallogeny of Pericratonic Terranes at the Ancient Pacific Margin of North America: Canadian and Alaskan Cordillera, Geological Association of Canada Special Paper, v. 45, p. 229–260.
Orchard, M.J., 2007, Conodont diversity and evolution through the latest Permian and Early Triassic upheavals: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 252, p. 93–117.
Orchard, M.J., 2008, Lower Triassic conodonts from the Canadian Arctic, their intercalibration with ammonoid-based stages and a comparison with other North American Olenekian faunas: Polar Research, v. 27, p. 393–412.
Orchard, M.J., 2010, Triassic conodonts and their role in stage boundary definition: Journal of the Geological Society of London, v. 334, p. 139–161.
Orchard, M.J., 2014, Conodonts from the Carnian-Norian boundary (Upper Triassic) of Black Bear Ridge, northeastern British Columbia, Canada: New Mexico Museum of Natural History and Science Bulletin, v. 64, 139 p.
Orchard, M.J., and Bucher, H., 1992, Conodont-ammonoid intercalibration around the Lower-Middle Triassic boundary: Nevadan clocks help tell British Columbian time: Geological Survey of Canada Paper, v. 92-1E, p. 133–140.
Orchard, M.J., and Tozer, E.T., 1997, Triassic conodont biochronology, its calibration with the ammonoid standard, and a biostratigraphic summary of the Western Canada Sedimentary Basin, *in* Moslow, T.F., and Wittenberg, J., eds., Triassic of the Western Canada Sedimentary Basin: Bulletin of Canadian Petroleum Geology, v. 45, p. 675–692.
Orchard, M.J., Grădinaru, E., and Nicora, A., 2007a, A summary of the conodont succession around the Olenekian-Anisian boundary at Deşli Caira, North Dobrogea, Romania, *in* Lucas, S.G., and Spielmann, J.A., eds., The Global Triassic: New Mexico Museum of Natural History and Science Bulletin, v. 41, p. 341–346.
Orchard, M.J., Lehrmann, D.J., Wei, J., Wang, H., and Taylor, H., 2007b, Conodonts from the Olenekian-Anisian boundary beds, Guandao, Guizhou Province, China, *in* Lucas, S.G., and Spielmann, J.A., eds., The Global Triassic: New Mexico Museum of Natural History and Science Bulletin, v. 41, p. 347–354.
Pander, C.H., 1856, Monographie der fossilen Fische des silurischen Systems der russisch-baltischen Gouvernements: St. Petersburg, Akademie der Wissenschaften, 91 p.

https://doi.org/10.1017/jpa.2017.123 Published online by Cambridge University Press

Ritter, S.M., 1989, Morphometric patterns in Middle Triassic *Neogondolella mombergensis* (Conodonta), Fossil Hill, Nevada: Journal of Paleontology, v. 63, p. 233–245.
Silberling, N.J., and Nichols, K.M., 1982, Middle Triassic molluscan fossils of biostratigraphic significance from the Humboldt Range, northwestern Nevada: U.S. Geological Survey Professional Paper, v. 1207, 77 p.
Silberling, N.J., and Tozer, E.T., 1968, Biostratigraphic classification of the marine Triassic in North America: U.S. Geological Survey Special Paper, v. 110, 63 p.
Silberling, N.J., and Wallace, R.E., 1969, Stratigraphy of the Star Peak Group (Triassic) and overlying Mesozoic rocks, Humboldt Range, Nevada: U.S. Geological Survey Professional Paper, v. 592, 50 p.
Stone, J., 1987, Review of investigative techniques used in the study of conodonts, *in* Austin, R.L., ed., Conodonts: Investigative Techniques and Applications: British Micropalaeontological Society Series: Chichester, Ellis Horwood Ltd., p. 17–34.
Tian, C.R., 1982, Triassic conodonts in the Tulong section from Nyalam County, Xizang (Tibet), China: Contribution to Geology of Qinghai-Xizang (Tibet) Plateau, v. 10, p. 153–165.
Tozer, E.T., 1967, A standard for Triassic time: Geological Survey of Canada Bulletin, v. 156, 103 p.
Tozer, E.T., 1994, Canadian Triassic Ammonoid Faunas: Geological Survey of Canada Bulletin, v. 467, 663 p.
Wang, C.Y., and Wang, Z.H., 1976, Triassic conodonts from the Mt. Jolmo Lungma region, *in* Tibetan Scientific Expedition Team of Chinese Academy of Science, eds., A Report of Scientific Expedition in the Mt. Jolmo Lungma Region (1966–1968). Palaeontology: Beijing, Science Press, 2, p. 387–424.
Wardlaw, B.R., and Jones, D.L., 1980, Triassic conodonts from eugeoclinal rocks of western North America and their tectonic significance: Rivista Italiana di Paleontologia e Stratigrafia, v. 85, p. 895–908.
Wyld, S.J., 2000, Triassic evolution of the arc and backarc of northwestern Nevada, and evidence for extensional tectonism: Geological Society of America Special Paper, v. 347, p. 185–207.
Zonneveld, J.-P., 2010, The Triassic of northeastern British Columbia: sedimentary characteristics and stratigraphic architecture of conventional and unconventional reservoir successions: Geological Association of Canada-Mineralogical Association of Canada Joint Annual Meeting (GeoCanada 2010), Williston Lake Field Trip Guidebook, 158 p.

Accepted 11 September 2017