Southern Illinois University Carbondale
OpenSIUC

Honors Theses | University Honors Program

May 2016

PTEROTOCRINUS WING PLATE MORPHOLOGY IN THE HOMBERGIAN

Julie Driebergen
Southern Illinois University Carbondale, jewelz@siu.edu

PTEROTOCRINUS WING PLATE MORPHOLOGY IN THE HOMBERGIAN

Julie Driebergen

A thesis submitted to the University Honors Program in partial fulfillment of the requirements for the Honors Degree

Southern Illinois University Carbondale
Spring 2016

Introduction

This project is an extension of a Masters Degree thesis of a paleontology student, Tony Tobenski, who went to SIU (Tobenski, 2011). Tobenski (2011) examined the Menard Limestone of the Kinkaid Formation (Late Mississippian) to determine the function, morphology, evolution, and biostratigraphical usefulness of crinoid wing plates. I will examine the Golconda and Glen Dean Formations of the Upper Mississippian Hombergian. *Pterotocrinus* is an extinct genus of crinoid (an echinoderm; related to starfish and sea urchins) and its wing plates are thought to be used for feeding or defense depending on the morphology of the plates. The goal is to test its biostratigraphic use by using the wing plates to show evolutionary changes in wing plate morphology and to possibly identify useful *Pterotocrinus* indices for the Golconda Formation.

There was a shallow empiric sea in the Illinois Basin during the Mississippian. This, and the fact that the area was near the equator at the time, allowed for marine reefs to form. Sea levels dropped in the Late Mississippian exposing more of the basin. Now, the reefs remain as fossiliferous limestone deposits (Treworgy 2016). The Hombergian Stage is a part of the Chesterian Series in the early portion of the Late Mississippian (Tobenski 2011). The Golconda Formation is below the Hardinsburg Formation and includes the Beech Creek Limestone Member, Big Clifty Sandstone Member, the Haney Limestone Member, and the Frailey's Shale. It is mainly in Pope County in Illinois and is primarily a limestone-shale (Willman et. al. 1975).

Crinoids, a member of Echinodermata, inhabited the area during the Mississippian. Specifically, *Pterotocrinus* is found throughout the Chesterian Series of the Mississippian (Figure 1) (Tobenski 2011). Crinoids are stalked organisms made up of plates that have different morphologies depending on the function and location of the plate. The calyx, or "base" of the crinoid theca consists of rigid plates that is ventral to a flexible tegument (roof) that contains the mouth and anus. Arms that are used to catch food particles suspended in water currents extend above this feature. The base of the calyx attaches to a stalk of columnar plates that attach to cirri that allow for locomotion (Clarkson 2007) (Figure 2b). Wing plates are often one of the only useful fossil remains of crinoids that can be used as index fossils and can be used to identify the species of crinoid (Tobenski 2011) (Figure 2a). They are thought to have been predatory defense devices, a way to stabilize and support the crinoid in/on the substrate, as hydrodynamic baffles, a way to reduce drag in moving water, or as a way to make feeding more efficient like stabilizing rudders (Baumiller and Plotnick 1989).

