Effects of Various Environmental Stimuli on Super Worms, *Zophobas morio*

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Abstract

With the gaining popularity of Super Worms as a food source for pets and people, the need for further study into these virtually unknown arthropods increases. For example, more research into their lifestyles and habitats helps understand them and comprehend the world and ecosystems we are responsible for. This study examines the preferential choices between spicy and sweet and whether they play on their habitat selection, which begs whether they are picky insects when it comes to their habitats. After their habitat was set up with each variable, the Super Worms were observed over time for their distinction. There were no unanimous votes from the specimens. The general conclusion was that there is not enough data to signify a deviation from the random chaos of possible directional choices.

Introduction

A recent study indicated that the Super Worm, *Zophobas morio,* might be relatively 'super' after all—that is, through their method of digestion. Researchers in waste management have observed the reactions of feeding and biodegrading low-density polyethylene and expanded polystyrene foams in Super Worms and had success dependent on their gut microbes (Peng et al. 2020). This inspiring discovery comes from an insect larva in the *Tenebrionidae* family—also known as darkling beetles—about which we know relatively little. What is known is that they usually live in the dirt or under tree bark, while others adapted to infiltrating our kitchens as pests (Gorham 1991). I have seen them in flour, oats, grains, and even yeast. Jacques (2020) posited that some even live off fungus. Whether it is food or living spaces, it cannot be overstated the importance of a specimen's habitat and what can be gained.

The *Zophobas* genus is comprised of hydrophobic, fossorial, and temperately fickle creatures. This means habitat choice is of the utmost importance. If they are allowed near water, they will drown, put them in sunlight they dehydrate, or let them get too hot or cold—again, death. In their Super Worm care guidelines, Schulte (1996) stated explicitly they never gave them water because the specimens drowned themselves. Instead, the researchers gave them fresh fruit to keep hydrated. Super Worms go through a four-step life cycle typical of most beetles: egg, larva, pupa, and adult. The small variation by this species is that they grow much larger than their relatives during their larval stage, making them more ideal for protein consumption. Friederich (1981) recalled that around 1977, *Z. morio* was first initiated to European zoos as an insect wonder named the *Giant Mealworm*, mostly food for other animals. *Z. morio* is also trending as a snack for people, being compared to the flavor of crunchy toasted bread.

My study examined the preference Super Worms might have between cayenne pepper and granulated sugar. Based on what has been presented so far and other information learned, I expect the Super Worms to have a voracious appetite but with a slow gait due to their size. I predict that *Z morio* will have a slight inclination and bias towards sugar.

Methods and Materials

The supplied habitat was a large plastic 9.4-liter Rubbermaid™ container (Walmart, Kearney, NE) rinsed and thoroughly dried out. For the substrate, a layer (two cups) of oats (Walmart, Kearney, NE) evenly lined the bottom as dry bedding. Equal measurements (14 grams) of granulated sugar and cayenne pepper (Walmart, Kearney, NE) were separately measured and situated into the habitat. Specifically with sugar on one side (a little more than one-third of the habitat) and cayenne on the opposing one-third, leaving the smaller middle area with no changes (Fig. 1). Ten *Z. morio* (Carolina Biological Supply in Burlington, NC) were selected and held momentarily in a shallow paper cup (Walmart, Kearney, NE) for transfer to said habitat. A timer was started as soon as the specimens were lightly dispersed to the middle of the habitat. They were allowed five minutes to habituate to their surroundings, at which point they were counted as being on in one of the two zones and ultimately returned to their original home. This operation was repeated two more times with a new set of *Z. morio* specimens for each test; nothing else was altered.

Figure 1. Habitat readied for experiment.

Results

In the first run, six Super Worms immediately went to the cayenne side, while four went towards the sugar side—all had burrowed underneath the oats in under twenty seconds. After four minutes had elapsed, the specimens made little to no movement, aside from one that traveled to the middle, making the final count at the end of five minutes: six cayenne and four sugar. When first inserted into the experiment, most of the Super Worms were highly agitated, but they were docile by the end of each run, with only two showing defensive aggression when removed for counting. The second run ended with six cayenne and four sugar. During this run, multiple *Z. morio* were observed, their heads and thoraxes completely covered in cayenne. The last run yielded four cayenne and six sugar. Aside from two outliers, the specimens were found in the furthest corners from the middle in each run. The total coverage resulted in 53% preferring cayenne to 46% sugar.

