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

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Introduction

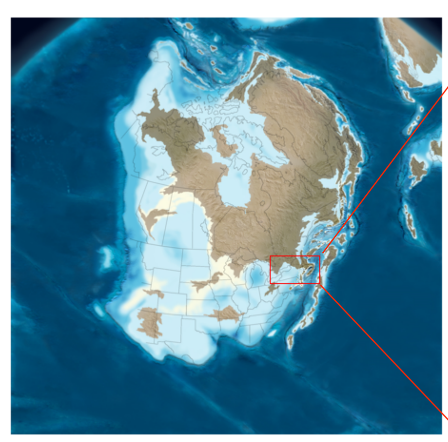
Body size of organisms is a significant characteristic associated with metabolic rate, extinction, and other ecological and evolutionary traits. Body size has also been linked to species abundance; the number of individuals supported by an environment is limited due to resource allocation. The Middle Ordovician Trenton Group located in central New York represents deposition of shallow-shelf carbonates to deep-water shales within the Taconic foreland basin. Cisne and Rabe (1978) determined that the Trenton Group fossil communities were distributed along a water depth gradient. Other environmental factors change in conjunction with water depth and influence the distribution of fauna that live along the sea floor. 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 whether there is a difference in body size between the two genera along the gradient. The findings of this study will provide information on trilobite body-size distribution to help elucidate environmental factors within the Taconic foreland basin.

Hypothesis & Prediction

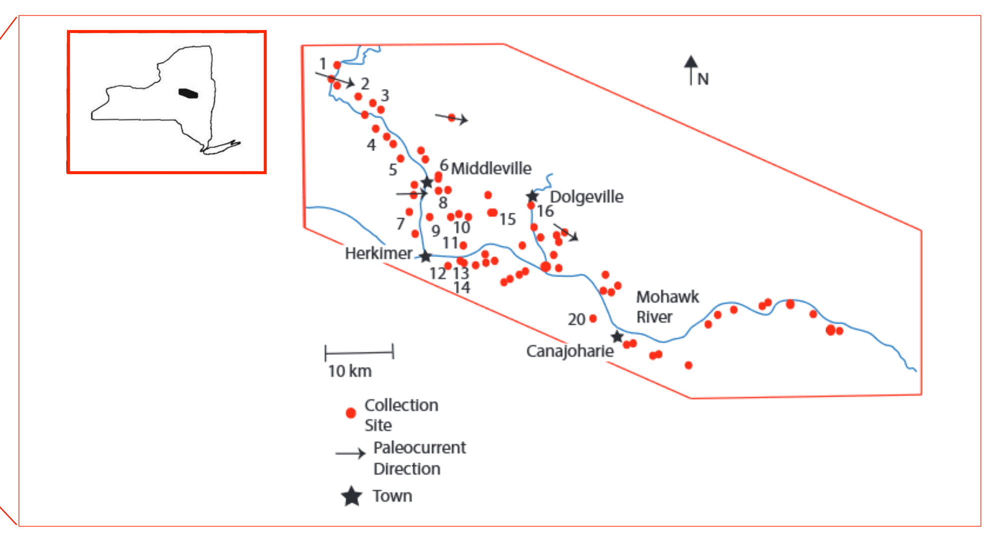
Hypothesis: There is a greater abundance of the smaller-bodied trilobite species on the deeper part of the Taconic Basin.

Prediction: A greater abundance of smaller *Triarthrus* fossils will dominate the deeper portion of the Taconic basin, while the larger *Flexicalymene* fossils will be more abundant in shallow areas of the basin.

