

Science as a Process: Mealworm Behavior

I. Framing the Investigation:

Introduction: **Ethology** is the study of animal behavior. Behavior is an animal's response to sensory input, and falls into two basic categories: **learned** and **innate** (inherited).

Orientation behaviors place the animal in its most favorable environment. In **taxis**, the animal moves toward or away from a stimulus. Taxis is often exhibited when the stimulus is light, heat, moisture, sound, or chemicals. **Kinesis** is a movement that is random and does not result in orientation with respect to a stimulus. If an organism responds to bright light by moving away, that is a taxis. If an animal responds to bright light by random movements in all directions, that is kinesis.

Agonistic behavior is exhibited when animals respond to each other by aggressive or submissive response. Often the agonistic behavior is simply a display that makes the organism look big or threatening. It is sometimes studied in the laboratory with Bettas (Siamese Fighting Fish).

Mating behaviors may involve a complex series of activities that facilitate finding, courting, and mating with a member of the same species.

Background: The mealworm is a larval form of the darkling beetle (*Tenebrio molitor*), from the Kingdom: Animalia, Phylum: Arthropoda, and Class: Insecta. Two species of mealworms, the dark mealworm and the yellow mealworm occur in Michigan. The dark mealworm occurs throughout the U.S., while the yellow mealworm is absent from the southern states. Mealworm adults are robust, slightly flattened, 3/4 – 1" long beetles. The dark mealworm adult is a dull, black color, while the yellow mealworm adult is a shiny, polished dark brown or black. Mealworm larvae are shiny, smooth, hardened "worms." They have three pairs of segmented thoracic legs, and two short, horn-like appendages on the tip of the abdomen. Full grown larvae are 1 – 1 1/4" in length. Dark mealworms are dark brown; yellow mealworms are honey-yellow in color. Mealworms overwinter as partially grown larvae. The overwintered larvae complete their development in the spring, pupate, and emerge as adults during the summer (mid July to early August in Michigan). Adults live for 2 to 3 months. After mating the females deposit 275 to 500 eggs, either singly or in small batches. The eggs are deposited in areas where the larvae will find ample food. The eggs hatch in about two weeks. The larvae feed and grow over a period of 6 to 9 months (as long as 20 months in some cases), molting a total of 14 or 15 times. The complete life cycle, therefore, requires 6 months to 2 years for completion. One generation per year is normal. Mealworms are scavengers and are most commonly found in damp, spoiled grain and grain products. Adults and larvae hide in refuse, sacks, bins, grain and similar undisturbed situations. Adults and larvae are also found in cereal products, macaroni, meal, bran, meat scraps, feathers, and dead insects. Mealworms are popular as fish bait and as food for many types of small pets. They are easy to raise, and there is information available on this subject. Mealworms also show great potential as a source of protein for human nutrition.

Purpose: Note it is missing for this example, however, required for other labs.

Hypothesis: Note it is missing for this example, however, required for other labs.

II. Designing the Investigation:

Materials:

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|-------------------|----------------------|
| 1. Mealworms | 5. Plastic bad |
| 2. Choice Chamber | 6. Moist paper towel |
| 3. Hot Plate | 7. Tin Foil |
| 4. Tongs | 8. Timers |

Part I: Procedures- Observations

1. Place 10 mealworms and a small amount of bedding material in a small petri dish. They generally try to get out so cover the dish with a petri dish cover.
2. Observe the mealworms for 20 minutes. Make notes on their general appearance, movements about the dish, and interactions with each other. Notice if they seem to prefer one area over another, if they keep moving, settle down or move sporadically. Note any behaviors that involve two or more mealworms. **Do not interfere with the specimens in any way.**
3. Make a detailed sketch of a mealworm.

Part II: Procedures- Kinesis in Mealworms:

1. Prepare a choice chamber. The choice chamber consists of two large plastic petri dishes taped together with an opening cut in between. Several alternatives to this concept can be produced. Take 2 plastic petri dishes and cut out one 1/2 inch openings at the side. Place the petri dishes together, matching the cut ends. Now tape the petri dishes together by placing a strip of tape under each one. The dishes now can be used to test for the variables.
2. Teacher will assign one variable to be tested: Moisture, warm temperature, cool temperature, light, and set up the adjacent room accordingly.
3. Using variable assigned, develop a hypothesis, using the **If**, and, **then** concerning the mealworm's response to the factor.
4. Gently transfer ten mealworms from the stock culture into the center choice chamber. Cover all chambers being used.
5. Count how many mealworms are on each side of the choice chamber every minute for 20 minutes. Record your data in Table 1.1. Continue to record even if they all move to one side or stop moving.
6. Return your mealworms to the stock chamber.