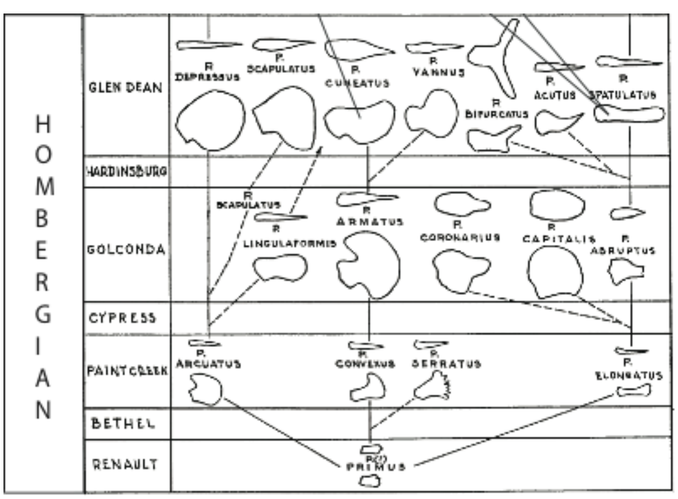
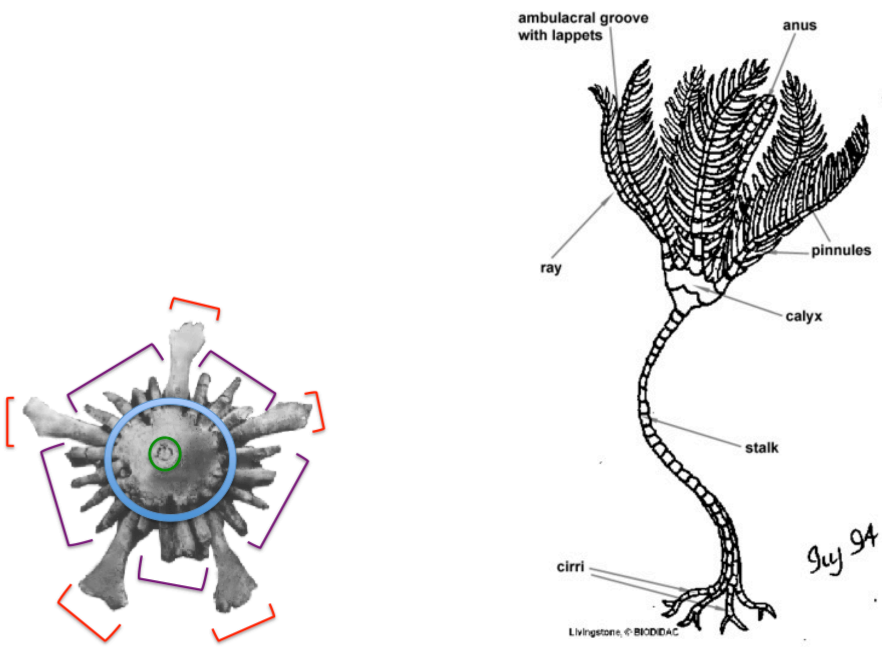


Figure 1. ***Pterotocrinus*** **species in the Hombergian. (Tobenski 2011).**



a. **b.**

Figure 2. a.) Modified Diagram of a Crinoid calyx originally from the University of Kentucky, Kentucky Geological Survey 2012. Red= Wing Plates/Defense, Purple= Food Gathering Arms, Blue= Calyx, Green=Where the Column Attaches; b.) Anatomy of a crinoid by Animal Diversity Web University of Michigan 2014 CC BY-NC-SA 3.0.

Here I present the results of a study of Pterotocrinus crinoid wing plates collected from two localities (Southern Illinois and Western Kentucky) in the Golconda Formation to determine their utility as possible index fossils and to document the diversity of crinoid species and morphology between species.

Methods

I used pre-collected specimens from Joe Devera's collection and also specimens that Dr. Ishman, Joe Devera, and I collected in the field. We drove to two localities, one in Southern

Illinois (Golconda, IL near the Marina parking lot on the slope and weathered watersheds) and the second in Western Kentucky across the Ohio River from Cave-In-Rock approximately 6 miles south to Heathhollow Road in a small creek bed. There I collected any wing plates that were found (Figure 3). The wing plates were weathered out of the rock or collected as parts of limestone slabs in which they were found.

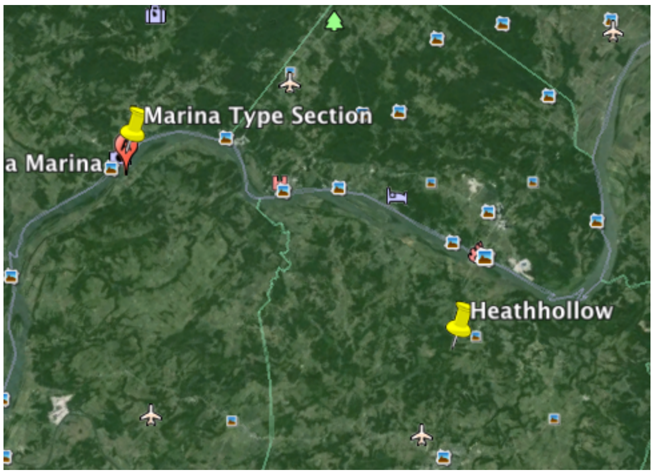


Figure 3. Locations of the two localities (Golconda, IL Marina, Type Section 37° 22' 22.4"N, 88° 28' 66.05" W, Elevation 408 ft.; Cave-In-Rock, KY Heathhollow Road Creek 37° 24' 01.18" N, 88° 08' 02.9" W, Elevation 461 ft.)