Geologic Background

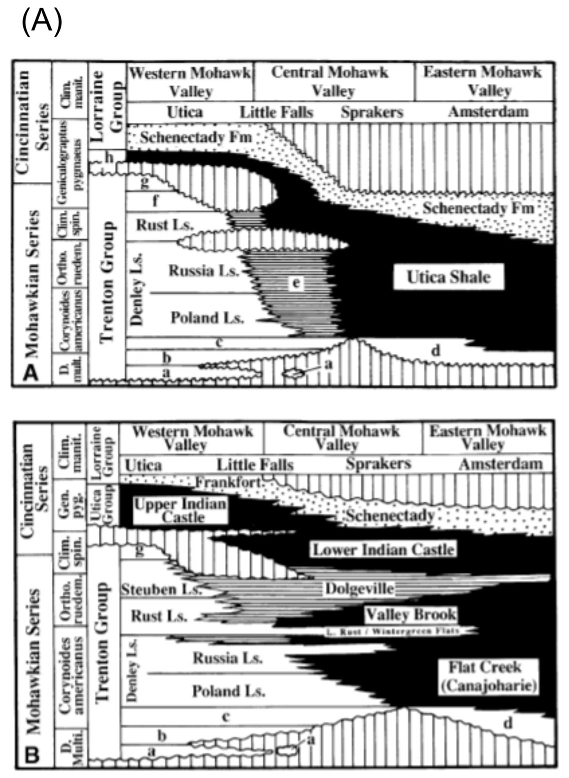


From Ron Blakey, NAU Geology

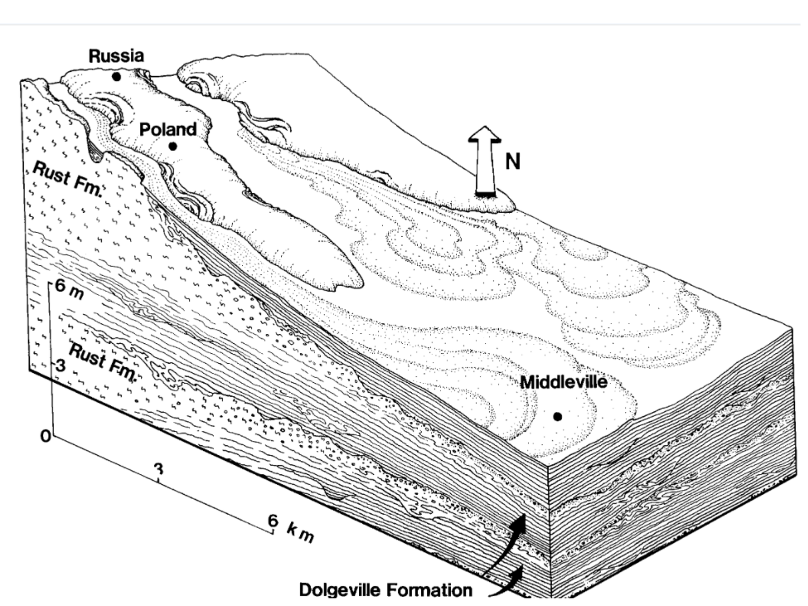


The study area is the Taconic foreland basin that formed as a result of the collision between the eastern coast of North America and a volcanic island arc system. The Middle Ordovician Trenton Group was deposited within the basin. It contains limestones and shales, representing shallow-water deposition in the west and deep-water deposition in the east. The map on the right shows the locations of John Cisne's fossil collections. Paleocurrent information is based on fossils, mainly graptolites. Modified from Cisne et al. (1982).

(A)



(B)

