How do varying levels of CO2 affect the behavior of *Drosophila Melanogaster*?

Avery Davis - Friends Academy, 7th Grade
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Intro

For years, I've been very intrigued in studying and contributing to a solution to the greenhouse effect caused by CO2 and other greenhouse gasses that humanity continues to release into the Earth's atmosphere, and the effects it has on our planet such as Global warming. As you know, Climate change is a critical subject being debated by many around the world. Now that this generation and future ones to come are well aware of this problem and the threats it poses, we need to do something to stop it! I also wanted to know how Greenhouse Gas would affect humans, so I set up viable studies using fruit flies as model organisms. I decided to use *Drosophila Melanogaster* because, 1) many of their genes are very similar to mammals including humans, and 2) they reproduce very quickly, allowing data collection of numerous generations in one year. *Drosophila Melanogaster* is often used as a proxy for mammalian and human study due to these features. By pumping increasing increments of PURE CO2 into the fly's habitats, I observed and documented that the effects of the CO2 on the fly's activity levels were very powerful and that differing levels of CO2 exposure led to differing levels of effects on *Drosophila Melanogaster*. Could this mean that Greenhouse Gas would affect humans the same way?.....

Abstract

To introduce my topic, CO2 is actually widely known and used as an alternative for chemical anesthetic on adult *Drosophila Melanogaster*. It is mainly used to knock them out in a chemically safe way in order to weigh, inject, or observe the flies. My experiment tests the effects of different levels of CO2 on this model organism and their larvae. I observed their behavior, weight and any other drastic changes that might have occurred by the change in their atmospheric CO2 level over the course of a year. Since CO2 is a greenhouse gas and one of the biggest proponents of global warming and climate change, I decided to use this gas to observe

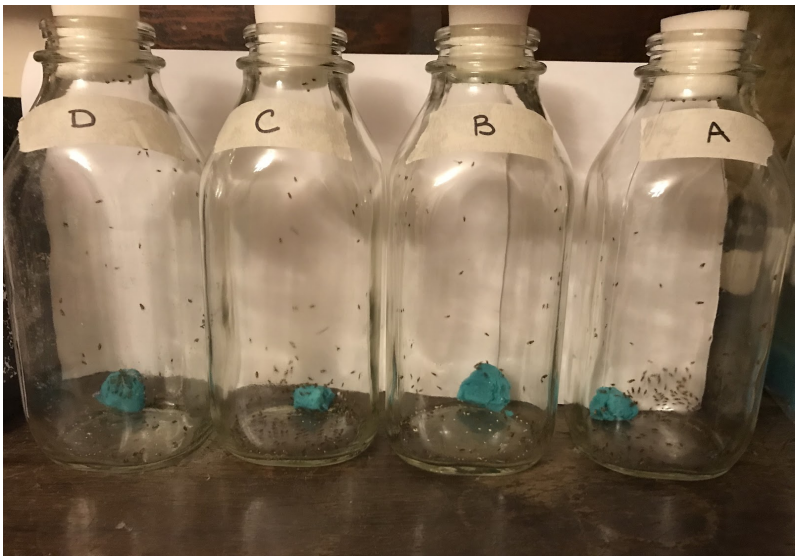
their reaction. I pumped the CO2 through a Soda Stream for increasing increments of 2-second holds, 3-second holds, 4-second holds and 5-second holds in different vials labeled A, B, C, and D. Note that when working with CO2 and *Drosophila Melanogaster*, one must be very careful because if they are exposed to too much of the gas, results could be fatal. During the course of my experiment, I compared the adult flies and their larvae. I chose to add larvae observation to compare with these flies because during my first trial of observing the movement of the adult flies, I noticed an interesting and notable change in larvae behavior.

When exposed to CO2, the larvae which were burrowed beneath the food were not affected, but the larvae which were climbing on the walls of the vials were immediately frozen. Why were the larvae having a "delayed reaction" to the CO2? After some research, I found that larvae breathe through breathing tubes called spiracles, which graze the surface of their environment (this is to protect them from any predators that might eat them if they came up for air).