I measured (in millimeters) each specimen recording the maximum thickness, minimum thickness, width, maximum height, minimum height, and basal chord using a caliper micrometer. Measurements were taken to the nearest millimeter. I arranged the data on an Excel spreadsheet. I also gave each specimen a specimen number and included information on the formation, location, by whom it was collected, the species, and a basic description of the plate. If I was able to remove the specimens from the surrounding matrix without breaking it, I did so, if not, I left it within the matrix. I compared the wing plates to figure 1 to determine (if I could) the species, as well as, used the species given to me by Joe Devera.

Results

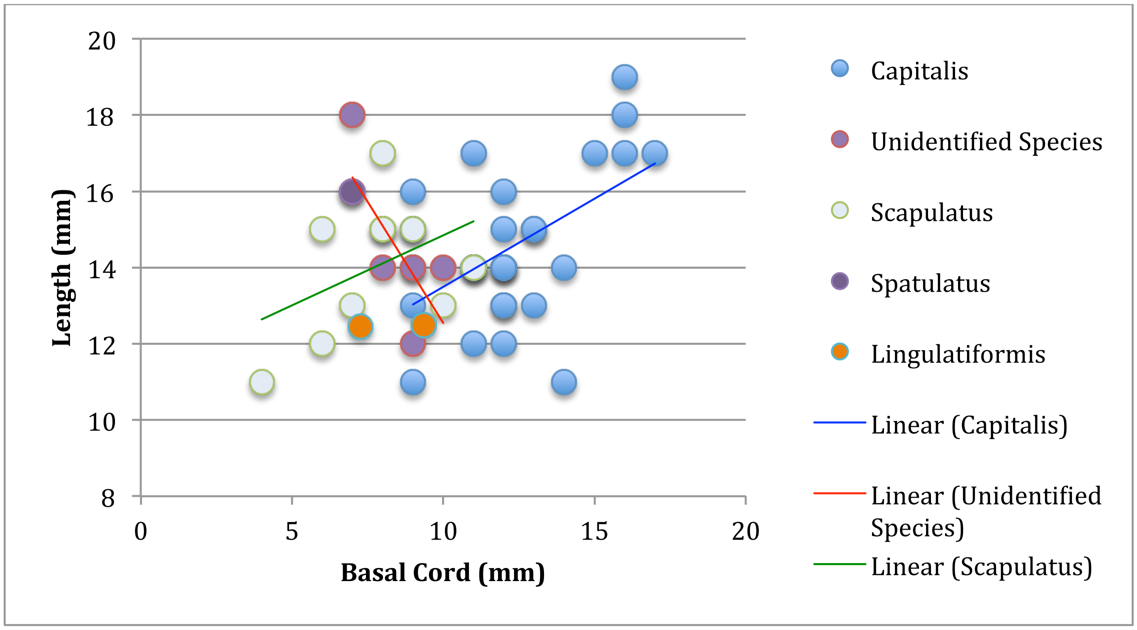


Figure 4. Golconda Type Section (Marina) *Pterotocrinus* Species Basal Chord Vs. Length (*P. capitalis* trend line y= 0.4623x + 8.8706, R^2 = 0.26969, *P. scapulatus* Trend Line y= 0.3675x +11.171, R^2= 0.18373)

