Meta-Analysis: How Temperature and Inbreeding Levels Affect Fitness in Offspring

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Abstract

As global warming becomes an increasingly pertinent threat, its warming of oceans may have extreme effects on the organisms that live there. One specific area that requires more research is how these increased temperatures may affect inbreeding, and in turn, the fitness of inbred offspring. My research aimed to explore this correlation as it exists in the literature today. In my research, I analyzed 48 papers that manipulated temperature and inbreeding levels to further investigate the correlation between environmental temperature and inbreeding depression. The literature analyzed presented findings that suggested that temperature leads to high levels of inbreeding among many different species. These high levels of inbreeding and temperature stress led to a decrease in fitness across species. However, there was a taxonomical gap noticed as a majority of studies were on *Drosophila melanogaster*. More research must be done to explore the effects of temperature along with inbreeding on the fitness of inbred offspring in marine environments.

Introduction

The warming of ocean waters is one of the most pertinent issues in marine ecology and conservation to date. Marine heatwaves, a consequence of ocean warming, are capable of reducing the size of vulnerable populations(Poloczanka et al., 2016). This reduction in size can predispose individuals to inbreeding. Through preliminary research on why this occurs, inbreeding has come into focus due to its effects on fitness. Inbreeding is when an individual produces offspring with a related individual. Inbreeding has been shown to decrease the fitness of offspring over multiple generations. This reduction in fitness is known as inbreeding depression. Further, studies suggest that environmental stressors can adversely affect the severity of inbreeding depression.

Even though marine heatwaves/ocean warming can predispose marine populations to inbreeding, and therefore, inbreeding depression, there appears to be a lack of research conducted on temperature and inbreeding depression in marine systems (Sharp & Agrawal., 2016). To address this hole in the literature, we are aiming to explore the relationship between temperature, inbreeding, and inbreeding depression in the marine invertebrate species *Bugula neritina*. My mentor aims look at the relationship between temperature and inbreeding levels in a specific marine invertebrate population, *Bugula neritina*. Specifically, we are looking into how different temperatures affect inbreeding depression in lab grown populations. We are hoping that this research will give us insight into how environmental temperatures affect inbreeding depression specifically in marine systems. The findings of our proposed experiment may have implications in marine conservation.

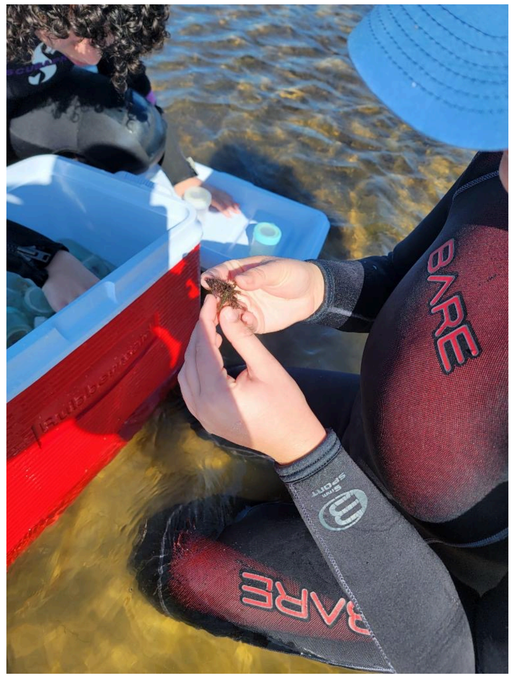
Before the experiment is conducted, we sought to gather some preliminary findings to better inform our experimental design. This comes in the form of a meta-analysis. A meta-analysis is a study which analyzes prior research in order to build proper conclusions which can be used in one's study. This meta-analysis was my main contribution to this research.

Methods

The methods for our study are quite simple. A meta-analysis is simply an exploration into prior research that relates to the research we are trying to complete. This means that we analyzed different scientific articles around our field of study. Before we could begin to analyze these papers, we first had to decide whether our not the paper would be included. To do this, my mentor compiled a list of sources. These sources were found on Web of Science suing the search terms "temperature" and inbreeding depression". This search yielded 237 sources. After excluding papers that did not include temperature and inbreeding depression, we were left with 48 papers. From there we split, the amount of sources between the two of us. In these sources we looked for studies that had two independent variables, temperature and inbreeding levels. In these studies, these must be manipulated into the look at how they would effect offspring fitness.

The papers had to contain experimental manipulations of both inbreeding depression and temperature to be included in the meta-analysis. A paper that manipulates inbreeding depression contained: an inbred group (may contain more than one level of inbreeding), an outbred group, and a measure of the fitness difference between the outbred and inbreed group. Keywords included: inbreeding depression, levels of inbreeding depression, fitness, fitness depression, fitness estimate. A paper that manipulated temperature contained more than one experimental temperature, with one control temperature. Keywords included: temperature, thermal stress, heat, heat shock, cold, and Celsius. Over 3 weeks through January and February, we compiled a list of sources that would be analyzed. These sources were put into an excel that contained the title, the species name, date, and journal.

The next step was an actual analysis. This period lasted 3 weeks for me. Over that period, I created annotated bibliographies for the papers that were selected. This allowed me to analyze each paper and relate how it helps the understanding of our research and findings. My mentor was completing an experiment at the time of this research, however I was not involved in that as much as the meta-analysis. I primarily utilized my MacBook computer and the FSU digital library in order to analyze and locate the sources.



Results

Due to the fact the research I completed was in the form of a meta-analysis, my results look different as compared to a regular study. However, there are still some extremely interesting findings one can draw from the research that is present. The major result that we found in the literature was that stressed conditions lead to an increase in inbreeding depression across species. There is also evidence to suggest this inbreeding could be lethal in certain instances A majority of this was done on fruit flies and different species of plants; however, there is evidence to suggest this happens across land and marine species. Because of the adverse relationship between temperature and inbreeding depression were consistent across various taxa, it is plausible that the correlation might be present in the marine invertebrate, *Bugula neritina*

Discussion

So what does this all mean? The ultimate goal of this meta-analysis was to have a complete understanding of what the literature says about our specific subject. This understanding is the foundation on which my mentor and I's research is built upon. However, this is not the only objective a meta-analysis strives to complete. A meta-analysis allows us to find the gaps that the literature has not filled.

So, as stated in the results section, there is evidence to suggest that inbreeding depression is affected by environmental conditions. This shows that the research my mentor intends is backed up by the literature. If environmental conditions affect inbreeding depression in *Drosophila*, then one could infer that temperatures might affect inbreeding depression at a high level. However, this is where the gap in the literature is involved. There is no literature exploring the direct effects of temperature on the inbreeding depression in our model organism, or marine systems in general This information could become extremely valuable as ocean temperatures change due to climate change.

However, there is also something that must be stated. In the research on the effects of the environment on inbreeding depression, there is an obvious taxonomical bias. Most of the research done on this subject focused on terrestrial species, specifically fruit flies and plants. The lack of solid research in this relationship in the marine systems could be room for concern.

References

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