



Reconstruction of the multielement apparatus of *Neogondolella* ex gr. *regalis* Mosher, 1970 (Conodonta) from the Anisian (Middle Triassic) in British Columbia, Canada

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Abstract. The multi-element apparatus of the Middle Triassic conodont *Neogondolella* ex gr. *regalis* has been reconstructed based on material collected from the upper Anisian in British Columbia, Canada. The apparatus of this species group is distinguished by the presence of a segminiplanate P1 element with a high, fused carina, and an alate S0 element with anterior processes that bifurcate at the cusp. This S0 element morphology is unlike those of other species from the upper Anisian of North America, but similar to those from the Lower Triassic. The new reconstruction demonstrates that *Neogondolella* ex gr. *regalis* does not belong to the genus *Neogondolella*, nor to any other Triassic gondolellid genus. It is therefore proposed that *Neogondolella* ex gr. *regalis* should be referred to a new genus.

1 Introduction

The earliest multielement reconstructions of Triassic conodonts were carried out by Huckriede (1958), who recognized recurring associations of elements in his collections from the Middle Triassic. Sweet (1970) subsequently used statistical methods to analyze associations between conodont elements and concluded that most Triassic conodont species were unimembrate, consisting of only pectiniform elements. The ramiform elements were thought to belong to separate multimembrate apparatuses. Kozur (1989) and Hirsch (1994) maintained that all Triassic conodonts were multimembrate. The discovery of fused clusters (Ramovs, 1977, 1978; Mittero, 1982; Huang et al., 2010; Goudemand et al., 2012) and natural assemblages (Rieber, 1980; Orchard and Rieber, 1999; Goudemand et al., 2011) has subsequently demonstrated that Triassic conodonts were indeed multimembrate, and both types of elements existed together in the same apparatus. Statistical reconstructions of a number of Triassic apparatuses were attempted by Kozur and Mostler (1971), Ramovs (1977), Bagnoli et al. (1985), Zhang and Yang

(1991), Hirsch (1994), Koike (1996, 1999), Orchard (2005), and Ishida and Hirsch (2011).

The description of natural assemblages of *Neogondolella* by Orchard and Rieber (1999) established a 15-element plan for the apparatus of this genus. Investigation of fused clusters by Goudemand et al. (2012) led to a revision of the *Neogondolella* apparatus by switching the position of the S1 element with the S2. As currently reconstructed, the *Neogondolella* apparatus contains seven paired elements (segminiplanate P1, angulate P2, dolobrate S1, breviform digyrate S2, bipennate S3, bipennate S4, and breviform digyrate M) and a single alate S0 element. The P1 element is the most variable in the apparatus and is used to define species. The S3 element has a distinctive bifid anterior process, whilst the lateral processes of the S0 element diverge either at the cusp or slightly anterior of it (Orchard, 2005; Goudemand et al., 2012).

Thus far, the only species of *Neogondolella* to have their multielement apparatuses illustrated are *N. constricta* (Mosher and Clark, 1965), *N. inclinata* (Kovács, 1983), *N. ex gr. subcarinata* Sweet, 1973, and *N. n. sp.* A *sensu* Goudemand et al. (2012). The multielement apparatus of the type species for the genus of *Neogondolella*, *N. momburgensis*

(Tatge, 1956), has not been illustrated; however, both types of S0 element were illustrated by Tatge (1956), and they occur together in Anisian collections of *N. mombergensis* (Orchard, 2005). The S0 element that bifurcates at the cusp is found predominantly in the Permian and Lower Triassic and occurs up to the middle Anisian (Middle Triassic). It has been suggested that species with this type of S0 element should be referred to *Clarkina* or *Neoclarkina* instead of *Neogondolella* (Henderson et al., 2006; Henderson and Mei, 2007); however, the apparatuses of the type species of these genera, *Clarkina leveni* (Kozur et al., in Kozur, 1975) and *Neoclarkina discreta* (Orchard and Krystyn, 1998), have not been reconstructed either. The multielement description of other species of *Neogondolella* is necessary to help resolve this taxonomic issue and to provide a more robust definition for the genus.