7. Complete Table 1.2 of class data from each of the variable, the data from two groups with the same variable must be averaged before data is recorded into Table1.2:

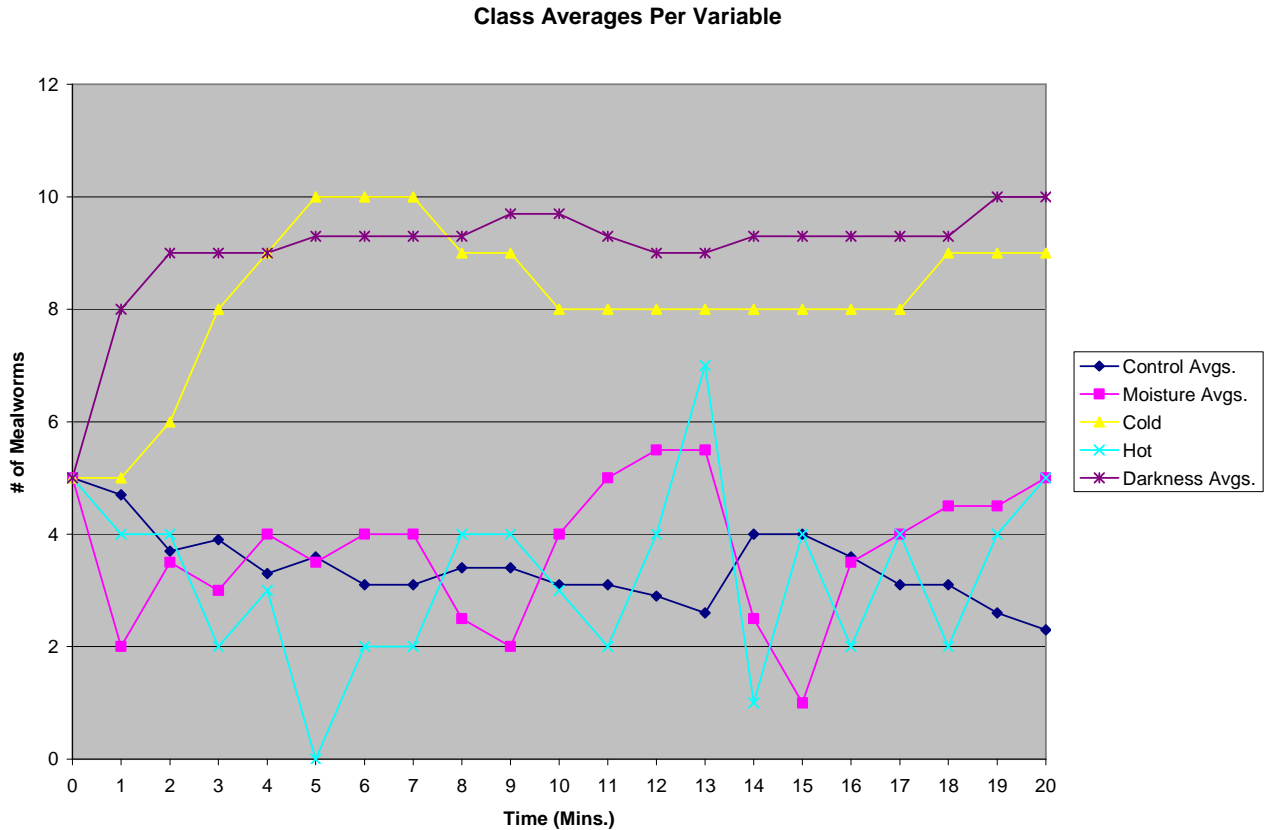
8. Graph both the number of mealworms in wet chamber, dry chamber using the graph below.

