HOW DOES BODY SIZE OF TRILOBITES CHANGE ALONG A WATER DEPTH GRADIENT IN THE TRENTON GROUP (MIDDLE ORDOVICIAN) OF CENTRAL NEW YORK?

Lyndsey E. Farrar and Leigh M. Fall
Dept. of Earth & Atmospheric Sciences, SUNY Oneonta, Oneonta, NY 13820

SUNY ONEONTA

Introduction

Body size of organisms is a significant characteristic associated with metabolic rate, extinction, and other ecological and evolutionary traits. Body size has also been linked to species abundance; the number of individuals supported by an environment is limited due to resource allocation. Environmental factors change in conjunction with water depth and influence the distribution of fauna that live along the sea floor. Cisne and Rabe (1978) determined that the Middle Ordovician Trenton Group fossil communities were distributed along a water-depth gradient. The trilobite *Flexicalymene* is found throughout the Trenton Group but is restricted to shallower-water relative to *Triarthrus*, a deep-water genus (Cisne et al., 1980; 1982). It is unknown how body size changes along a water depth gradient. This study tests the hypothesis that the larger-bodied trilobite species are present in shallow water, while the smaller-bodied trilobite species are present on the deeper part of the Taconic Basin. The findings of this study will provide information on trilobite body-size distribution to help elucidate environmental factors within the Taconic foreland basin.

Geologic Background

The study area is the Taconic foreland basin that formed as a result of the collision between the eastern coast of North America and a volcanic island arc system. The Middle Ordovician Trenton Group was deposited within the basin. It contains limestones and shales, representing shallow-water deposition in the west and deep-water deposition in the east.

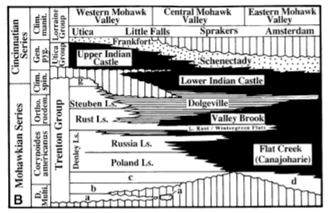
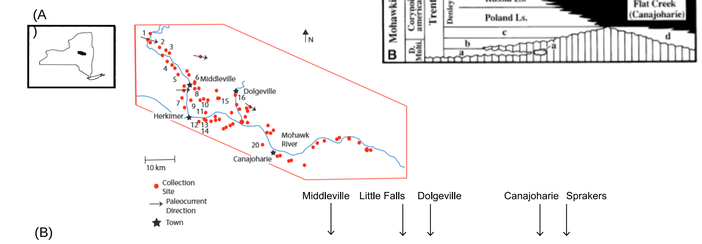


Fig. 1: Stratigraphy of the Trenton Group as revised by Brett and Baird (2002). The Dolgeville Formation is interpreted to be a widespread interval of "east-flowing turbiditic carbonate wash", rather than a transitional slope facies.



1 – Trenton Falls
2 – Gravesville Mill Creek
3 – Poland composite section
4 – Rathburn Brook
5 – Shedd Brook
6 – Buttermilk Creek and various
7 – Brook on Farber Lane
8 – Stoney Creek composite
9 – Creek along Miller Road
10 – North Creek
11 – Gun Club Road
12 & 13 – New York Thruway
14 – New York Route 5-S
15 – West Crum Creek composite
16 – Dolgeville Dam

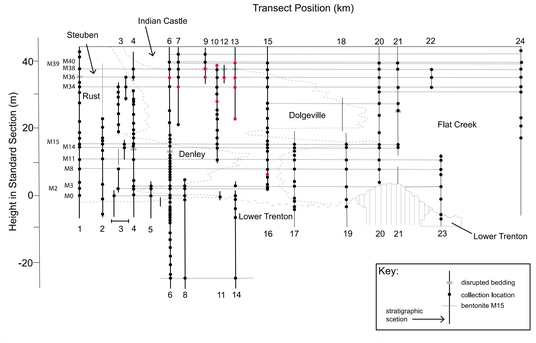


Fig. 2: Location of Cisne's collection sites within the Trenton Group. (A) Cisne's location map Paleocurrent information is based on fossils, mainly graptolites. (B) Cross section of collecting localities Sections 1 – 16 were used in this study. The black dots represent a collection and red dots represent the collections used in this study. The Rust and Steuben limestones replace the Denley Limestone above M15 based on Brett and Baird (2002). Modified from Cisne et al. (1982).