My thought on why this reaction was happening was mainly based on the fact that CO2 is heavier than oxygen and travels downwards. The problem wasn't that the food was delaying the CO2 or the spiracles were delayed somehow as well, but rather the fact that the CO2 affected the flies first because it was traveling downwards and the flies were at the top. Over the course of the next couple of trials, I solely observed the larvae and my hypothesis proved to be true. A few seconds after the flies were knocked out, the larvae all started to turn around and climb up to the surface, in order to breathe oxygen.

How does atmospheric change affect the body mass of *Drosophila Melanogaster*?
For years, I've been very intrigued with the concepts of global warming and the greenhouse effect. a solution to greenhouse gas caused by pollution and the effects it has on our planet such as Global warming. As you know, Climate change is a hot topic being debated by many. Now that this generation and future ones to come, know about Global Warming and how it is caused we need to do something to stop it! With increasing CO2 in the atmosphere due to the greenhouse effect, it is very important for humans to understand, as well as they can, the consequences that this will have on our planet and ecosystems. I have formed an experiment testing on the model organism: *Drosophila Melanogaster* and expose them to varying CO2

levels. The reason to use this model organism is because, 1) many of their genes are very similar to mammals including humans, and 2) they reproduce very quickly, allowing data collection of numerous generations in one year and 3) even though they might be small, they are still a key part of our ecosystem and food chain and if something negative happens to them, humans will eventually be affected in one way or another. I exposed the larvae and adult *Drosophila Melanogaster* to pure CO2 through a soda stream and I saw that the effects on the fly's activity levels were very powerful. This then poses the larger question of how climate change will affect the human population.



Hypothesis

I hypothesize that altering levels of increasing CO2 will change the behavior of wild type Drosophila Melanogaster and their larvae.

Experimental Variables

Every experiment requires a carefully considered set of variables. Adjusting the variables and observing (and documenting) their relative effects on each other is what comprises the actual experiment.

Independent Variable: Increasing CO2 dosages

Dependent Variables:

(1) body mass of Drosophila Melanogaster and

(2) behavior of Drosophila Melanogaster

Controlled Variables:

Same number of Drosophila Melanogaster vials being tested

Same amount of food in each

Same wild-type strain of Drosophila Melanogaster in each

The same type of vials

Same scale for all trials

Same aquarium tubing

Same source of CO2

Same temperature exposure

Conclusion and Discussion

I was interested in observing the effects of atmospheric changes on *Drosophila Melanogaster*, specifically, increasing increments of Carbon dioxide. I created 3 trials to fully test my hypothesis; these trials mainly focused on the behavioral aspects.

I noticed a pattern with increased CO2. It took longer for the flies to wake with increased levels of CO2. Similar to the sleeping stage, I discovered a lethargic stage which is the amount of time it takes for the flies to fully recover from the affect the CO2 had on them.

I noticed that the number of days it took the flies to break this lethargic stage increased with higher levels of Carbon dioxide. As stated in my hypothesis, I thought that increased carbon dioxide would result in slower movement and increased days in the lethargic state.

My hypothesis proved to be true because, with the increased increments of CO2, the flies took longer to leave the lethargic state and the sleep state.

In detail, Vial A1 took 21 days to wake from the lethargic state and only took 1 minute and 40 seconds to wake from the sleep state, while Vial B1 took 33 days to wake from the lethargic state and exactly 3 minutes to wake from the sleep state. This proves my hypothesis to be true, but there is still much to discover.

While observing vial C1 I noticed that the flies were half in the lethargic state and half out. To explain, as soon as I tapped the vial once, it was a chaotic "whirlwind" of flies, it was as if I brought them back to life! After a couple of seconds, they resumed their half-dead, lethargic state. This observation shows that the lethargic state almost dissipated but is not completely gone. In the future, I would like to continue to observe the flies at this newly discovered state and also try to understand what it is in the fly's brain that causes this to happen.

Future Research and Improvement

In the near future, I hope to do germline engineering with the flies, which means; exposing the *Drosophila Melanogaster* eggs to these atmospheric changes and observing the effects that those changes have on the future generations of *Drosophila Melanogaster*. To further improve my study, I will look for a meter to measure the percentage of CO2 instead of using increments of time. I am also interested in analyzing what it is about CO2 that changes flying patterns or eating habits of the flies. To facilitate this study I will use a time-lapse camera to monitor the flies 24/7.

Thank you for reading my journey in developing this experiment and my conclusions. I hope that you have enjoyed and learned much from my experiment and presentation!

Sources

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