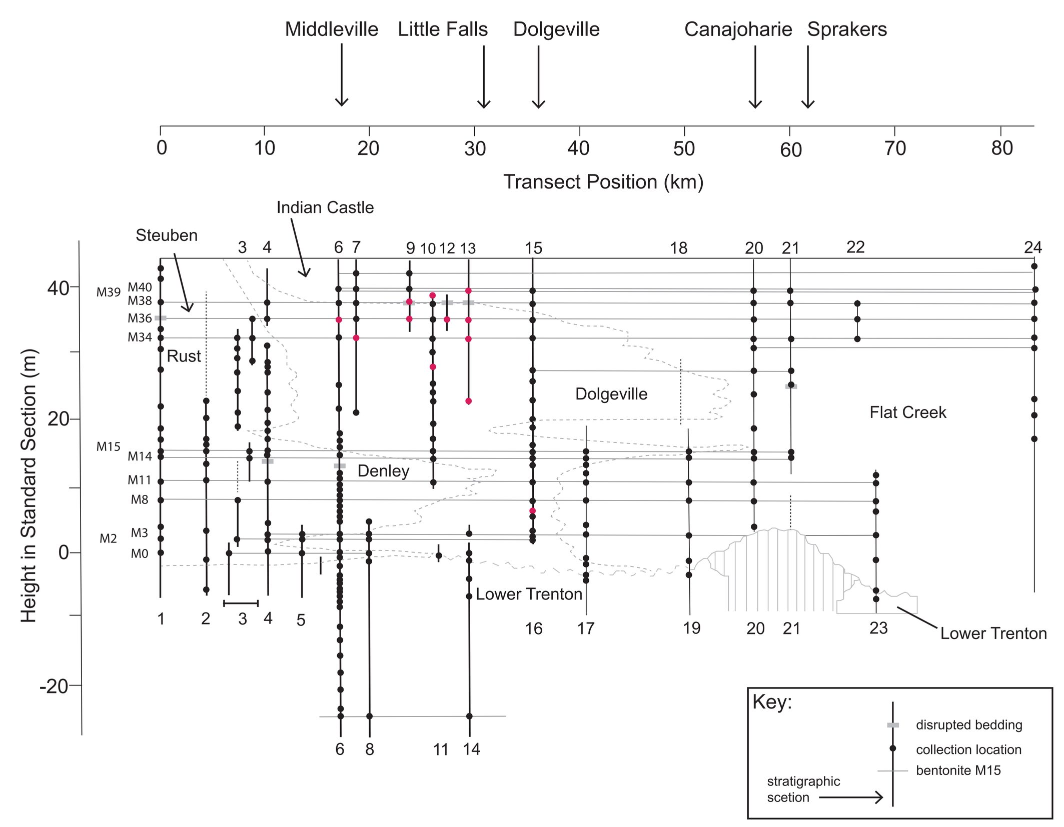


Stratigraphy of the Trenton Group. (A) The top chronostratigraphic chart comes from Fisher (1977) and Hay and Cisne (1988). Brett and Baird (2002) revised the stratigraphy, which is shown in the lower panel. (a) Napanee Formation (b) Kings Falls Limestone (c) Sugar River Formation (d) "Glens Falls Formation" or undifferentiated lower Trenton Group (e) Dolgeville facies (f) Steuben Limestone (g) Hillier Formation (h) Deer River Shale. From Brett and Baird (2002). (B) Depositional model of the Dolgeville Formation from Brett and Baird (2002). The trilobite *Triarthrus* was collected mainly from the Dolgeville Formation.

Material and Methods

John Cisne's Trenton Group collections are currently housed at the Paleontological Research Institution in Ithaca, NY. Over the summer, collections had to be organized before we could begin our study (Fig. 1).

Fig. 1: Cisne collections.



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

Cross section of the Trenton Group modified from Cisne et al. (1982) showing the distribution of collections. Each vertical line represents a stratigraphic column at a single location. The black dots represent a collection and red dots represent the collections used in this study. Cisne made collections in relation to the bentonites. At most sampling locations, duplicate collections were made. Stratigraphic sections were correlated using bentonite beds. Bentonite M15 represents the point at which there was a transgression in the basin and shoreline moves westward (Cisne and Rabe, 1978). The cross section corresponds to the study area map. Sections 1 – 16 were used in this study.

Cephalon length measurements. Due to preservation of *Triarthrus,* cephalon length was used as a proxy for body size (Trammer and Kaim, 1997). The cephalon was photographed and measured using ImageJ. (A) Blue line shows cephalon length measurement. Modified from Cisne et al. (1980). (B) Cephalon from collection 144-2. Photographed under 0.7 X 10 magnification. (C) Cephalon from collection 84-1.

Detrended correspondence analyses (DCA) and 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.

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 Polonica*, v. 42, p. 1-12.