References

Brett, C.E., and Baird, G.C., 2002, Revised stratigraphy of the Trenton Group in its type area, central New York State: sedimentology and tectonics of a Middle Ordovician shelf-to-basin succession: *Physics and Chemistry of the Earth,* Parts A/B/C, v. 27, p. 231-263.
Cisne, J.L., Rabe, B.D.,1978, Coenocorrelation: gradient analysis of fossil communities and its applications in stratigraphy: *Lethaia*, v.11, p. 341-364.
Cisne, J.L., Molenock, J., and Rabe, B.D., 1980, Evolution in a cline: the trilobite *Triarthrus* along an Ordovician depth gradient: *Lethaia*, v.13, p.47-59.
Cisne, J.L., Chandlee, G.O., Rabe B.D., and Cohen, J.A., 1982, Clinal variation, episodic evolution, and possible parapatric speciation: the trilobite *Flexicalymene senaria* along an Ordovician depth gradient: *Lethaia*, v.15, p.325-341.
Trammer, J., and Kaim, A., 1997, Body size and diversity exemplified by three trilobite clades: *Acta Palaeontologica Poloncia*, v. 42, p. 1-12.

Acknowledgments

Lyndsey would like to thank the Paleontological Research Institution for receiving the John W. Wells Grants-in Aid of Research, the Paleontological Society for receiving the Allison R. "Pete" Palmer Award, and SUNY Oneonta for receiving a 2016 Student Grant Program for Research and Creative Activity grant.

Material and Methods

- *Flexicalymene* specimens were obtained from the Museum of Comparative Zoology at Harvard University. Specimens were either complete or mostly complete cephalons, but some specimens were the entire body. Some specimens were partially enrolled or fully enrolled. *Triarthrus* specimens were obtained from the Cisne collections (Fig. 2) currently housed at the Paleontological Research Institution (PRI) in Ithaca, NY. For *Triarthrus*, only the cephalon was preserved.
- Cephalon length was used as a proxy for body size (Trammer and Kaim, 1997). *Flexicalymene* cephalons were measured with a caliper. *Triarthrus* cephalons were photographed and measured using ImageJ**.** Cisne's measurements of *Triarthrus* are also included in these analyses.
- Detrended correspondence analyses (DCA) and abundance bar plot were run with abundances obtained from Cisne's notes.
- To test for differences in body size, Kruskal-Wallis and Mann-Whitney (Wilcoxon) tests were performed. All analyses run in R.

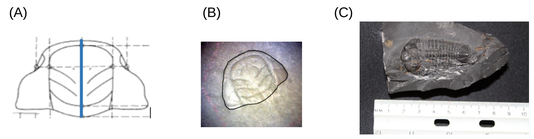


Fig. 3: Trilobite body size measurements. (A) Blue line shows cephalon length measurement used to measure both trilobite genera. Modified from Cisne et al. (1980). (B) *Triarthrus* cephalon from collection 144-2 (see Fig. 2B). Photographed under 0.7 X 10 magnification. (C) *Flexicalymene* specimen (MCZ catalog number 186329).

Results

- DCA ordination shows a separation of collections along axis 1 (Fig. 4). Axis 1 explains most of the variation among the collections.
- *Flexicalymene* is more abundant in the shallow-water sections (1-8), while *Triarthrus* is more abundant in deep water sections (9-16).
- *Flexicalymene* body size is significantly larger than *Triarthrus* (Mann-Whitney W= 8909.5, *p* = 1.615x10^-13).
- Body size of *Triarthrus* along bentonite M36 does not significantly differ across the basin (Kruskal-Wallis χ^2=8.2439, p= 0.1433).
- Body size of *Triarthrus* in section 13 does not significantly differ up section (Kruskal-Wallis χ^2=3.1839, p=0.2035).

