Paper 10-21: CHANGE IN EDENIAN *TRIARTHRUS* SPECIES ALONG A DEPTH GRADIENT IN THE TACONIC FORELAND BASIN, PA

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1. Introduction

A study was conducted to identify and interpret the *Triarthrus* trilobites found in the Upper Reedsville Formation at Swatara Gap, PA and the Antes Shale at Bellefonte, PA. These two different facies are coeval. They also contain *Triarthrus* species resembling both *beckii* and *eatoni*, which have been much described by many past workers. Although some workers have regarded the two species as synonymous, we agree with those who regard them as discrete species based on an in-depth literature review and identification of new distinct characteristics.

2. New Distinct Characteristics

Triarthrus beckii has a short palpebral lobe that terminates or barely exceeds at a line that intersects the distal ends of the S2 furrows plus a maximum of 16 thoracic segments (Figure 1). Lines drawn from the posterolateral angles of the fixigenae/cephalon, through the abaxial ends of the S1 lateral glabellar furrows, intersect (sag.) on the anterior glabellar furrow/border of the cephalon. *Triarthrus eatoni* has a long palpebral lobe that terminates at a line that intersects the distal ends of the S1 furrow plus a maximum of 14 thoracic segments (Figure 1). Lines drawn from the posterolateral angles of the fixigenae/cephalon, through the abaxial ends of the S1 lateral glabellar furrows, intersect (sag.) on the frontal lobe of the glabella. Shape of the glabella and posterior end of the facial suture were also used to distinguish the species but are less reliable in flattened/sheared specimens.

Ludvigsen & Tuffnell (1994) and Tuffnell & Ludvigsen (1984) characterized *beckii* as having an anteriorly rounded, barrel-shaped glabella and *eatoni* as having a less anteriorly rounded, parallel sided glabella. Ruedemann (1926) also characterized *eatoni* has having a glabella that was longer than wide while *beckii* with a glabella that was equally long as wide. According to Tuffnell & Ludvigsen (1984), the posterior facial suture on *beckii* follows an arc of a circle to meet the cephalic margin at a right angle. The posterior facial suture on *eatoni* diverges at 40°- 45° from the exsagittal line before meeting the cephalic margin. While we agree with these assessments, we found these features proved unreliable in specimens showing deformation. A literature review and study of New York and Pennsylvania specimens has revealed that *beckii* has a maximum of 16 thoracic segments and *eatoni* a maximum of 14 thoracic segments. While we acknowledge the value of this characteristic, the lack of full body specimens in our localities limited its usefulness. The new distinct characteristics, as highlighted in Figure 1, were the primary method of identification of the specimens found at Swatara Gap, PA and Bellefonte, PA.

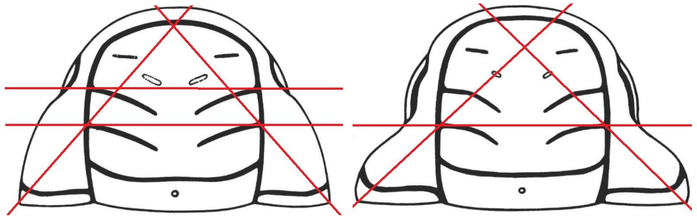


Figure 1: Morphology of *T. beckii* (left) and *eatoni* (right) adapted and modified from Ludvigsen & Tuffnell's (1994) Figures 14 & 15 to show both their (black) and our new distinctive characteristics (red). Note red lines drawn from the posterolateral angles of the fixigenae/cephalon and through the abaxial ends of the S1 lateral glabellar furrows on both figures. Also drawn are lines that intersect the S1 furrow on *eatoni* (right) and the S1 and S2 furrows on *beckii* (left).

Figure 4: *T. beckii,* Antes Fm, Bellefonte, PA.

Figure 3: *T. beckii,* Reedsville Fm, Swatara Gap, PA.

Figure 2: *T. eatoni,* Reedsville Fm, Swatara Gap, PA.

3. *Triarthrus beckii* chronozone

Fisher (1977) identified a New York *T. beckii* chronozone that he regarded as coeval with the *Orthograptus reudemanni* graptolite zone and younger *T. eatoni* chronozone that he regarded as coeval with the *Diplacanthograptus spiniferous* graptolite zone. Ludvigsen and Tuffnell (1994) regarded New York *beckii* as Late Franklin/Sherman through Early Maysville age. We now report that *beckii* occurs with *eatoni* in the Reedsville Formation at Swatara Gap, PA, where their first appearance datum is concealed and their last occurrence datum occurs just below the regional unconformity with the overlying Tuscarora/Shawangunk Formation. These rocks also contain *D. spiniferous* (Ganis et al., 2012), which is of Late Sherman to Middle Eden age (Dix and Al-Dulami, 2011; Figure 5). In the Antes Shale, the *beckii* chronozone is of Late Sherman through Middle Eden age, *O. reudemanni* through *D. spiniferous* graptolite zones (Beares et al., 2002). *T. beckii* has also been reported from the Bromley, Fulton, and Alexandria shales of Ohio; rocks of Late Sherman through Middle Eden age (Davis, 1981; Brett, Algeo, and McLaughlin, 2008). So the *beckii* zone in Pennsylvania and Ohio is of Late Sherman through Middle Eden age.