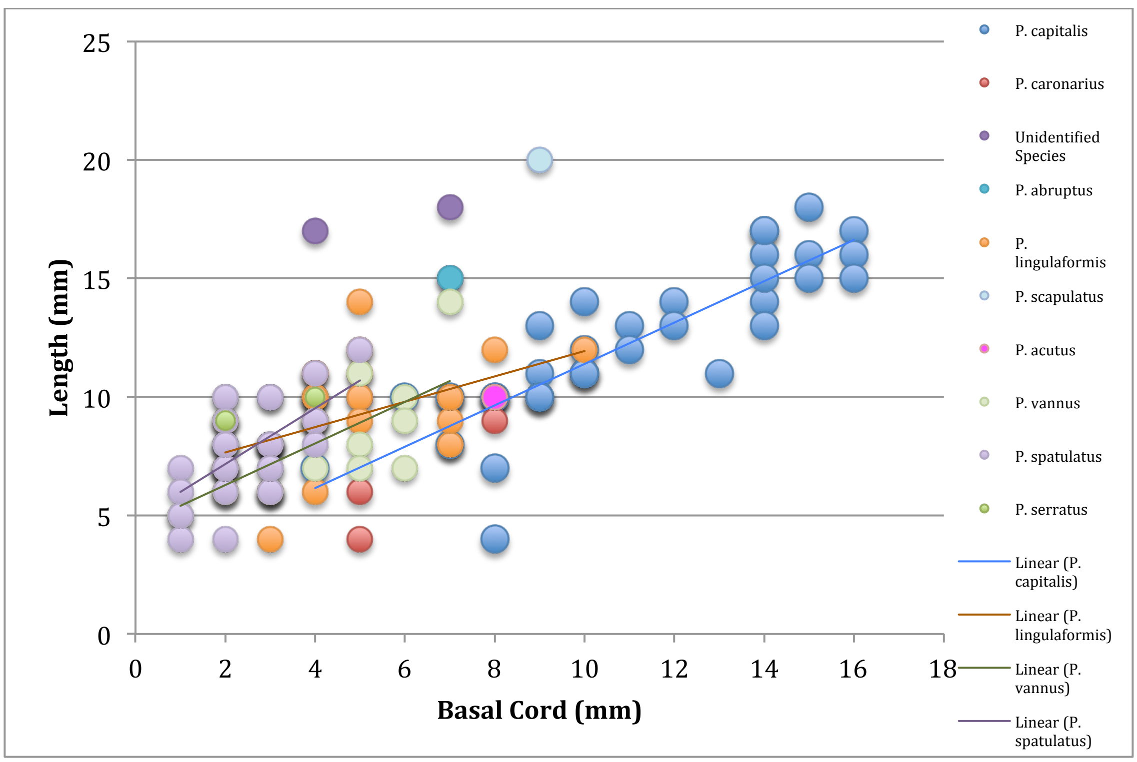


Figure 5. Heathhollow Kentucky Section *Pterotocrinus* Species Basal Chord Vs. Length (*P. capitalis* y = 0.8728x + 2.6639 R^2 = 0.73718, *P. lingulaformis* y = 0.5349x + 6.588 R^2 = 0.26841, *P. spatulatus* y = 1.1762x + 4.8159 R^2 = 0.38971).