Results

- Cinse and Rabe (1978) identified a water depth gradient based on fossil collections. Results from a DCA ordination also show a separation of taxa and collections along axis 1 and 2 (Fig. 2).
- Body size within section 13 does not significantly change (Mann-Whitney W=88, p=0.7655) up section (Fig. 3A). Median cephalon length: 4.63 mm (M34) and 5.15 mm (M36).
- Body size within sections 6, 9, and 13 do show a significant change (Kruskal-Wallis χ^2=6.3537, p=0.04172) but this result may be due to the small sample size in section 6 (Fig. 3B). There is no significant body size change (Mann-Whitney W=95, p=0.06134) between sections 9 and 13. Median cephalon length: 5.40 mm (section 6), 3.62 mm (section 9), and 5.15 (section 13).
- *Flexicalymene* is more abundant in the shallow water sections (Denley Ls., Rust Ls, and Steuben Ls.), while *Triarthrus* is more abundant in deep water sections (Dolgeville Fm) (Fig. 4).

Water Depth

So – *Sowerbyella*
Pa – *Paucicrura*
Fl – *Flexicalymene*
Ra – *Rafinesquina*
li – linguid brachiopods
Tr – *Triarthrus*

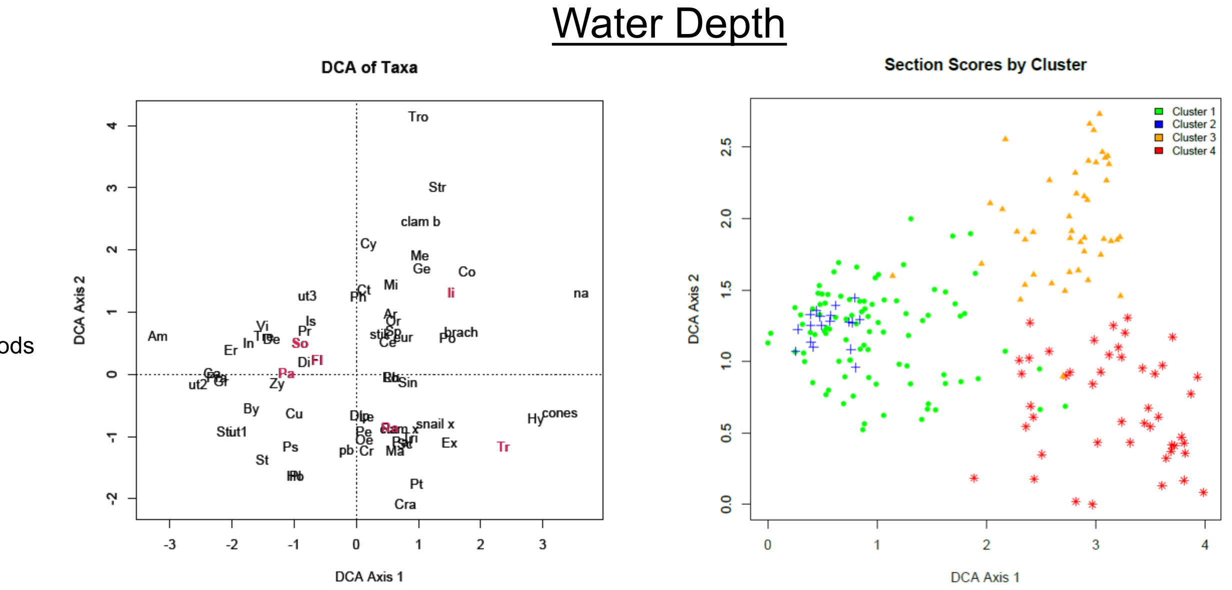


Fig. 2: DCA ordination of taxa (left) and samples (right). The taxa that are highlighted in red represent the taxa with the greatest abundances. Clusters 1–4 identified in the ordination by samples was determined by a R-mode cluster analysis.

