**Analysis of** *Thamnophis Melanogaster***Teeth Number and Head Width and the Relationship Between the Two Variables for Food Adaption**

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ABSTRACT

The following study analyzes data from the database website Dryad by the article, “Morphological convergence in a Mexican garter snake associated with the ingestion of a novel prey.” The data collected was utilized to tell morphological differences in similar species of semiaquatic snakes such as *Thamnophis melanogaster* to test their phenotypic differences regarding the type of food resources they prey on, either vulnerable non-molted animals or hard exoskeleton. From the data analysis, there was a positive correlation between the variable traits of *T. melanogaster*. However, there was an overlap in the data which contradicts the original hypothesis that suggests a lesser occurrence of morphological difference between the two types of *T. melanogaster*. This overlap suggests a lesser occurrence of morphological difference between the two species of *Thamnophis melanogaster*.

INTRODUCTION

In the evolution of biology, scientists can better understand phenotype changes and how species converge by looking at the morphology of the species. Many factors can affect the change in the morphology of species when it comes to predation such as divergence, geographic change, and microevolutionary change among natural populations (Manjerrz, 2017), (Bronikowski, 2000). *Thamnophis melanogaster* (Mexican black belly garter snake) is a species of snake in the family Colubridae that is sympatric (splitting of an ancestral species without geographical isolation) with freshwater crustaceans from Mexico (Manirrez, 2017). *Thamnophis melanogaster* originally was a species of snake that preferred soft-molted crayfish due to their vulnerability (Manjerrz, 2017), then presented a food resource niche within their evolution that caused some of these snakes to eat hard exoskeleton crayfish. Snakes are a good resource to study because their development depends on feeding, therefore, their morphology would adapt to their prey preference (Dwyer, 1997). Since *Thamnophis melanogaster* is semiaquatic, they prey on soft aquatic animals like leeches, tadpoles, fish, and especially the preference of soft-shelled crayfish (Drummond, 1983). According to the study by Manjerrz et. al 2017, the convergence of many snake species that consume soft crayfish/non-molted caused the demand for these water crustaceans to increase, therefore, forcing the *Thamnophis melanogaster* to morphologically change. Also in the study, the authors touched on how the percentage of garter snakes that consumed molted crayfish was small compared to the non-molted, but it was a start of understanding the niche that caused the change in morphology for the species to consume such hard animals. Head morphology (size of the head) and dentition (arrangement of teeth/number of teeth) can be a large morphological change in a species to help them consume and adapt to certain prey, especially in garter snakes because they can easily adapt and inherit stable feeding preferences that correlate with food availability and diet (Drummond, 1983). Due to the information introduced, a hypothesis can be drawn that between *Thamnophis melanogaster* that eats molted crayfish and does not eat molted crayfish, the snakes that eat the molted crayfish will have larger head width (mm) will also show increased dentition helping the ones that eat molted crayfish better adapt to their food resource of an exoskeleton.

MATERIALS AND METHODS

*Data Collection*

Database from Dryad was used in the publication of the article “Morphological convergence in a Mexican garter snake associated with the ingestion of a novel prey” published by Manjarrez et al., Constantino Macías Garcia, and Hugh Drummond in 2017 ([doi.org/10.5061/dryad.mg152](https://doi.org/10.5061/dryad.mg152)). The authors measured wild species of 80 hard-shelled crayfish-eating *Thamnophis melanogaster* from 10 populations and 88 non-hard-shelled crayfish-eating from 29 populations. For each of the species, they took measures of jaw length, head length, head width, and dentition. For this study, the measurement of head width (widest part measured while applying pressure on the posterior portion of the head to spread the quadrates and mandibles laterally) and dentition (number of maxillary teeth) was measured.

*Data Analysis*

Data was downloaded into R Studio (2021.09.1 Build 372) and used to create a plot consisting of 200 total species of *T. melanogaster* (103 soft-shelled eating and 97 hard-shelled eating crayfish) correlating head width(mm) and dentition against one another. The x-axis was labeled and showed “Teeth number”, and the y-axis was labeled and showed the “Head width(mm).”

RESULTS

The X-Y scatter plot showed an overlap in head width(mm) and teeth number between the species variants with a moderate positive linear regression line. The overlap of the two variables and traits was strong between 30-35 teeth dentition numbers and a head width between 5-13 mm.

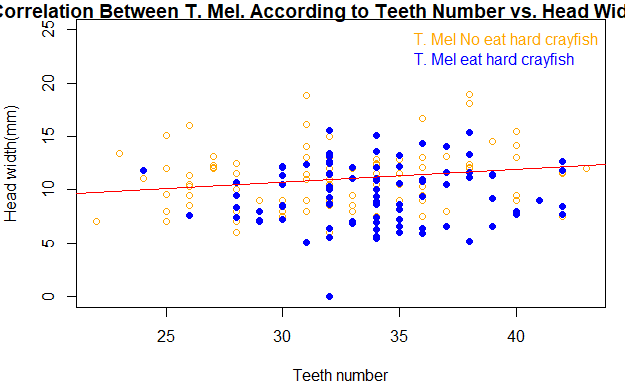


Figure 1. Positive correlation of teeth number and head width(mm) for 200 T. Mel. Orange dots represent the non-crayfish (non-molted) garter snakes. Blue dots represent the molted crayfish eating garter snakes.

*Pearson’s Correlation*

There was a weaker positive correlation between the two variables and two species, with correlation coefficient r= 0.1045431 and p-value= 0.1556. Pearson’s correlation through R Studio was run to show the statistical analysis between the two traits; the correlation test had a 95% confidence interval and a correlation coefficient of >0.10 was considered to show a significant correlation between the variables.

DISCUSSION

From the data, there is a positive correlation between head width (mm) and teeth number and from the Pearson’s correlation test analysis from the molted and non-molted eating crayfish. The r coefficient showed that there is a weak positive correlation, and the lower p-value confirms that there is a correlation between the two variables. From *Fig. 1*, there was a strong overlap of the two variables with a moderate positive linear regression line which draws the conclusion that there is still similar head morphology in garter snakes that eat molted crayfish and do not eat molted crayfish. Therefore, this goes against the original hypothesis that larger width of the head will increase dentition when it comes to the hard-shelled eating *T. melanogaster*. Although in *Fig. 1*, there are a few outliers for *T. melanogaster* that do not eat molted crayfish with <28 teeth and head width >18 mm. This could be from the fact that *T. melanogaster* lives in the same geographical location in Mexico, therefore, the locality is limited which can impact the phenotype characteristics causing a sort of selection bias. Resources for non-molted crayfish could be decreasing due to competition causing the *T. melanogaster* to inherit such expected morphological changes that allow them to adapt to their other food resource of hard-shelled crayfish. Although according to the data, there is not a large morphological difference between how they are structured to help themselves better consume prey in this species of snake. Since the food niche studied is fairly new (Manjerrz, 2017) between the species of *T. melanogaster*, this leaves more time for research and questions to be expanded upon. It raises questions about how much the morphology would change in the species such as the size of their heads or the number of their teeth; if they were distributed in a completely different geographical location where there are more hard-shelled crustaceans and fewer soft animals to prey on.

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