2 Material and methods

The recovery of large monospecific collections of *Neogondolella* ex gr. *regalis* Mosher, 1970 from the subsurface of British Columbia has facilitated the reconstruction of the apparatus of this species group for the first time; this is also the first time that a Triassic conodont apparatus has been reconstructed from subsurface material. The collections occur in two samples from the Talisman Altares 16-17-083-25W6 hydrocarbon well, located to the west of Fort St. John (surface location 56.201495° N, 121.906891° W; Fig. 1). The core from this well consists primarily of siltstone, with minor amounts of carbonate and fine sandstone belonging to the Montney and Doig formations. Multiple samples were collected from this core for conodont processing, and a detailed discussion of the sedimentology and biostratigraphy of this core is provided in Golding et al. (2014). The two samples discussed in this paper both come from the upper Anisian (Middle Triassic) part of the Doig Formation, at depths of 2238.74–2239.75 m (GSC curation no. V-002978) and 2234.10–2234.57 m (GSC curation no. V-002980) below the Kelly bushing datum.

3 Results and discussion

Both of these samples contain pectiniform and ramiform elements of *Neogondolella* ex gr. *regalis*. Eight different element types can be recognized and related to the standard *Neogondolella* apparatus (Fig. 2; Table 1). The P1 elements are segminiplanate and possess a distinctive high fused carina, which is typical of *N. ex gr. regalis*. The P2 element is angulate, the M element is breviform digyrate, and the S1 element is dolobrate. The S2 element is breviform digyrate or “enantiognathiform”, which is typical of the superfamily Gondolelloidea (Lindström, 1970). The S3 element is bipennate with a bifid anterior process, which is typical of the subfamily Neogondolellinae Hirsch, 1994. The S4 element

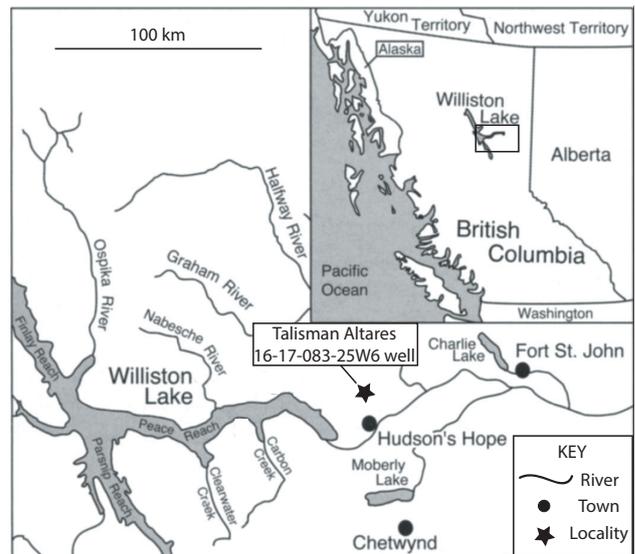


Figure 1. Map showing the location of the Talisman Altares 16-17-083-25W6 well in British Columbia.

Table 1. Table of elements in *Neogondolella* ex gr. *regalis* recovered from the Talisman Altares 16-17-083-25W6 well.

Element	Sample V-002978	Sample V-002980	Total
P1	28	242	270
P2	2	22	24
S1	1	15	16
S2	15	52	67
S3	1	0	1
S4	3	40	43
S0	4	17	21
M	2	29	31
Total	56	407	473

is bipennate with a single anterior process, and the S0 element is alate with bifurcation of its anterior processes at the cusp, unlike the S0 element in other species from the upper Anisian in North America but similar to those from the Lower Triassic (Orchard, 2005).

