

## Morphology and relationships of the enigmatic stenotheceid pan-brachiopod *Stenotheceoides*—new data from the middle Cambrian Burgess Shale Formation

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Bulk sampling of middle Cambrian carbonate units in the lower Burgess Shale Formation (Wuliuan) and the upper Wheeler Formation (Drumian) in Utah have yielded abundant silicified stenotheceids. Previously unreported from the Burgess Shale, stenotheceids discovered include at least two species: *Stenotheceoides* cf. *elongata* and *Stenotheceoides rasettii* sp. nov. The Utah material is assigned to *Stenotheceoides elongata*. The new stenotheceid material confirms some earlier observations including a set of interior grooves and ridges forming nested chevrons across the midline and a finer set disposed around the interior shell margin. The chevroned grooves are interpreted here as mantle canals and the peripheral furrows as setal grooves. A prominent boss occurs at the valve apex in both valves. An apparent socket receiving the boss in the opposite valve described in earlier studies we show to be an artefact of preservation. Consequently, the bosses were juxtaposed when the valves were conjoined and so must have had some function other than valve articulation. Most extraordinary in *Stenotheceoides* is an embayment at the shell apex, which likely represents a rudimentary pedicle foramen. This and other features including apparent articulate brachiopod-like calcitic fibrous shell microstructure replicated in silica, indicate phylogenetic propinquity of the Stenotheceida is with the Brachiopoda, not the Mollusca. However, phylogenetic proximity of the Stenotheceida relative to any of the brachiopod crown groups is unclear. Stenotheceids may represent a pan-brachiopod stem group derived from organocalcitic, multisclerite, eccentrothecimorph tommotiids via sclerite reduction to two opposing mitral sclerites. Discovery of stenotheceids in carbonate debris aprons in the Burgess Shale suggests transport of shelly biota downslope from the adjacent platform. However, their absence in siliciclastic units of the Burgess Shale preserving both shelly and soft-bodied biota indicates these units lack significant input of transported elements from the adjacent platform

**Key words:** Stenotheceida, Brachiopoda, Mollusca, Cambrian, Burgess Shale Formation.

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