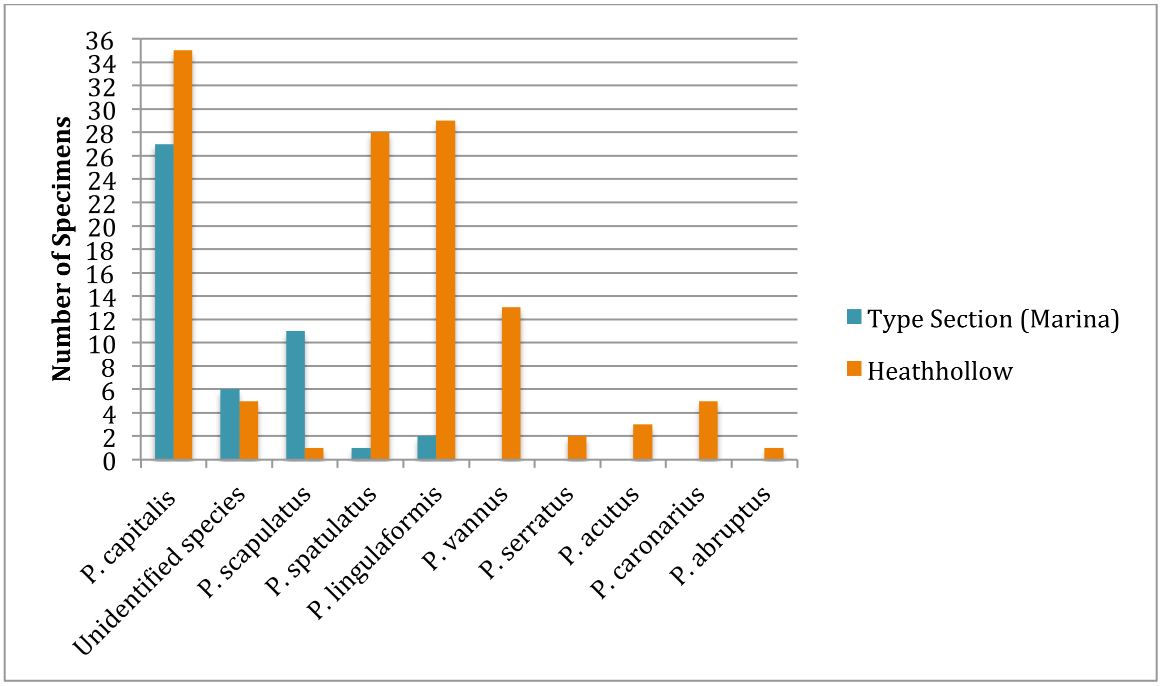


Figure 6. Species Diversity of Golconda Type Section (Marina) (Teal) and Heathhollow Kentucky Section (Orange).

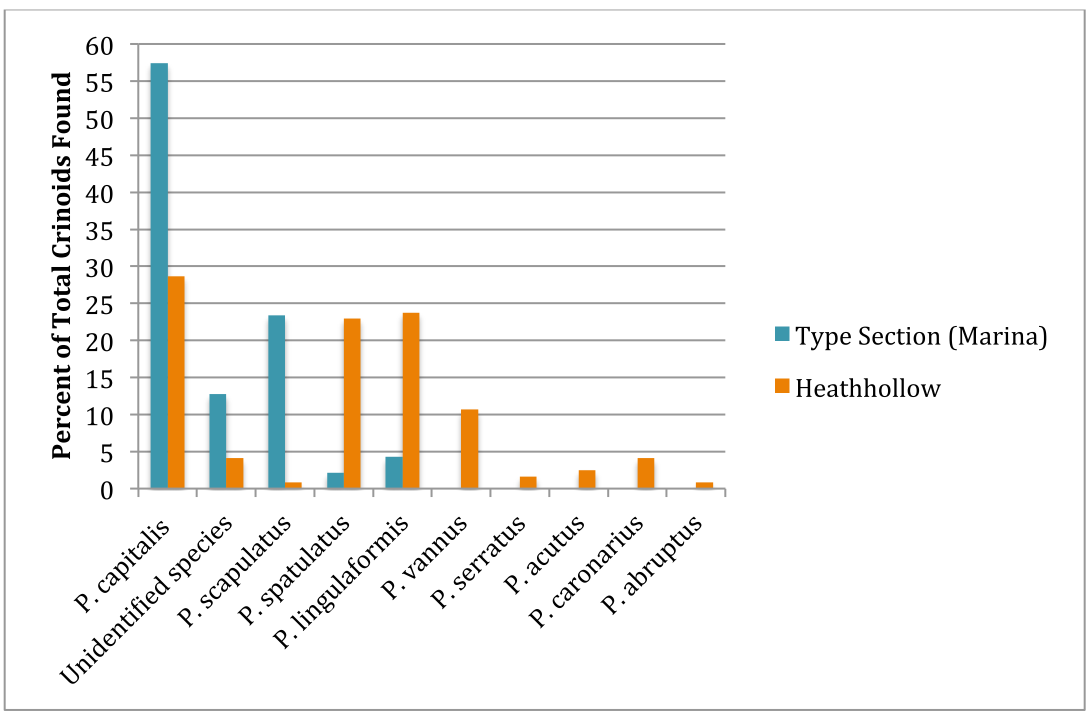


Figure 7. Species Diversity of Golconda Type Section (Marina) (Teal) and Heathhollow Kentucky Section (Orange) Adjusted to Percentage of Total Locality Crinoid Species.

