Is competition structuring this ancient ecosystem?
Instructor Notes

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Was competition important in structuring ancient ecosystems? Most people probably feel that it was, but how can you tell? Competition is notoriously hard to observe in modern ecosystems and perhaps even more difficult in ancient systems. Hermoyian *et al* (2002) provide a relatively easy test for competition on brachiopods, a fossil group that is an important part of Paleozoic faunas, that is commonly studied in fossil labs, and that is readily available in bulk in many places. In this exercise, students use the same protocols and procedure used by Hermoyian *et al* (2002) on a collection of middle Paleozoic brachiopods to test the same hypothesis, namely, did competition help shape a fauna? We use brachs from the Middle Devonian Onondaga Limestone from western New York, but different brachs from different times could certainly work as well.

Although you can do this exercise cold (*i.e.* without introduction of the ecological concepts beforehand), it helps if you've already introduced the subjects. I do this lab after lectures on paleoecology and a review of natural selection. The handout includes a long introduction describing Hutchinson's niche partitioning and MacArthur's extension of the idea, Hermoyian et al's work, as well as step-by-step directions to complete the procedure, including how to calculate the ratio sum (a comparator statistic) and the z-statistic. You or the students will need to provide a statistical table to find the correct value of the area under the normal curve for their calculated z statistic. Having the students read the Hermoyian et al (2002) paper ahead of time and discussing it in class would probably help students as well.

Choice of brachiopods for measurement is important. The original analysis used strophomenids. These had similar overall shape and can conceivably have had the same mode of life. It's not clear to me that using disparate shell shapes would work very well, because that might correlate with different resource use. The assumption made in the analysis is that the commissure length correlates with length of the lophophore, which is inferred to link with feeding strategy. If studied shells included very different forms, *e.g.* rhynchonellids vs. strophomenids, it might be harder to make the linkage argument.

It might make sense to use closely related species, perhaps even adding a phylogenetic component; one might be able to link resource portioning with speciation. Who knows – that could lead to a real publication for the students.

Students generally do well identifying the different brachiopods. Measurement works best if all brachs of each species are pooled together and students work together to measure and record the data. Working in pairs, one measuring and one recording the data seems to work well. Once each pair has completed measuring their batch, the data can be shared among the entire class. Instructions for calculations allow each student to do his or her own work. We use MS Excel – this particularly makes the graphing go easily and quickly. If things go smoothly during lab, students can have their z-statistic tabulated and have tested the significance of their results. (Again, likely negative, but if you get positive results, great!) You can have a discussion about the results and have them think about what are the possible sources of error. This discussion can also help ensure that students understand what their results mean. Sometimes, in spite of prepping, they confuse whether to accept or reject the null hypothesis (that the distribution along the resource axis is random). If graphs are finished (this takes longer) it's very easy to compare them with the results from the original paper (Fig. 2 in the handout.), which is a clear indicator of whether there's any likely resource partitioning.

How many brachiopods do you need? More is better; we use between 20 and 50 of each species. If there's a place nearby to collect the students could make the collections, too. Of course, the specimens are necessary; without access to a bulk sample, it'll be difficult to do.

The exercise may also be a lesson in negative results, as there's no guarantee they'll get a positive result; more than likely there *won't* be evidence for competition. Either way, the results are interesting.

The final part of the exercise, the composition of a conference-type abstract, should be done out of class and turned in later. The abstract shows very clearly who understood the entire exercise and who didn't. It's also great practice. It pays to show a few examples in class to model what you're expecting.

This is a stand-alone exercise, but it dovetails well with lecture units on paleoecology, competition, and testing hypotheses, as well as part of continuing practice on synthesizing results and summarizing material in abstract form.

Hermoyian, C.S., L.R. Leighton, and P. Kaplan. 2002. Testing the role of competition in fossil communities using limiting similarity. *Geology* 30:15-18.

MacArthur, R.H. 1972. *Geographical Ecology*. Princeton University Press, Princeton, NJ, 269 p.