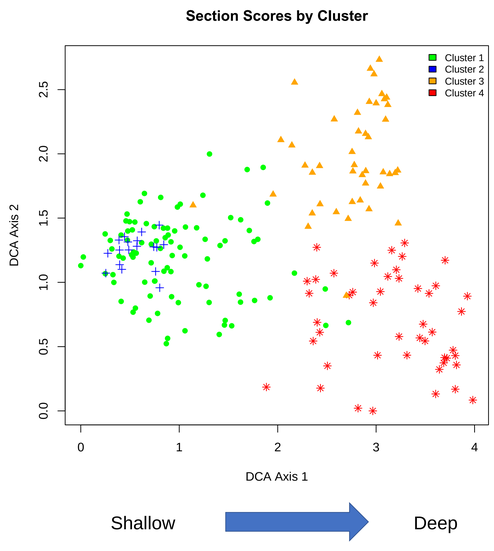
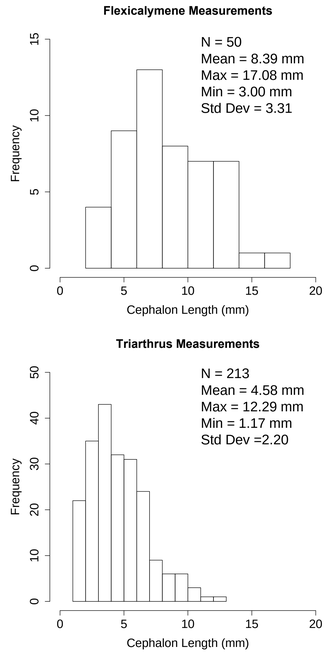
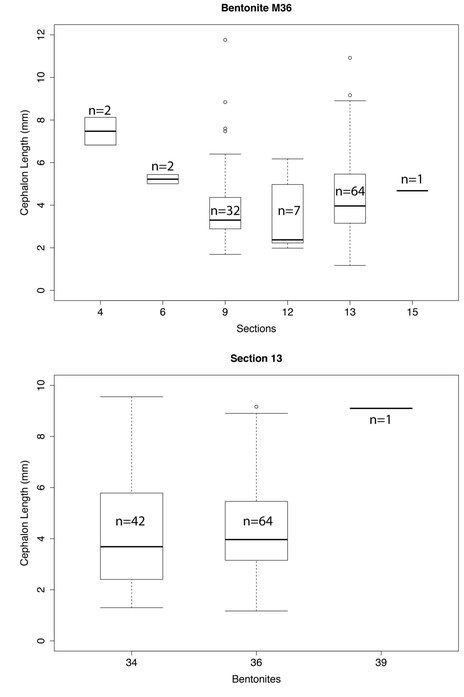


Fig. 4: DCA plot of faunal abundances from Cisne's collections. Colors represent results from a Q-mode cluster analysis.

Body Size



Triarthrus Body Size Trends



Discussion

- The separation on DCA axis 1 supports Cisne's interpretation of a water-depth gradient within the Middle Ordovician Trenton Group. Collections in clusters 1 and 2 are mainly from sections 1-6 (Fig. 2B), which are interpreted to be shallower water deposits within the Rust Limestone (Brett and Baird, 2002). These collections contain *Flexicalymene*, *Cryptolithus*, *Paucicrura*, *Sowerbyella*, and trepostome bryozoans. Collections in clusters 3 and 4 are mainly from sections 9-16 (Fig. 2B) within the Dolgeville, which is interpreted to be deeper relative to the Rust Limestone (Brett and Baird, 2002). These collections contain *Triarthrus*, *Mastigograptus*, *Rafinesquina, Geisonoceras*, and bryozoans.
- Body size results support the hypothesis that larger trilobites are found in shallower water (see body size histograms). The DCA ordination shows that *Flexicalymene* plots with the shallow-water clusters, while *Triarthrus* plots with the deeper-water clusters. The distribution of trilobite body size shown here may be due to a greater abundance of resources upslope, where *Flexicalymene* were living. The smaller trilobite *Triarthrus* lived in deeper water, which may indicate fewer resources are available downslope.
- The box and whisker plots of *Triarthrus* body size trends do not show a significant body size in *Triarthrus* across the basin or through time. *Triarthrus* may not have changed in body size because their access to resources and the level of predation remained constant through time and across the basin.