	Max Thickness	Min Thickness	Length	Max Height	Min Height	Basal Chord
P. capitalis	8.0	4.7	14.6	13.9	11.3	12.3
P. Species	3.8	1.7	14.7	8.7	5.8	8.3
P. scapulatus	3.1	1.1	14.0	12.2	5.9	7.7
P. spatulatus	2	1	16	8	6	7
P. lingulaformis	6.0	3.5	12.0	10.0	7.5	8.0

Table 1. Average measurements (mm) per *Pterotocrinus* species Golconda Type Section (Marina).

	Max Thickness	*Min Thickness*	*Length*	*Max Height*	*Min Height*	*Basal Chord*
P. capitalis	7.48	4.29	12.31	11.60	8.80	11.06
P. Species	3.80	1.80	14.00	6.00	4.40	5.20
P. vannus	4.00	3.00	8.31	5.08	3.54	4.31
P. spatulatus	1.80	1.06	7.71	3.75	2.21	2.46
P. lingulaformis	3.00	2.09	9.21	5.62	3.55	4.90
P. serratus	0.00	0.00	9.50	3.50	2.00	3.00
P. acutus	0.00	0.00	8.00	4.67	2.00	4.67
P. caronarius	0.00	0.00	8.0	6.4	3.4	6.0
P. scapulatus	5.00	2.00	20.00	16.00	9.00	9.00
P. abruptus	0.00	0.00	15.00	7.00	4.00	7.00

Table 2. Average measurements (mm) per *Pterotocrinus* species Heathhollow Kentucky Section.

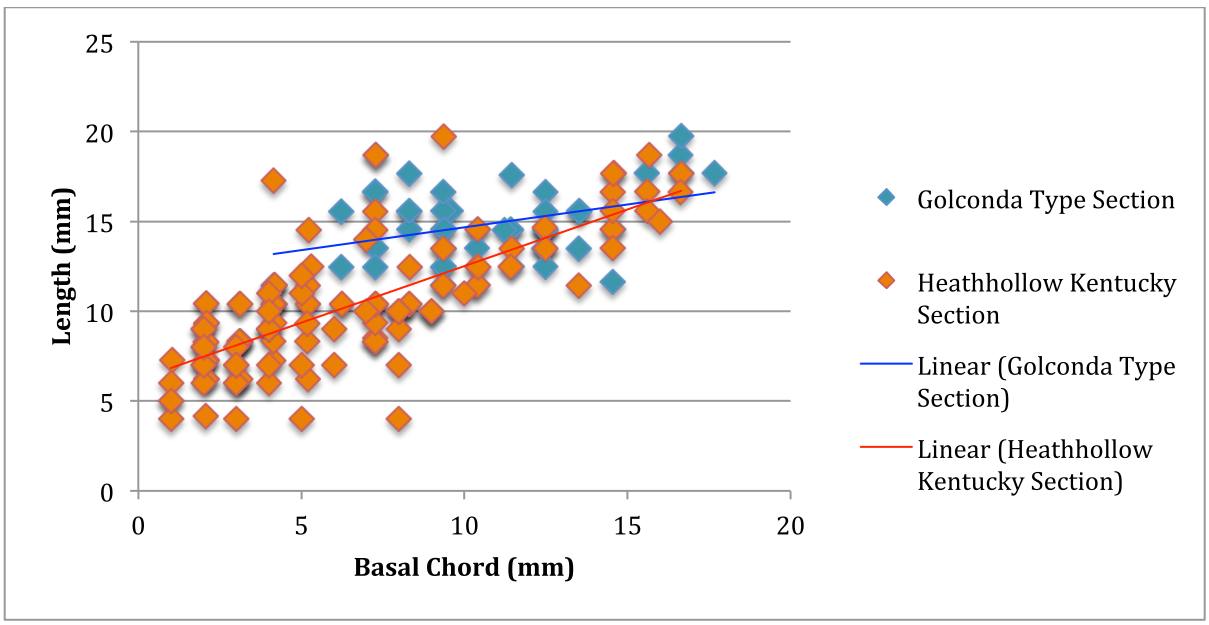


Figure 8. Golconda Type Section (Marina) vs. Heathhollow Creek Basal Chord vs. Length of all *Pterotocrinus* specimens collected (Golconda y=0.2541x + 12.135 R^2 = 0.1546, Heath Hollow y = 0.6305x + 6.2119 R^2 = 0.55563).

