## Dr. Langerhans' answers to questions

**From minute papers**

1) **If the blue holes were able to allow migration of species between each other, what organisms would move (predator or prey) and how fast would these species adapt to their new environment?**

*Based on the frequency of colonization of blue holes, the prey species (Gambusia hubbsi) is more successful at moving across the landscape into blue holes (89% occurrence vs. 29% occurrence in blue holes based on my survey of 45 blue holes on North Andros). Of course, molecular genetic data suggests that once a population has established within a blue hole, and become locally adapted, gene flow is minimal. Adaptation to the new environment appears quite rapid, but also appears to vary across traits—this is based on the rate of very rapid trait changes in another system with these fish during the last ~40 years.*

2) **Does "drag" in the fish influence their escape speed a lot?**

*Yes. Drag reduces locomotor performance, and experiments have demonstrated that morphologies with greater drag result in reduced locomotor performance.*

3) **Can it be inferred that if we introduced a predator into one of the unpredated lakes that we would slowly be able to watch the changes take place?**

*Yes… and it might not be that slowly either. There are ongoing similar experiments in the wild, some "natural" experiments where humans unintentionally conducted such experiments in the wild, and many lab experiments that address this general question, and the consensus is that rapid evolution in response to strong changes in selection in the rule, not the exception.*

4) **There was one population in Dr. Langerhans' "# of young" graph that was inconsistent with the rest of the data and he indicated that he had no idea why. Can you conclusively draw conclusions when you have situations like this? Doesn't it skew data?**

*Yes, you can draw conclusions based on any pattern of any data; you just need to be careful to draw the correct conclusions. No, it doesn't "skew data," but I don't really know what is meant by this phrase. If you mean "skew results," then no it doesn't do that either. When thinking about most data and conclusions, especially in evolutionary biology, it's useful to think in terms of distributions, probabilities, and hypotheses, not absolutes. Perhaps you wanted to test the hypothesis that ALL populations exhibit the exact same response—that hypothesis would be rejected.*

*However, the hypothesis I tested was whether population means tended to differ between blue holes with and without predators (technically, that the variance between predation regimes was greater than the variance between populations within the same predation regime). The likelihood of those two groups being as similar to one another in their mean value as populations within the same predation regime was less than 0.01 %; thus, a clear trend exists where populations within each predation regime tend to respond in particular ways, but not ALL of the populations happened to do that. And we can quantify things like how many populations differed from one another, what percent differences they exhibited, how many standard deviations different they were, how much variance in the data was explained by differences between predation regimes (especially compared to variance among populations within predation regimes)—and indeed we do*

*that. Perhaps by "conclusively draw conclusions" you were hoping for answers like YES or NO to questions concerns absolutes, but reality is generally more nuanced than that.*

5) **I still have a question regarding life history. I want more info on how this affects evolution and mutations in populations like in the dorsal-fin fish from the Bahamas. Why does it matter that the females in high-predation history may have more offspring? I feel like if there was high predators in a population the maternal instinct wouldn't want to be pregnant because it would slow their swimming down. Or I wouldn't want my babies in danger. Is this reasoning incorrect? Wouldn't high predation environments eventually kill of what is being hunted?**

*I don't follow the link to mutations or dorsal fins here, but I think the question mostly concerns understanding life-history theory (as well as links to other aspects of natural selection that could influence life histories, and how predators might drive prey extinct).*

*Life history theory has proven to be one of the most predictive theories in evolutionary biology, and I hope you will learn more about it in this class and others (and on your own) so that you can better understand it. But briefly, imagine a population with high levels of extrinsic mortality rates. This means that all individuals have a high mortality rate and short life expectancy. Individuals vary in how many offspring they have per brood. Individuals having only a few offspring tend to leave no descendants behind because they all die after a few generations (because everyone has a high probability of dying). Individuals having lots of offspring per brood tend to leave more descendants behind because there's a decent probability that some of their many offspring will survive and reproduce (and so on for their descendants, etc.). Thus, after several generations, the average number of offspring per brood increases within the populations (that's simply evolution by natural selection).*

*However, this cannot simply increase forever, and the question about swimming performance gets at constraints to this increase in offspring number. And you're correct. There are several lines of evidence suggesting strong constraints, where the females breed early and often, while having many offspring, however selection against large abdominal regions during pregnancy via selection on locomotor performance has kept this shift from going to extremes. Therefore, there's an optimal number of offspring per brood because multiple selection pressures are acting in contrast.*

*Your argument about not wanting to have offspring because the babies are in danger doesn't work because that strategy would simply go extinct since it leaves no descendants. However, protecting offspring from danger has repeatedly evolved in all sorts of forms in different systems, including livebearing itself. And yes, predators can drive prey extinct, that seems like a very disconnected question from the rest of what's here. I'm not following this question, other than to say that while possible, there are many reasons that this actually seems to rarely occur (other than when humans are the predator).*