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Substrate-related phenotypic variation in the Cambrian Burgess Shale brachiopod *Micromitra burgessensis*

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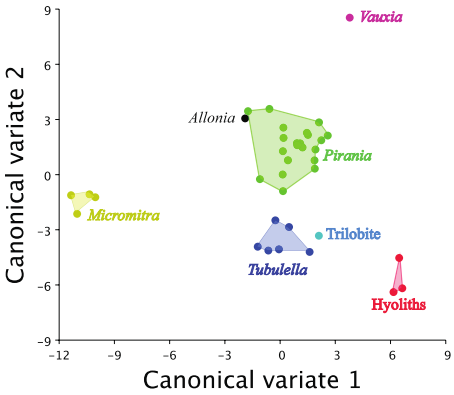
Phenotypic variation is a ubiquitous phenomenon in nature and is most likely a response by organisms to increase their survival and persistence rates across a wide range of habitat types [1]. The underlying mechanisms of which are crucial to our understanding of how organisms respond to changing ecosystem structure. The Cambrian represents a period of time that witnessed dramatic biological and environmental changes to marine ecosystems, yet our knowledge of how individual species responded to these changes is scant.

Fig. 1. Micromitra attached to Tubulella

Our understanding of the evolution and ecology of animals during this explosion of life in the Cambrian is largely driven by the examination of soft-bodied organisms from Burgess Shale-type deposits [2,3]. The beauty of Lagerstätte deposits is that they have perfectly captured some organisms in life position. Individuals of the brachiopod, *Micromitra burgessensis* in the Cambrian Burgess Shale Lagerstätte are preserved in such a manner, attached to a range of hard substrates, including skeletal debris, conspecific brachiopod shells, enigmatic tubes and sponges. Here we investigate the phenotypic variability of *M. burgessensis* testing for adaptations related to contrasting substrate attachments.



We apply the methods of geometric morphometrics, by plotting landmarks on the exterior of ventral and dorsal valves of *M. burgessensis* specimens that are preserved attached to different substrates. We use a suite of quantitative analyses to determine whether there are distinct variations in shape related to substrate. Canonical variate analyses, for both ventral and dorsal valves indicate that specimens attached to the same substrate are unique and distinct from other specimens attached to other substrates. Morphological variation associated with substrate choice is stronger than shape variation between populations strengthening the link between changes in phenotype and substrate choice. For specimens that have been preserved disarticulated from their substrate we can additionally begin to infer their attachment preference based on their morphometric signature. Despite this morphological plasticity there is insufficient evidence to suggest pseudocryptic speciation in *M. burgessensis*. Our results show the significance of phenotypic adaptations within a single brachiopod species providing valuable insights into the role that substrates play in the adaptive strategies and distribution of the Brachiopoda.

Fig. 2. CVA of brachiopod shape with attachments highlighted

[1] Fordyce (2006) J. Exp Biol, 209(12), 2377-2383.

[2] Caron and Jackson (2008). Pal Pal Pal 258, 222-256.

[3] Zhao et al. (2009). Palaios, 24(12), 826-839.