III. Collecting and Presenting Data:

Class Averages Table

Time (mins.)	Control Avg.	Moisture Avg.	Cold	Hot	Darkness Avg.
0	5	5	5	5	5
1	4.7	2	5	4	8
2	3.7	3.5	6	4	9
3	3.9	3	8	2	9
4	3.3	4	9	3	9
5	3.6	3.5	10	0	9.3
6	3.1	4	10	2	9.3
7	3.1	4	10	2	9.3
8	3.4	2.5	9	4	9.3
9	3.4	2	9	4	9.7
10	3.1	4	8	3	9.7
11	3.1	5	8	2	9.3
12	2.9	5.5	8	4	9
13	2.6	5.5	8	7	9
14	4	2.5	8	1	9.3
15	4	1	8	4	9.3
16	3.6	3.5	8	2	9.3
17	3.1	4	8	4	9.3
18	3.1	4.5	9	2	9.3
19	2.6	4.5	9	4	10
20	2.3	5	9	5	10

Table1.2: Class data showing mealworm activity, during exposure to all variables (avgs.)



Graph 1.1: Graph displays the averages of the class variables and the difference in amounts.

IV: Analyzing and Interpreting Results:

CONCLUSION:

Questions & Answers

- 1. State the variable your group tested. From each group list the variables which best suit the natural conditions of you mealworm’s habitat.**

Your Group’s Variable: Cold Water Temperature – Variable	List variables of mealworm habitat: Temperature, Moisture, Light, Darkness, Stimulus-stable internal environment, or not.
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- 2. What was the independent variable? What was the dependent variable?**
 The independent variable is the temperature. The dependent variable is the number of mealworms located on (cold or normal) each side.
- 3. Explain the importance of having only one independent variable. What are the implications to multiple variables?**
 If you have multiple variables it would be harder to analyze and break down the data/experiment while watching the experiment and variables, including the control(s) take place. In this situation, you would have to look for many different effects and

conclusions within the small time period and won't be able to fully understand what happens.

4. **Is the mealworm's response to your group's variable best classified as kinesis, or taxis? Explain your response.**

Our mealworm's response was mostly taxis because the organism is moving away from the stimulus or to the stimulus. The mealworms demonstrated guided movement to and from the cold temperature. Kinesis is movement, but doesn't describe the lab fully.

5. **What conclusions do you draw from the data? Explain physiological reasons for the behavior observed in this activity.**

I can conclude that the mealworms usually live in dark, warm places, like the dirt. From this lab, I could analyze the mealworms' behaviors and movements taking place. Once the mealworms realized the cold temperature was on one of the sides, many went into "migration" because their metabolism slows down. I thought this was very odd and didn't expect this at all. The variable was something "new" to the mealworms and attracted the mealworms towards the temperature and light and away from the dark areas because there was no light available.

6. **List and explain at least 3 factors that could have caused your results to be inaccurate or to vary.**

The direction the bag of ice was placed, where the bag was placed –top or bottom of chamber – and the amount of time for the experiment could have caused inaccurate or variable results. The overall temperature would vary as well.

- **Hypothesis:** If the temperature is lower on one side of the choice-chamber, then the mealworms will migrate to that side with the lower temperature.
- **Discussion:** My hypothesis statement was indeed true. After watching the mealworms up close, I concluded that the mealworms liked the colder side better and migrated in that location. By creating a table of the averages of the class variables and a line graph, I was able to compare what differences in the amount of mealworms existed. I compared the number of mealworms to the cold temperature and found that the mealworms seemed to be attracted to the new stimulus and were settling into the new environment. The significance of the results is that these compare and contrast the different amount of variables to the number of mealworms per variable change.
- **Experimental Error:** One factor that may vary is the location of the bag with the cold ice places underneath or on top of the chamber. Another is if a person interferes with the experiment and causes the data to change in a drastic way affecting the overall outcome. If the temperature is too hot or cold – which will cause the worms to freeze or dehydrate and die, error would be induced.
- **What's next?:** The experiment could continue is you could test the differences in light intensity and compare and analyze the new data. I would like to test different variables like darkness, warm temperature, etc. Can mealworms really survive in cold areas for long? How long can they survive? If experimental errors had occurred, then the results for my data would be different.