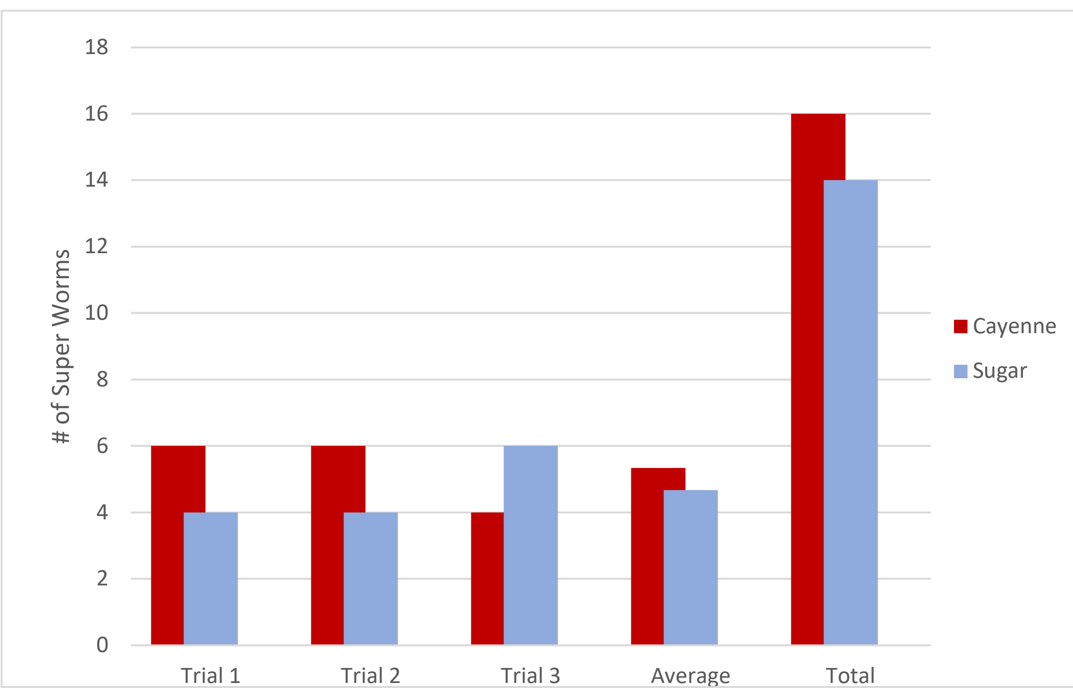

Figure 2. Area preference of Z. morio

Discussion

The few research papers studying *Z. morio* suggest how little is known about them; however, comparisons and suppositions can be made with reasonable judgment by looking beyond genus to the family *Tenebrionidae*. Tschinkel (1976) found that the larger larvae of Z. morio moved around significantly less than their smaller relatives of the family and genus during their experimentation. One observed trait during this experiment was the same effect. Once the Super Worms had found the edges of the habitat, they completely stopped moving. In consideration, the larvae of *Z. morio* are much larger than any of the other *Zophobas* species, and this increased mass is likely a large contributor to this expenditure of energy. One observed trend in our results was a vaguely implied preference to one variable over the other. However, there does not seem to be any major significance to this correlation, as further trials could arguably achieve these same results we got with new Super Worms. One possible explanation for this comes from diet research by Morales-Ramos (2011), where they discovered effective results by using specific ratios of carbohydrates and proteins. While our experiment was not attempting to test the insect's dietary habits specifically, it should be compelling to mention cayenne and sugar are not good sources of nutrients and therefore are unlikely to represent or introduce much bias for food by the Super Worms.

The larvae of closely related *Tenebrio molitor* are believed to sense food using their antennae's chemoreceptors (Morales-Ramos 2011). There is reason to suggest that this might be a trait throughout all of the *Tenebrionidae* larvae, meaning it is also possible for *Z. morio*. Furthermore, Bloom et al. (1982) explicate that other sensilla forms actively occur in the papillate, uniporous pegs, placoid, and trichoid sensilla from a third antenna. This could be a reason for our lack of real significance in their movements. Overall, it comes as no surprise from the accepted insect anatomy from books in the library and research in the lab. They stipulate that the trichoid sensilla—or trichodea—are the primary tools used by other insects for their sense of smell and taste (Morales-Ramos 2011, Wigglesworth 1972, Frazier 1985, Zacharuk and Shields 1991). Some other considerations include looking closer at the ingredients themselves. Cayenne does come from a pepper that the related adult red flour beetle—the *Tribolium casteneum Herbst*—is widely known to infest, among a long list of other food items (Metcalf and Flint 1951). It is plausible the larvae detected the pepper—even though we used it in powder form and not fresh—and traveled towards it, indicated by the slight preference over sugar. Even though sugar is essentially glucose or energy in its ready-to-ingest form, most *Tenebrionidae* likely have not evolved a taste for sugar, or possibly there is a chemical reaction missing, and their metabolism cannot convert the sugar. Whatever the case, there was no research found for non-adult beetles seeking out sweets or sugar as a food source, leading to that conclusion.

The prediction that the *Z. morio* would prefer sugar was based mainly on the potential energy found within the glucose compound and because most other insects seek out sugary foods. Weighing the data, observations, and facts in inventory leads me to think that the Super Worms possibly detected the cayenne, yielding to the slight bias. However, there is not enough data or variance to support my alternate hypothesis and thus reject it. This study has plenty of room for improvement. Statistically, larger sample sizes increase the accuracy of the results we get. Testing larger quantities of Super Worms with even more trials would give us a better idea and understanding of the lifestyles of *Z. morio.* Another thought would be in testing for more specific outcomes or traits.

It is essential to study these subjects for several reasons. The first is our responsibility as the dominant animal to learn and understand everything around us. Secondly, the more we know and understand, the better decisions we can make that support our planet; the next discovery made in science could lead to medical and other advances that save many lives. This study helped me remember to stay mentally sharp, not allow complacency to creep in on decisions, and that anything is possible, however improbable it might be.

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