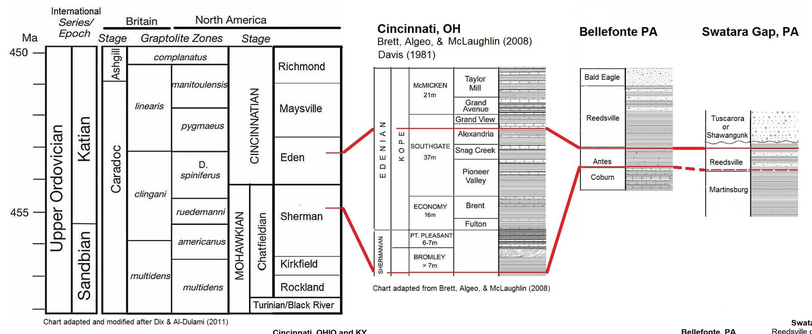


Figure 5: *T. beckii* chronozone in Pennsylvania and Ohio.

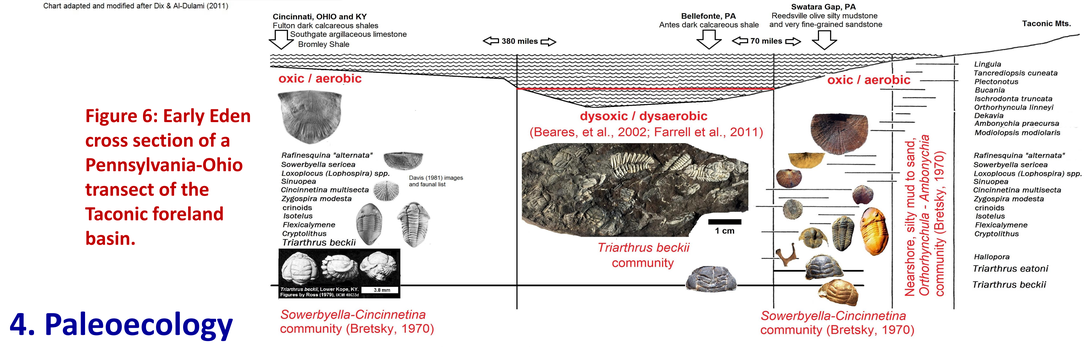


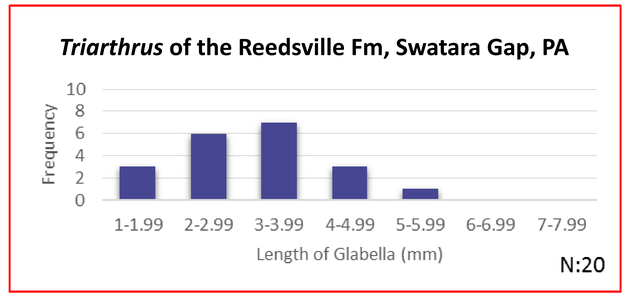
Figure 6: Early Eden cross section of a Pennsylvania-Ohio transect of the Taconic foreland basin.

4. Paleoecology

The Antes Shale at Bellefonte, PA is a deep ramp (basin axis) dark-gray to black calcareous shale containing only *T. beckii*. Like other reported occurrences of *beckii*, it was the dominant member of a low diversity community that lived under conditions that others described as dysaerobic/dysoxic. At Swatara Gap, the Reedsville Formation contains both *eatoni* and *beckii*. This is the first record of both species occurring in the same location, lithology (olive gray, micaceous, silty mudstone interbedded with cross-laminated siltstone and very fine-grained sandstone) and community (high-diversity fauna living under oxic/aerobic conditions). *T. eatoni* and *beckii* lived together as members of Bretsky's (1970) diverse, shelly, *Sowerbyella-Cincinnetina* community (Figure 6) in the oxic/aerobic lower shoreface environment of eastern Pennsylvania while only *beckii* (larger and more abundant) lived 70 miles west (Bellefonte) as the dominant member of the low diversity *Triarthrus* community living in a deeper (below wave base) dysaerobic/dysoxic basin-axis environment. Continuing 380 miles west of Bellefonte, to Cincinnati, the basin eventually shallowed back to the oxic environment of the shelly *Sowerbyella-Cincinnetina* community (Davis, 1981).

5. Population Change

Figure 7 shows the size comparisons of coeval *Triarthrus* from Swatara Gap and Bellefonte, PA. Although the mode is similar for both populations, there is a clear difference in size distribution. Larger specimens occur in the Antes Shale at Bellefonte, where they also are more abundant. Therefore, the Antes ecosystem at Bellefonte allowed for *Triarthrus* to grow one to several instars larger than in the coeval Reedsville ecosystem at Swatara Gap; although, the reason for this is not clear. The result is an increase in maximum size of *Triarthrus* along a depth gradient in the Taconic foreland basin of Pennsylvania during Late Ordovician time.



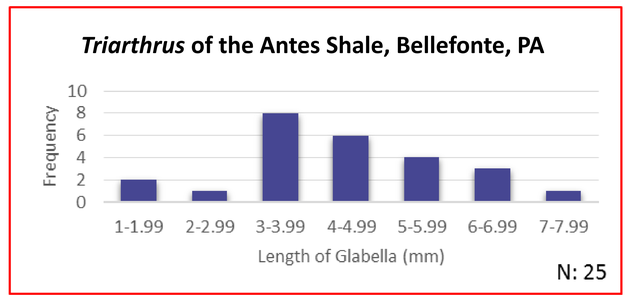


Figure 7: Glabellar lengths of *Triarthrus* from the Reedsville Formation at Swatara Gap, PA versus the Antes Shale at Bellefonte, PA. No corrections were made for deformation.

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