Discussion

There were at least four species found at the Golconda Type Section within the watersheds of the area as single loose fossils or within smaller limestone rock pieces (Figure 4). There were at least nine species found at the Heathhollow locality (Figure 5). The Golconda section was not nearly as abundant as the Heathhollow location where slabs of fossiliferous shaley limestone were removed containing abundant crinoid wing plates (Figure 6). There were 47 wing plates collected from the Golconda Type Section, and 122 wing plates collected from the Kentucky Section. The crinoids embedded in the limestone (from the Heathhollow location only) were less useful for thickness purposes (I could not remove them without destroying the specimens), but still yielded lengths, heights, and basal cord lengths, which were useful for analyses, as well as were useful in identifying species (Table 2). The environment at the Heathhollow location may have been more suitable for crinoids to diversify and disperse, since there were many more species found there.

The wing plates at the Heathhollow location had a wider range of lengths, but the lengths were much higher consistently at the Golconda Type Section (Figure 8). This can be used as a possible indicator for the locality, if the lengths were all similarly high rather than over a large range. *Pterotocrinus capitalis*, for example, had much larger measurements in all of the dimensions measured at the Type Section than those at the Heathhollow location (Table 1). The environment must have been suitable for larger growth of individuals, which may have hindered the diversity since there may not have been as much space for other larger forms.

In both localities, *P. capitalis* was the most abundant species found, although *P. spatulatus* and *P. linguaformis* at the Heathhollow Section were within 5% of *P. capitalis* (Figure 7). Also, despite having more specimens collected, the Heathhollow location only had 10 more wing plates of *P. capitalis* than the Golconda Type Section (Figure 6). The environmental transition between these two localities favored *P. capitalis* overall, but despite the relative abundances, the fossil record yielded similar numbers of them, indicating that they may preserve better than other species.

If I had more time, I would have collected more specimens at more localities within the Golconda Formation. If I could have, I would have removed specimens from their slabs, however, I would have destroyed viable specimens in the process. I would have also liked to have better identified the species of crinoids to better see changes in morphology.

Conclusion

The overall size was a good measurement to distinguish between the two localities (the Golconda Type Section had much larger basal plate and length measurements than the Heathhollow location). However, the Heathhollow location had a higher diversity of species than the Type Section. The *Pterotocrinus* species differences at the two locations can indicate varied environmental conditions during the Hombergian, as well as, a possible preservation bias for more robust forms.

Acknowledgements

I would like to thank Dr. Ishman and Joe Devera for helping me with the project and collecting crinoid plates with me. I would like to thank the SIUC Honors Department for this opportunity.

References

Baumiller, Tomasz K. & Plotnick, Roy E. Rotational stability in stalked crinoids and the function of win2–. plates in *Pterotocrinus depressus. Lethaia*, Oslo. 1989. 07 15: 22. 317–326.

Clarkson, E.N.K. Echinoderms. Invertebrate Paleontology and Evolution Fourth Edition. Blackwell Publishing: Malden, MA. 2007. 291-293

Tobenski, T. "Proterotocrinus of the Menad Limestone and the Kinkaid Formation (Elviran Stage) Chesterian in the Illinois Basin." Thesis. Southern Illinois University Carbondale, 2011.

Treworgy, J.D. " Mississippian Rocks in Illinois." Illinois State Geological Survey. 2016. https://www.isgs.illinois.edu/outreach/geology-resources/mississippian-rocks-illinois

Willman, H.B., Atherton, E., Buschbach, T.C., Collinson, C., Frye, J.C., Hopkins, M.E., Lineback, J.A., and Simon, J.A. Handbook of Illinois Stratigtaphy. State of Illinois Department of Registration and Education Illinois State Geological Survey Bulletin 95. Urbana, Illinois. 1975. 155-163