The present reconstruction extends the range of S0 elements that bifurcate at the cusp into the upper Anisian. Henderson and Mei (2007) suggested that species with this S0 element morphology should be referred to *Clarkina* or *Neoclarkina*, with species of *Neogondolella* having an S0 element that bifurcates anterior of the cusp. However, no associations of elements were illustrated in support of this conclusion. In the original publication of Tatge (1956), P1 elements in *Neogondolella mombergensis*, the type species of *Neogondolella*, are illustrated with both forms of S0 element. The only other P1 elements illustrated from this fauna belong to *Nicoraella kockeli* (Tatge, 1956), the apparatus of which has subsequently been reconstructed with an S0 element that

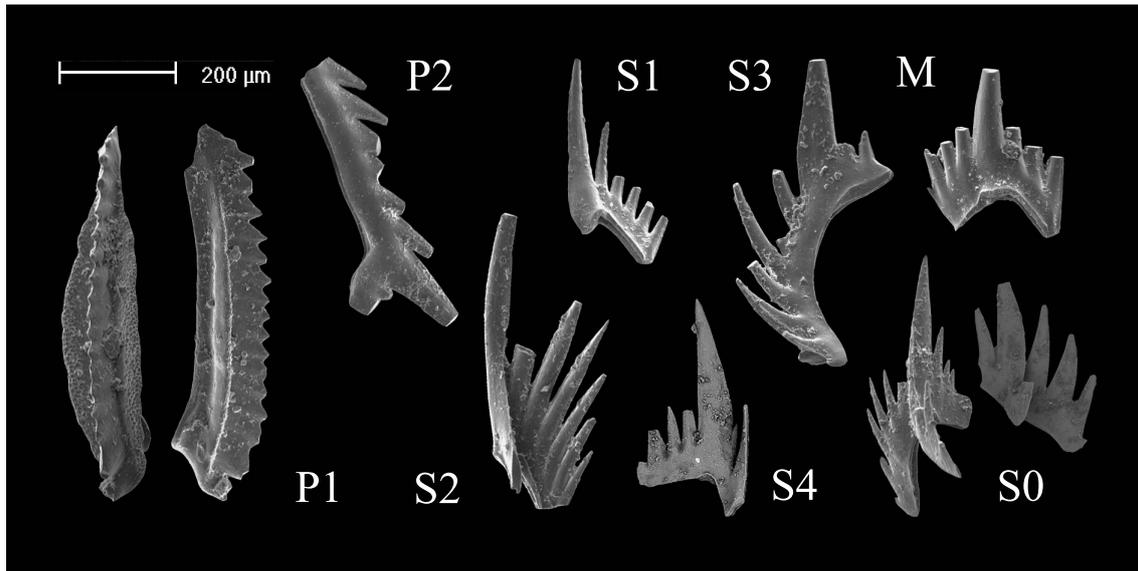


Figure 2. *Neogondolella* ex gr. *regalis* Mosher. P1, GSC type no. 131563; P2, GSC type no. 131564; S0, GSC type no. 131565 and GSC type no. 131566; S1, GSC type no. 131567; S2, GSC type no. 131568; S3, GSC type no. 131569; S4, GSC type no. 131570; M, GSC type no. 131571. P1, S3, and M from sample V-002978; P2, S0, S1, S2, and S4 from sample V-002980. Both samples are from the Doig Formation, Talisman Altares 16-17-083-25W6 well.

bifurcates at the cusp (Sun et al., 2009). It is therefore possible that the S0 elements that bifurcate anterior of the cusp belong to *Neogondolella* as suggested by Henderson and Mei (2007). If so, this would necessitate the placement of *N. ex gr. regalis* into either *Clarkina* or *Neoclarkina*. The high carina and lack of an anterior free blade on the P1 element of *N. ex gr. regalis* precludes association with *Clarkina*. The genus *Neoclarkina* is defined by the lack of a platform on the P1 element at the earliest growth stages (Henderson and Mei, 2007), a growth pattern that is shared with *N. ex gr. regalis*; however, the carina of *N. ex gr. regalis* is very different to that of *Neoclarkina discreta*. It may be appropriate to separate this group into its own genus, which in turn would mean that the morphology of the S0 element in gondolellids has a taxonomic significance above the level of genus. Systematic work on diverse collections of *N. ex gr. regalis* from North America is ongoing in an attempt to resolve this issue.

Data availability. Illustrated specimens are housed at the National Type Collection of Invertebrate and Plant Fossils at the Geological Survey of Canada in Ottawa, Ontario, Canada.

Competing interests. The author declares no conflict of interest.

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