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Cambrian Correlation: the use of quantitative biostratigraphy as a test of the traditional trilobite biostratigraphic framework

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Biostratigraphy has always involved the systematic collection, examination, and determination of fossil taxa found in successions of strata. The ultimate goal of this work is understanding and utilising recorded faunal successions for relative age determination. In the Cambrian System trilobites remain the main index fossil group for which this technique applies (Babcock *et al.*, 2017). In North America, the 20th century involved great advancements in the field of trilobite biostratigraphy, culminating in the continental-scale synthesis of local trilobite biostratigraphic schemes by Lochman-Balk and Wilson (1958). Their synthesis produced inter-regional genus-level assemblage biozones that still form the basis of most Cambrian relative-age determinations in Laurentia. These assemblage zones did however, come at a cost. The temporal resolution was lowered to produce zones that could be recognised across the continent. High-resolution, species-based biostratigraphic zones are largely limited in spatial extent, often only useful within the region where they were first defined (Rasetti, 1951; Palmer, 1965; Pratt, 1992; Sundberg, 1994; Sundberg and McCollum, 2003; McCollum and Sundberg, 2007). This conflict between continent-wide correlation and high-precision relative-age dating continues to be a pre-occupation of biostratigraphic studies, with the added imperative to integrate Laurentian biozonal schemes with efforts to produce an international chronostratigraphic framework (Babcock *et al.*, 2017).

Fortunately, the traditional methodology forming the basis of trilobite biostratigraphic studies has produced a large amount of data to help address these issues. A massive dataset of trilobite occurrences accumulated and preserved in monographs and museum collections is available for analysis. Cambrian trilobite biostratigraphy as a result is a field ripe for examination with tools designed to handle Big Data. A number of quantitative techniques have been developed for this purpose, ranging from classic methods such as Graphic Correlation (Shaw, 1964), to computer driven processes such as Constrained Optimisation (Kemple *et al.*, 1995; Sadler, 2004) and Unitary Association (Monnet *et al.*, 2015). While the majority of past biostratigraphic analyses have been subject to constraints of regional scope, these methods can analyse much larger datasets and produce continent-scale biostratigraphic correlations as well as test regional results and resolve complications caused by biofacies (Ludvigsen *et al.*, 1986).

For the Miaolingian Series (middle Cambrian), a dataset containing trilobite occurrences from 117 sections (48 formations, 994 sampled horizons containing 588 trilobite taxa) across western North America was analysed with the Unitary Association method to examine the potential for high-precision, species-defined interval-range biozone recognition. The results of this analysis are encouraging with recognition by the program of 28 previously defined interval-range biozones. In addition, the output also allowed five new interval-range biozones to be defined or redefined.
These results not only form a useful test of the UA method for trilobite biostratigraphy but also present a high-resolution temporal framework that can be tested by further biostratigraphic studies. This new biostratigraphy has also allowed for a re-assessment of the correlation of 48

Cambrian formations across western North America from Arctic Canada to the Sonoran region of northern Mexico. The improved precision will aid in correlating important events such as sequence-stratigraphic surfaces, as well as key evolutionary events of biotic importance, including calibrating part of the Cambrian explosion and Burgess Shale-type deposits during this interval.

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