Body Size and Abundance

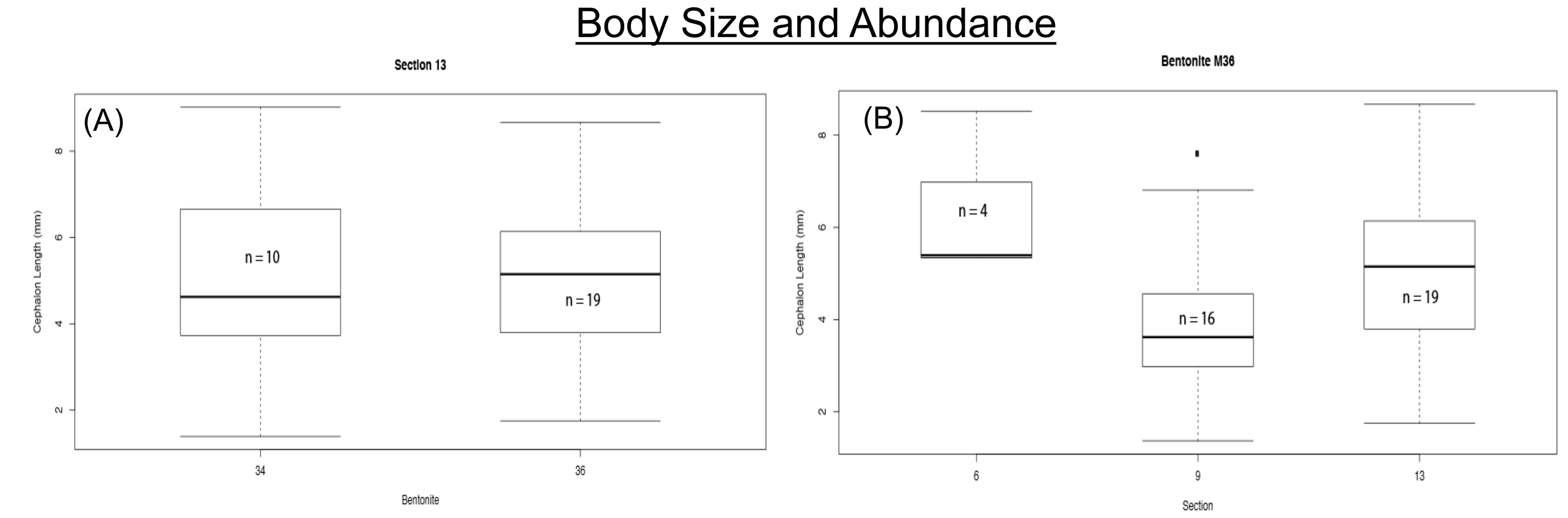


Fig. 3: Plots showing distribution of *Triarthrus* cephalon lengths. (A) Body size of *Triarthrus* through time. (B) Body size of *Triarthrus* across the basin.

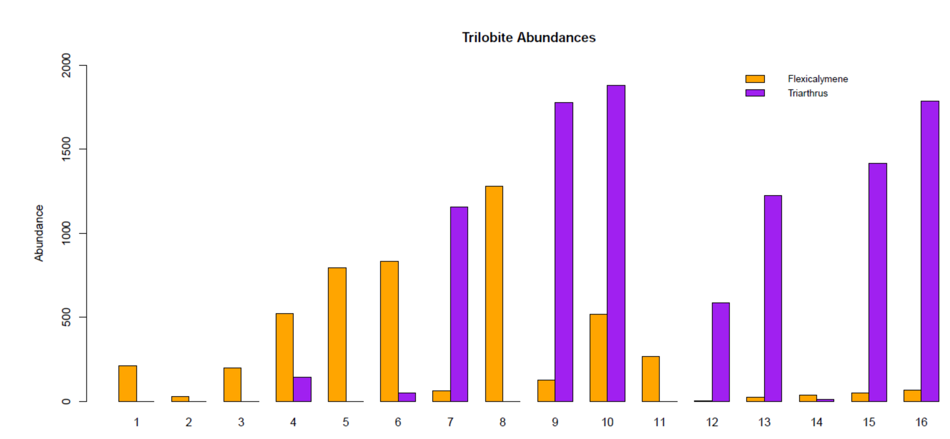


Fig. 4: Abundances of both *Flexicalymene* and *Triarthrus* from section 1 to section 16.

Next Steps

- Obtain *Flexicalymene* fossils to measure and compare body size with *Triarthrus* along the depth gradient.
- Determine why clusters 3 and 4 are separating along DCA axis 2 in the ordination of samples.

Acknowledgments

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