Independent Project: "<u>You Can't Hide from Sulfide</u>". [redacted] and [redacted]
BIO 295 14 April 2014

In the 17th Volume of Ecology Letters published in 2013, Rüdiger Riesch and several colleagues including NCSU professor Brian Langerhans conducted original research documenting the size difference in a fish family called *Poeciliidae* when they were raised in toxic sulfidic environments. The results revealed an interesting and highly predictable trend: the fish in sulfidic environments exhibited lower fecundity and higher body mass in their offspring (Riesch, 1). The trend in these statistics lines up perfectly with ideas proposed by the Life-History Theory. Fish were collected from across the Western Hemisphere from Oklahoma to the Bahamas to Venezuela. The fish were genetically analyzed organized into a phylogenetic tree to find common ancestors. This helped distinguish ancestral traits from parallel evolution.

Life-history theory defines the stages of gestation, infancy, childhood, adolescence, and adulthood and seeks to explain the difference of the timing of development, fertility, and death in living organisms. Large organisms such as humans have long gestation periods and few offspring which take a long time to reach reproductive development. Contrastingly, organisms with small offspring such as fish have shorter gestation periods, smaller offspring, and mature and die faster. Many things help shape an organism's development such as mate availability, energy availability, energy requirements of the offspring, and many more. Even environmental factors help determine aspects of life-history.

Phylogenetics allows us to analyze the evolutionary relationships of organisms. Specifically, a phylogenetic tree is a branching diagram that employs genetic mapping to illustrate the evolutionary relationships between species. The scope of a phylogenetic tree can be adjusted so that you can look at the relationships between large groups of animals such as kingdoms, or even look at the smallest ancestral lineages of subspecies.

Parallel evolution is the development of the same trait amongst different species, despite having different ancestors. Events of parallel evolution typically occur in species that develop in similar envirionmental conditions such as terrain or climate changes. An example of parallel evolution is the development of flight in bats and birds. Though they're not closely related by an ancestor, the two species independently developed flight to occupy a vacant niche and thrive in their ecosystems.

Dr. Riesch took measurements of the fish he captured from all of his collection sites. He took note of the surface area and fecundity of the fish. The larger fish were found in sulfidic environments. The fish in sulfidic environments need the extra surface area to help them diffuse the poisonous sulfide that they are constantly taking in. He noted a distinct trend where the larger the fish was, the fewer offspring it had. Conversely, the smaller the fish was, the more offspring it had (Riesch, 6). This trend follows perfectly with the Life-History Theory. Because the larger fish had a higher energy requirement, it is advantageous for the parent generation to have fewer offspring. If the parents had more offspring, there would be less energy to devote to the developing young. The lack of nutrition would lead to smaller young that may die due to their small size.

In order to track the evolutionary ancestors of the fish species and their offspring, Dr. Reisch and his team employed the use of phylogenetics. A phylogenetic tree is a branched map showing the evolutionary relationships between multiple species by tracing their common ancestors back to divergent events. Dr. Reisch was able to determine how related the multiple species of live-bearing fish he used by comparing a 402 basepair long sequence of their DNA (Riesch, 8). Using this data, he created a phylogenetic tree of the nine species of live bearing fish that he studied.

When the phylogenetic data was analyzed, Dr. Reisch saw an interesting result. Some species that did not share close ancestors possessed the adaptation to sulfide-rich waters (increased size). Additionally, some species had large individuals living in sulfidic waters and some small individuals living in non-sulfidic waters (Riesch, 1). The trait evolved separately and in different locations, but both species shared the trait because it was necessary to survival.

In our movie, we attempted to use hand drawn visual aids to assist in our presentation of the research. We discussed all three of our topics, life-history theory; phylogeny; and parallel evolution. In addition to our hand drawn animations, we provided helpful graphs, maps, and data directly from the research paper.

Riesch, Rüdiger, Martin Plath, Ingo Schlupp, Michael Tobler, and R. Brian Langerhans. "Colonisation of Toxic Environments Drives Predictable Life-history Evolution in Livebearing Fishes (Poeciliidae)." Ed. Jean-Michel Gaillard. *Ecology Letters* 17.1 (2014): 65-71. Print.

FEEDBACK FROM INSTRUCTOR:

Hi [redacted] & [redacted],

You did an excellent job on the **movie**. You included all elements I asked for and satisfied the criteria indicated in the rubric. You earned full credit for your movie.

I really liked your movie. The fast motion drawing worked really well for explaining this study and you guys executed it nicely!

A few things I noted:
You need to be careful with the distinction between parallel and convergent evolution: Although your definition of parallel evolution was ok ("related but distinct species"), the tuna vs. dolphin example seems like a convergent evolution example. Since tuna and dolphin are not closely related at all, I assume that they exhibit different pathways in fin development which makes this an example of convergent evolution. Let me know if you have any questions about this.
Ashton, you are a very fast talker, sometimes it was hard to follow what you were saying, but it got better towards the end!

Overall very well done! It was very enjoyable to watch.

Here's what your peers said about your movie:

- *Information presented in a unique way, clear & easy to follow*
- *Explained findings, reasons for findings and how it relates to life history well*
- *Funny, I liked the drawings*
- *GREAT DRAWINGS*
- *Appreciate the comedy*
- *Well-explained, good cooperation*
- *I loved the simplicity of it and very fun to watch! The humor in it was cute and catchy!*
- *Casual and fun to watch*
- *Unique filming idea*
- *I appreciated the personality of the video*
- *AWESOME VIDEO STYLE! Loved it.*

Overall, you did a very good job on the **final script**. You included most of the elements I asked for and satisfied most of the criteria indicated in the rubric. You earned 70 out of 75 points.

Here are some comments:

- You did a good job on the summary, just the last sentence is a bit confusing: *This helped distinguish ancestral traits from parallel evolution.* I'm not sure what you were trying to say here since ancestral traits and parallel evolution are two separate ideas. Please, see me before the final exam if this isn't clear. (-1 pt)
- Your theory concepts are very short, I required 100-200 words PER concept, your entire section consists of 236 words. This word limit was an indication of the level of detail I was expecting. Some of your explanations are a little confusing, for instance the use of the word "genetic mapping" in the

context of phylogenetic trees is confusing. “Genetic mapping” or more commonly “gene mapping” refers to finding which DNA fragments code for which traits. This doesn’t have much do to with phylogenetics. (-3 pts)

- Your movie description is very short, you could have expanded a little more on what exactly you did. (-1 pt)
- I noticed that you cite the publication as Riesch plus page number. Although we didn’t specify a format for citations for this assignment, you cannot cite a paper that has multiple authors by just naming the first author. It would need to be *Riesch et al.* In addition, in the standard citation format, you also need to include the year, no need to include page numbers. So the way you would do this in a paper is: *Riesch et al. (2014) took measurements of the fish…* OR …*the more offspring it had (Riesch et al. 2014*).

Best,
D. Magdalena Sorger